Manures

"Animal waste" redirects here. For other types of animal waste, see Urine.

This article is about organic material used as soil fertilizer. For animal dung used for other purposes, see feces.

Animal manure is often a mixture of animal feces and bedding straw, as in this example from a stable

Manure is organic matter used as organic fertilizer in agriculture. Manures contribute to the fertility of the soil by adding organic matter and nutrients, such as nitrogen, that are trapped by bacteria in the soil. Higher organisms then feed on the fungi and bacteria in a chain of life that comprises the soil food web. It is also a product obtained after decomposition of organic matter like cow-dung which replenishes the soil with essential elements and add humus to the soil.

In the past, the term "manure" included inorganic fertilizers, but this usage is now very rare.

Animal manures

Cement reservoirs, one new, and one containing cow manure mixed with water. This is common in rural Hainan Province, China.

Most animal manure is feces. Common forms of animal manure include farmyard manure (FYM) or farm slurry (liquid manure). FYM also contains plant material (often straw), which has been used as bedding for animals and has absorbed the feces and urine. Agricultural manure in liquid form, known as slurry, is produced by more intensive livestock rearing systems where concrete or slats are used, instead of straw bedding. Manure from different animals has different qualities and requires different application rates when used as fertilizer. For example horses, cattle, pigs, sheep, chickens, turkeys, rabbits, humans (sewage), and guano from seabirds and bats all have different properties. For instance, sheep manure is high in nitrogen and potash, while pig manure is relatively low in both. Horses mainly eat grass and a few weeds so horse manure can contain grass and weed seeds, as horses do not digest seeds the way that cattle do. Chicken litter, coming from a bird, is very concentrated in nitrogen and phosphate and is prized for both properties.

Animal manures may be adulterated or contaminated with other animal products, such as wool (shoddy and other hair), feathers, blood, and bone. Livestock feed can be mixed with the manure due to spillage. For example, chickens are often fed meat and bone meal, an animal product, which can end up becoming mixed with chicken litter.

Compost containing turkey manure and wood chips from bedding material is dried and then applied to pastures for fertilizer.

Compost

Compost is the decomposed remnants of organic materials. It is usually of plant origin, but often includes some animal dung or bedding.

Plant manures

Green manures are crops grown for the express purpose of plowing them in, thus increasing fertility through the incorporation of nutrients and organic matter into the soil. Leguminous plants such as clover are often used for this, as they fix nitrogen using Rhizobia bacteria in specialized nodes in the root structure.

Other types of plant matter used as manure include the contents of the rumens of slaughtered ruminants, spent hops (left over from brewing beer) and seaweed.

Uses of manure

Manure on a wall

Animal dung has been used for centuries as a fertilizer for farming, as it improves the soil structure (aggregation), so that it holds more nutrients and water, and becomes more fertile. Animal manure also encourages soil microbial activity, which promotes the soil's trace mineral supply, improving plant nutrition. It also contains some nitrogen and other nutrients that assist the growth of plants.

Manures with a particularly unpleasant odor (such as human sewage or slurry from intensive pig farming) are usually knifed (injected) directly into the soil to reduce release of the odor. Manure from pigs and cattle is usually spread on fields using a manure spreader. Due to the relatively lower level of proteins in vegetable matter, herbivore manure has a milder smell than the dung of carnivores or omnivores. However, herbivore slurry that has undergone anaerobic fermentation may develop more unpleasant odors, and this can be a problem in

some agricultural regions. Poultry droppings are harmful to plants when fresh but, after a period of composting, are valuable fertilizers.
Manure is also commercially composted and bagged and sold retail as a soil amendment. Sometimes even human sewage sludge is used, as is the case for Dillo Dirt, a product that has been sold by the city of Austin, Texas municipal wastewater department since 1989.

Precautions

Manure generates heat as it decomposes, and it is possible for manure to ignite spontaneously if stored in a massive pile. Once such a large pile of manure is burning, it will foul the air over a very large area and require considerable effort to extinguish. Therefore, large feedlots must take care to ensure that piles of fresh manure do not get excessively large. There is no serious risk of spontaneous combustion in smaller operations.
There is also a risk of insects carrying feces to food and water supplies, making them unsuitable for human consumption.

Livestock antibiotics

In 2007, a University of Minnesota study indicated that foods such as corn, lettuce, and potatoes have been found to accumulate antibiotics from soils spread with animal manure that contains these drugs.
Organic foods may be much more or much less likely to contain antibiotics, depending on their sources and treatment of manure. For instance, by Soil Association Standard 4.7.38, most organic arable farmers either have their own supply of manure (which would, therefore, not normally contain drug residues) or else rely on green manure crops for the extra fertility (if any nonorganic manure is used by organic farmers, then it usually has to be rotted or composted to degrade any residues of drugs and eliminate any pathogenic bacteria — Standard 4.7.38, Soil Association organic farming standards). On the other hand, as found in the University of Minnesota study, the non-usage of artificial fertilizers, and resulting exclusive use of manure as fertilizer, by organic farmers can result in significantly greater accumulations of antibiotics in organic foods.

