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Environmental Impact of Sugar Industry

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Abstract — Issue of economic and environment sustainability of the sugar industry has drawn attention of all stakeholders of sugar industry over the years. While for achieving the economic sustainability, there is growing concept of converting sugar factories to 'Agri-Business Complexes' for achieving environmental sustainability . There are growing concerns on environmental issues necessitating stringent control on the whole landscape of sugarcane cultivation and processing.

Keywords — Bio-diversity, environmental sustainability, ecosystem.

1.1 *Introduction*

The cultivation and processing of sugarcane to produce sugar creates environmental impacts through the loss of natural habitats, intensive use of water, heavy use of agrochemicals, discharge and runoff of polluted effluent and air pollution. This leads to the degradation of wildlife, soil, air, and water where sugar is produced and also of downstream ecosystems.

The adoption of Better Management Practices require support at various levels, which include changes in national and international policies, investment in appropriate irrigation infrastructure, and a stronger sustainability commitment from the sugar and allied industries. Sustainability does not necessarily mean reduced productivity or profits only, instead measures needed to reduce environmental impacts may often provide economic benefits for farmers and mills. This provides an opportunity to reconcile environmental and social needs with the long-term development of the sugar industry.

1.2 Impact on the Environment

Sugarcane cultivation and processing impacts on biodiversity and ecosystem services at the field, farm, and wider landscape levels.

Increase in Air Pollutants

Most of the sugar mills use bagasse as a fuel in boilers. The burning of bagasse in boilers produces particulate matter, oxides of nitrogen, carbon, sulfur and water vapor. Except for particulate matter, other emissions of bagasse fired boilers are within the limits prescribed by the pollution control authorities. The particulate matter usually referred to as fly ash, consists of ash, unburnt bagasse and carbon particles. Fly ash is very light and it contains a large percentage of fines. If air pollution control equipment is not adequately installed, fly ash escapes into the atmosphere through the chimney. The particulate matter coming out of the chimney may travel distances depending on particle size and atmospheric conditions. This may cause, reduce visibility in the areas surrounding the sugar mill. The heavier particles may settle on vegetation and damage them. There are reports of dizziness and physiological effects like irritation in the eye, nose, throat, and lungs, in the areas surrounding the sugar factories where desired air pollution control equipment have been installed.

As per the general emission standards, particulate matter is required to be within 250 mg/Nm^3. in case of horseshoe/pulsating grate and spreader stroker bagasse fired boilers, the particulate matter emission is required to be within 500 mg/Nm^3 (12 % Co_2) and 800 mg/Nm^3(12 % Co_2) respectively.

Economic and Environmental Aspects of Soil Erosion

In agronomic terms, the loss of soil by erosion is a major problem that can affect future yields and ultimately limit the sustainability of sugar cultivation by redistributing or removing soil organic matter and nutrient-rich material. Soil erosion also represents a substantial environmental threat from the washing of sediments, which are often polluted, into rivers, estuaries, and marine ecosystems.

1. Soil salinization

Salinization of soils is a problem that principally affects cane growers rather than beet growers and typically results from over-irrigation, inadequate drainage, and cultivation in a flood plain or where seawater intrusion occurs. The salinity of soils has been linked to serious cane yield declines.

2. Soil acidification

Increased soil acidity affects plant health and crop yield in some parts of the world. Acidification is also more prevalent in cane than beet growing areas, largely due to the use of inorganic nitrogenous fertilizers such as urea and ammonium sulfate. Under high rainfall conditions, nitrate leaching occurs, which also promotes acidification

3. Habitat Destruction for Cane Cultivation

The production of sugarcane is sometimes blamed to cause a greater loss of biodiversity on the planet than any other single crop. Fifteen countries around the world devote between 10 and 50 percent of their land area to cane cultivation and in seven countries sugarcane covers more than 50 percent of the land. Substantial areas of biodiversity-rich habitat have been cleared for cane cultivation, such as, a tropical rain forest and tropical seasonal forest. Land clearance not only results in the direct loss of species and habitats, but underlies a range of wider impacts on ecosystem function, including changes to hydrology and increased soil erosion.

