UNIT V

EMERGING ISSUES

Global environmental governance – alternate culture systems – Mega farms and vertical farms – Virtual water trade and its impacts on local environment – Agricultural environment policies and its impacts – Sustainable agriculture.

SUSTAINABLE AGRICULTURE

Sustainable agriculture is farming in sustainable ways (meeting society's food and textile needs in the present without compromising the ability of future generations to meet their own needs) based on an understanding of ecosystem services, the study of relationships between organisms and their environment.

It is a long-term methodological structure that incorporates profit, environmental stewardship, fairness, health, business and familial aspects on a farm setting.

It is defined by 3 integral aspects which are: economic profit, environmental stewardship and social responsibility.

Sustainability focuses on the business process and practice of a farm in general, rather than a specific agricultural product.

The integrated economic, environmental, and social principles are incorporated into a "triple bottom line" (TBL); when the general impacts of the farm are assessed.

Unlike a traditional approach where the profit-margin is the single major factor; Agriculture sustainability is also involved with the social and environmental factors.

There are several key principles associated with sustainability in agriculture:

The incorporation of biological and ecological processes into agricultural and food production practices. For example, these processes could include nutrient cycling, soil regeneration, and nitrogen fixation.

Using decreased amounts of non-renewable and unsustainable inputs, particularly the ones that are environmentally harmful.

Using the expertise of farmers to both productively work the land as well as to promote the self-reliance and self-sufficiency of farmers.

Solving agricultural and natural resource problems through the cooperation and collaboration of people with different skills. The problems tackled include pest management and irrigation.

Farming and natural resources

Sustainable agriculture can be understood as an ecosystem approach to agriculture. Practices that can cause long-term damage to soil include excessive tilling of the soil (leading to erosion) and irrigation without adequate drainage (leading to salinization). Long-term experiments have provided some of the best data on how various practices affect soil properties essential to sustainability.

The most important factors for an individual site are climate, soil, nutrients, and water. Of the four, water and soil quality and quantity are most amenable to human intervention through time and labor. When farmers grow and harvest crops, they remove some nutrients from the soil. Without replenishment, land suffers from nutrient depletion and becomes either unusable or suffers from reduced yields.

Sustainable agriculture depends on replenishing the soil while minimizing the use or need of non-renewable resources, such as natural gas (used in converting atmospheric nitrogen into synthetic fertilizer), or mineral ores (e.g., phosphate). Possible sources of nitrogen that would, in principle, be available indefinitely, include:

Recycling crop waste and livestock or treated human manure

Growing legume crops and forages such as peanuts or alfalfa that form symbioses with nitrogen-fixing bacteria called rhizobia

Industrial production of nitrogen by the Haber process uses hydrogen, which is currently derived from natural gas (but this hydrogen could instead be made by electrolysis of water using renewable electricity, or

Genetically engineering (non-legume) crops to form nitrogen-fixing symbioses or fix nitrogen without microbial symbionts.

Water

In some areas sufficient rainfall is available for crop growth, but many other areas require irrigation. For irrigation systems to be sustainable, they require proper management (to avoid salinization) and must not use more water from their source than is naturally replenishable. Otherwise, the water source effectively becomes a non-renewable resource. Improvements in water well drilling technology and submersible pumps, combined with the development of drip irrigation and low-pressure pivots, have made it possible to regularly achieve high crop yields in areas where reliance on rainfall alone had previously made successful agriculture unpredictable.

However, this progress has come at a price.

Several steps must be taken to develop drought-resistant farming systems even in "normal" years with average rainfall. These measures include both policy and management actions:

Improving water conservation and storage measures,

Providing incentives for selection of drought-tolerant crop species,

Using reduced-volume irrigation systems,

Managing crops to reduce water loss, and

Not planting crops at all.

Indicators for sustainable water resource development are:

Internal renewable water resources. This is the average annual flow of rivers and groundwater generated from endogenous precipitation, after ensuring that there is no double counting. It represents the maximum amount of water resource produced within the boundaries of a country.

Global renewable water resources. This is the sum of internal renewable water resources and incoming flow originating outside the country. Unlike internal resources, this value can vary with time if upstream development reduces water availability at the border.

Dependency ratio: This is the proportion of the global renewable water resources originating outside the country, expressed in percentage. It is an expression of the level to which the water resources of a country depend on neighbouring countries.

Water withdrawal: In view of the limitations described above, only gross water withdrawal can be computed systematically on a country basis as a measure of water use. Absolute or per-person value of yearly water withdrawal gives a measure of the importance of water in the country's economy. When expressed in percentage of water resources, it shows the degree of pressure on water resources.

Soil

Soil erosion is fast becoming one of the world's severe problems. It is estimated that "more than a thousand million tonnes of southern Africa's soil are eroded every year. Experts predict that crop yields will be halved within thirty to fifty years if erosion continues at present rates.". Soil erosion is occurring worldwide. The phenomenon is being called *peak soil* as improper soil management techniques in some areas of the world are jeopardizing humanity's ability to grow food in the present and in the future. Without efforts to improve soil management practices, the availability of arable soil will become increasingly problematic. Intensive agriculture reduces the carbon level in soil, impairing soil structure, crop growth and ecosystem functioning, and accelerating climate change. Soil management techniques include no-till farming, keyline design, windbreaks to reduce wind erosion, incorporating carbon-containing organic matter back into fields, reducing chemical fertilizers, and protecting soil from water run-off.

Phosphate

Phosphate is a primary component in chemical fertilizer. It is the second most important nutrient for plant after nitrogen, and is often a limiting factor. It is important for sustainable agriculture as it can improve soil fertility and crop yields. Phosphorus is involved in all major metabolic processes including photosynthesis, energy transfer, signal transduction, macromolecular biosynthesis, and respiration. It is needed for root ramification and strength and seed formation, and can increase disease resistance.

Phosphorus is found in the soil in both inorganic and organic forms and makes up approximately 0.05% of soil biomass. However, only 0.1% of that phosphorus present can be absorbed by plants.

Land

As the global population increases and demand for food increases, there is pressure on land resources. In land use planning and management, considering the impacts of land use changes on factors such as soil erosion can support long-term agricultural sustainability.

Looking back over the 20th century shows that for people in poverty, following environmentally sound land practices has not always been a viable option due to many complex and challenging life circumstances.

Currently, increased land degradation in developing countries may be connected with rural poverty among smallholder farmers when forced into unsustainable agricultural practices out of necessity.

Land is a finite resource on Earth. And although expansion of agricultural land can decrease biodiversity and contribute to deforestation, the picture is complex.

Energy

Energy is used all the way down the food chain from farm to fork. In industrial agriculture, energy is used in on-farm mechanisation, food processing, storage, and transportation processes. It has therefore been found that energy prices are closely linked to food prices. Oil is also used as an input in agricultural chemicals. The International Energy Agency projects higher prices of non-renewable energy resources as a result of fossil fuel resources being depleted. It may therefore decrease global food security unless action is taken to 'decouple' fossil fuel energy from food production, with a move towards 'energy-smart' agricultural systems including renewable energy. The use of solar powered irrigation in Pakistan has come to be recognized as a leading example of energy use in creating a closed system for water irrigation in agricultural activity.

Economics

Socioeconomic aspects of sustainability are also partly understood. Given the finite supply of natural resources at any specific cost and location, agriculture that is inefficient or damaging to needed resources may eventually exhaust the available resources or the ability to afford and acquire them. It may also generate negative externality, such as pollution as well as financial and production costs. There are several studies incorporating these negative externalities in an economic analysis concerning ecosystem services, biodiversity, land degradation and sustainable land management. the Economics of Land Degradation Initiative which seeks to establish an economic cost benefit analysis on the practice of sustainable land management and sustainable agriculture.

The way that crops are sold must be accounted for in the sustainability equation. Food sold locally does not require additional energy for transportation (including consumers). Food sold at a remote location, whether at a farmers' market or the supermarket, incurs a different set of energy cost for materials, labour, and transport.

Pursuing sustainable agriculture results in many localized benefits. Having the opportunities to sell products directly to consumers, rather than at wholesale or commodity prices, allows farmers to bring in optimal profit.

Triple bottom line frameworks (including social and environmental aspects alongside the financial) show that a sustainable company can be technologically and economically feasible. For this to happen, growth in material consumption and population need to be slowed down and there has to be a drastic increase in the efficiency of material and energy use. To make that transition, long- and short-term goals will need to be balanced enhancing equity and quality of life.

Methods

Two of the many possible practices of sustainable agriculture are

Crop rotation

Soil amendment

both designed to ensure that crops being cultivated can obtain the necessary nutrients for healthy growth. Soil amendments would include using locally available compost from community recycling centers. These community recycling centers help produce the compost needed by the local organic farms.

Using community recycling from yard and kitchen waste utilizes a local area's commonly available resources. These resources in the past were thrown away into large waste disposal sites, are now used to produce low cost organic compost for organic farming. Other practices includes growing a diverse number of perennial crops in a single field, each of which would grow in separate season so as not to compete with each other for natural resources. This system would result in increased resistance to diseases and decreased effects of erosion and loss of nutrients in soil. Nitrogen fixation from legumes, for example, used in conjunction with plants that rely on nitrate from soil for growth, helps to allow the land to be reused annually. Legumes will grow for a season and replenish the soil with ammonium and nitrate, and the next season other plants can be seeded and grown in the field in preparation for harvest.