Overuse of Water in Sugarcane Farming

Agriculture is by far the biggest user of water worldwide. Seventy percent of global freshwater withdrawals are for irrigation, rising to more than 90 percent in some arid countries. Major irrigation projects have often been promoted for development reasons, yet returns have frequently been insufficient to service the capital debt or cover running and maintenance costs. Planning has often not adequately addressed environmental or social needs, leading to impacts on downstream ecosystems and livelihoods of communities that rely on fisheries.

Sugar cane is an efficient converter of biomass from water, it still needs about 1,500-2,000 mm water per hectare per year and ranks among a group of crops noted for their significant water consumption (along with rice and cotton). It is a deep-rooted crop, which remains in the soil all year round and is able to extract soil water to depths well below one meter. In areas where sugar cane growth relies upon on rainfall, the crop can influence the river flows as it intercepts run-off from the catchment into rivers and taps into groundwater resources.

Due to poor management, in many areas of the world only an estimated 30-35 percent of the water withdrawn for farming reaches the crop and the rest is lost from irrigation channels by evaporation and through runoff from the field.

Since irrigation management is often very inefficient, high water withdrawal is generally coupled with the runoff of polluted irrigation water containing sediment, pesticides, and nutrients.

Both beet and (to a lesser extent) cane factories use significant amounts of water to wash off the considerable quantity of soil removed with the roots at harvest. However, use of fresh water during processing of sugarcane to produce sugar in factories is still high, being about 50-100 L/tonne of sugarcane in spite of the fact that sugarcane contains about 70 % water and even after meeting all processing needs about 10% water may be rendered surplus for other purposes.

Over-irrigation or inefficient irrigation systems that leave water standing in fields can enhance the incidence of water-borne parasitic infections such as Bilharzia (schistosomiasis).

Intensive use of chemicals

Intensive agricultural food production, in general, uses high levels of pesticides (herbicides, insecticides, fungicides, nematicides, rodenticides, plant regulators, defoliants or desiccants), with herbicides representing about 50 percent of pesticides used in many countries. A wide variety of pesticides are used in the cultivation of sugar crop. Inorganic fertilizers typically supply nitrogen, phosphorus and/or potassium in mineral form. Environmental impacts generally arise because of the nutrients in the fertilizers are not entirely taken up by the crop but move into the environment. The overuse of fertilizers on cane crop is typical of farming in general. Sugar-producing countries in the world, the sugarcane cane fields are burnt immediately before harvesting for easier cutting, post-harvest cultivation, and pest control. Scarcity of the farm labour and ease of harvesting are the two main reasons for harvesting sugarcane by burning. In India also such practice is followed on a greater scale in the state of Gujarat.

Impact of Pre-harvest Cane Burning on the Environment

Burning of sugarcane trash and leaves etc. generates a huge amount of air pollutants such as aerosols, fine (PM2.5) and coarse (PM10) particulate matter, gases such as carbon monoxide (CO) and carbon dioxide (CO_2), aldehydes (acrolein, formaldehyde), methane (CH_4), nitrogen oxides (NO), nitrous oxide (N_2O), and other gases. Such practice is still in vogue in some of the sugarcane producing states, particularly Gujarat.

There is evidence that sustained pre-harvest burning of sugar cane can contribute to a decrease in soil quality, by causing a decline in soil microbial activity and the physical and chemical properties of the soil.

Cane burning can reduce the quality of sugar recovered from the cane as well as reduce the quantity of cane retrieved by as much as by around five percent. Sugarcane harvested in this manner also deteriorates faster and thus requires minimum cut to crush delay.

1.3 Practices to reduce these environmental impacts

Efficient Irrigation System

The effectiveness of irrigation strategies can be assessed by an analysis of Water Use Efficiency (WUE) the ratio of crop yield to water consumed by the crop. Drip irrigation systems, which deliver water to the crop plant (surface drip) or root zone (sub-surface drip), are generally the most water-efficient, and followed by center-pivot systems, other sprinkler systems, furrow irrigation, and finally flood irrigation.

The key to improving water productivity is to match the irrigation system to the soil type, climate, farm management and affordability.

Larger-scale farmers are able to implement advanced commercial drip, sprinkler, or center-pivot systems while small-scale farms, and even some large estates, mainly use inefficient flood irrigation. Low-cost drip systems are available for small-holders provided that micro-credit is available for the purchase of the equipment and sufficient ongoing technical support are provided. Furrow irrigation only requires a ridge to cut the furrows and with alternate furrow irrigation

- Improved irrigation techniques can also be combined with trash mulching for further water savings.
- Increases in water use efficiency of 43-66 percent have been achieved in Tamil Nadu, India, by using alternate furrow irrigation in cane fields, with greater increases, attained in combination with trash mulching.
- Studies indicate that the use of a cane trash mulch enhanced water savings gained with drip irrigation by a further 16 percent.
- Tensiometers are the most responsive water potential sensor but require care and maintenance.

Drip Irrigation

Drip fertigation is the application of fertilizer through the drip system, delivering nutrients only to the plant base (surface drip) or root zone (sub-surface drip). Drip fertigation is of particular interest from an environmental perspective as it combines the increased water use efficiency of a drip irrigation system with the potential to manage fertilizer applications more effectively and thereby reduce fertilizer use. In addition, the application of soil pesticides can be reduced by 30 percent when applied directly to the root zone. By using drip irrigation, a farmer can use the least toxic pesticide at or below recommended dosages.

Many sugar factories in their studies they have consequently published recommendations on fertilizer use and incorporate these in the guidance provided to their farmers. Approaches for reducing fertilizer use in cane cultivation systems include a more site-specific assessment of fertilizer requirements, cultivation of leguminous green manure crops during fallow periods or in rotation, the use of bio-fertilizers (combinations of nitrogen-fixing micro-organisms and organic amendments), green cane harvesting and press mud, a sugar cane mill by-product which is particularly effective for reducing phosphorus deficiency in cane.

“Crop logging Method” used to monitor plant weight and leaf nutrient content can be used in sugar cane cultivation to assess the foliar nutrient levels and adjust the fertilizer rate or other elements only if needed. However, following can be taken up easily and may be implemented.

- Press mud bio-fertilizer: a phosphorous rich byproduct from sugarcane mills that can help overcome phosphorus deficiencies
- The use of bio-fertilizer in place of chemical fertilizers could reduce inorganic fertilizer requirements by 20-25 percent and reduce the risk of nitrate leaching.
- Trash blanket: Where green cane harvesting is practiced, using trash the blanket will improve water penetration. Trash slows the flow of water down the drill and allows more time for the water to infiltrate into the soil. Soil health management and prevention of soil erosion

Sugarcane is one such crop that produces 7-12 t ha-1 of trash, which is a rich source of organic carbon and plant nutrients. The ISTM (Integrated Sugarcane Trash Management) may increase the organic carbon content, available nitrogen, phosphorus and potassium in the soil.

Sustainable systems of cane cultivation that maintain or improve soil quality are required not only to mitigate environmental and social impacts but to ensure the future of the sugar industry. A wide range of measures have been proposed and investigated for the reduction of soil erosion and improvement in soil quality in sugar cane cultivation systems. These measures include trash mulching in cane cultivation, maintenance of crop rotation, terracing, contour and strip planting of the cane on slopes, maintenance of 'live barriers' (hedgerows, riparian zones), and modified (reduced or minimum) tillage.

Trash management technology may increase soil moisture and the number of earthworms, and reduced weed incidence. Farmers also observed that buds germinated 15 days earlier in ISTM (Integrated Sugarcane Trash Management) practice and that ISTM increased cane yield and did not hinder ratoon practices.

Increasing soil fertility

Retention of a cane trash blanket can result in up to 10-20 t/ha of organic matter from the cane leaves that are left on the soil surface after harvest. This has been shown to increase microbial biomass, carbon (C) and basal respiration in the surface soil and also to enhance the size of the earthworm community. In the long term, trash blanketing can be expected to raise soil organic matter content by around 40 percent after 60-70 years.

1.4 Conclusion

Sugarcane is a highly efficient, photo synthetically active long duration crop that produces a huge amount of biomass and requires a large quantity of water. Integrated nutrient management and integrated pest management practices should be used while pre harvesting cane burning practices should be discouraged. The adoption of the drip irrigation system in sugarcane is technically feasible and economically viable which needs to be vigorously followed.

1.5 References

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