Monoculture, a method of growing only one crop at a time in a given field, is a very widespread practice, but there are questions about its sustainability, especially if the same crop is grown every year. Today it is realized to get around this problem local cities and farms can work together to produce the needed compost for the farmers around them. This combined with growing a mixture of crops (polyculture) sometimes reduces disease or pest problems but polyculture has rarely, if ever, been compared to the more widespread practice of growing different crops in successive years (crop rotation) with the same overall crop diversity. Such methods may also support sustainable weed management in that the development of herbicide-resistant weeds is reduced.

Replacing a natural ecosystem with a few specifically chosen plant varieties reduces the genetic diversity found in wildlife and makes the organisms susceptible to widespread disease.

In practice, there is no single approach to sustainable agriculture, as the precise goals and methods must be adapted to each individual case. There may be some techniques of farming that are inherently in conflict with the concept of sustainability, but there is widespread misunderstanding on effects of some practices. Today the growth of local farmers' markets offer small farms the ability to sell the products that they have grown back to the cities that they got the recycled compost from. There are also many ways to practice sustainable animal husbandry. Some of the key tools to grazing management include fencing off the grazing area into smaller areas called paddocks, lowering stock density, and moving the stock between paddocks frequently.[42]

Sustainable intensification

The increased production of nourishment while simultaneously contributing a positive effect on natural and social investment; is a prospect of sustainable agriculture. Sustainable Intensification encompasses specific agriculture methodologies that increase production and at the same time help in improving environmental outcomes. The desired outcomes of the farm are achieved without the need for more land cultivation or destruction of natural habitat; the system performance is upgraded with no net environmental cost. Sustainable Intensification has become a priority for the United Nations as of late; the goal is to create an interrelation between agriculture and landscape. Sustainable intensification differs from prior intensification methodologies by placing specific importance on broader environmental and social outcomes. In light of concerns about food security, human population growth and dwindling land suitable for agriculture, sustainable intensive farming practises are needed to maintain high crop yields, while maintaining soil health and ecosystem services. The capacity for ecosystem services to be strong enough to allow a reduction in use of synthetic, non renewable inputs whilst maintaining or even boosting yields has been the subject of much debate. Recent work in the globally important irrigated rice production system of east Asia has suggested that - in relation to pest management at least - promoting the ecosystem service of biological control using nectar plants can reduce the need for insecticides by 70% whilst delivering a 5% yield advantage compared with standard practice.

Soil treatment

Soil steaming can be used as an ecological alternative to chemicals for soil sterilization. Different methods are available to induce steam into the soil in order to kill pests and increase soil health.

Solarizing is based on the same principle, used to increase the temperature of the soil to kill pathogens and pests.

Certain crops act as natural biofumigants, releasing pest suppressing compounds. Mustard, radishes, and other plants in the brassica family are best known for this effect. There exist varieties of mustard shown to be almost as effective as synthetic fumigants at a similar or lesser cost.

Off-farm impacts

A farm that is able to "produce perpetually", yet has negative effects on environmental quality elsewhere is not sustainable agriculture. An example of a case in which a global view may be warranted is over-application of synthetic fertilizer or animal manures, which can improve productivity of a farm but can pollute nearby rivers and coastal waters (eutrophication). The other extreme can also be undesirable, as the problem of low crop yields due to exhaustion of nutrients in the soil has been related to rainforest destruction, as in the case of slash and burn farming for livestock feed.

Sustainability affects overall production, which must increase to meet the increasing food and fiber requirements as the world's human population expands to a projected 9.8 billion people in 2050.

Side effects and the externalities

There is not a lot of data on the environmental and health costs that are caused by agriculture influence on other segments; the misuse of natural resources is one such example. These undesirable outcomes are labeled as externalities. Their costs are not part of market prices because they are non-market issues. Negative externalities occur because of market failures, where a contaminator is penalized for the damaged caused to the environment; these costs that are never paid are external costs. In the agriculture sector, these externalities have four aspects: the cost of them is ignored by the unlawful party; they happen within long intervals; susceptible populations with little to no political or decision altering power are negatively affected; the source of the external factor is not always deduced. modern agriculture has contributed to increased environmental and health issues; documented cases of these issues are nations such as,. An agricultural procedure may be sustainable if the externalities are low; however, this definition does not encompass all the values in the procedure and the potential effect that those values may have on the available resources.

Anthropogenic changes

As the Earth is entering the Anthropocene, an epoch characterized by human impacts such as climate change, agriculture and agricultural development are at risk. Agriculture has an enormous environmental footprint, and is simultaneously leading to huge amounts of environmental changes globally and being hugely impacted by these global changes.

Here are the seven principles for sustainable agriculture listed in Greenpeace's report:

Supply chain.

Food sovereignty.

Food production and consumption.

Biodiversity.

Soil fertility.

Ecological pest management.

Strengthen agriculture.