Irrigation system

Pakistan, a country of enchanting landscapes offers a combination of beaches, mountains, beautiful deserts and valleys. Its vast farm lands are sustained by the Indus Basin Irrigation System (IBIS), the largest contiguous irrigation system in the world. The IBIS irrigates 45 million acres of farm land which produces wheat, rice, fruits, vegetables, sugarcane, maize and cotton in abundance for local use as well as for export.
This report provides the historical context in which the IBIS was developed. It discusses the economic impact of the IBIS on Pakistan, and provides recommendations for some current problems related to insufficient drainage and inefficient farming practices.

Historical Background

The Indus Valley has been the host to one of the most ancient civilization of human history, the Indus Valley Civilization. After the extinction of the Indus Civilization, new settlements especially in doabs grew slowly. New irrigation systems started to evolve. Inundation canals and small dams were constructed and population grew all around this area. In order to reduce the occurrence of low irrigation water supply the British authorities, towards the middle of the last century, started modernizing and expanding the irrigation system of the Indus Basin.

Treaty Between Pakistan and India

In 1947, the Indian sub continent was partitioned by the British into two independent states – Pakistan and India. After the partition a commission was set up to resolve any issue that may emerge as a consequence of the partition. The matter of utilization of water resources of Indus Basin was raised by Pakistan. The boundary commission, chaired by Sir Cyril Radcliff, awarded control barrages (situated very close to the border) to India, while 90 percent of irrigated land lay in Pakistan.

After a protracted negotiation of ten years through facilitation of the World Bank, the Indus Basin Treaty was signed by India and Pakistan in 1960 for distribution of water resources in the Indus Basin. According to the terms of the treaty India was given the exclusive use of the waters of the eastern rivers namely Ravi, Sutlej and Beas. Pakistan was not given its full historic share and was allocated only 75 percent of its legitimate share of the waters in Indus Basin. Consequently, Pakistan agreed to embark upon a gigantic project nicknamed as "Indus Basin Replacement Works". The extensive undertaking involved the construction of two major dams, five barrages and eight link canals.

Pakistan's IBIS

Pakistan's economy is largely based on its agricultural produce. Water is therefore a critical resource for its sustained economic development. In order to fully utilize the river water resources, the IBIS has emerged as the largest contiguous irrigation system in the world. The IBIS comprises of three large dams, eighty five small dams, nineteen barrages, twelve inter-river link canals, forty-five canal commands and 0.7 million tube wells In monetary terms, this network is the biggest infrastructure enterprise of Pakistan accounting for approximately US$ 300 billion of investment.

Water Ability of the IBIS

There are three main sources of water availability in the Indus Basin:

A. The average annual flow of Western Rivers of Indus Basin is approximately 142 million acre feet (MAF). About 104 MAF of this water is diverted for irrigation purposes and about 35 million acre feet outflows to the Arabian Sea.

B. Rain Water:
Another source of water is the rain fall. Irrigated areas of Indus Basin receive on average 40 million acres feet of water annually.

C. Ground Water:
The third source of water is the ground water. It provides approximately 40 percent of crop water requirements of the country.

Challenges in Indus Basin Irrigation System

For any sustainable irrigation system that is dependent on river water supplies, it is necessary to have a system of affluent disposal. However, when the British engineers designed and constructed the barrages and canals in Punjab and Sindh, they did not install an affluent disposal system. This lack of an affluent disposal system gave rise to the twin problems of water logging and salinity. The problem is currently being addressed through construction of a network of disposal drains, many of which have been completed while more are under execution.

The Economic Impact of Indus Basin Irrigation System

The agricultural produce, in addition to providing food security constitutes:

A. 23 percent of GDP

B. 70 percent of total export earnings

C. 54 percent employment of labour force

The overwhelming majority of its produce comes from the areas irrigated in the Indus Basin. The IBIS is therefore essential in sustaining the agriculture and consequently economic well-being of Pakistan. The Indus Basin now serves as the bread basket of Pakistan. Its land use is furnished below.

Current Problems and Recommendations

Farmers in Pakistan receive their share of irrigation waters on a rotational basis. To protect the right of share of their water, the farmers are using more than the optimum quantity of water required for healthy crops. Lack of modern irrigation techniques and agricultural practices further add to the wastage of irrigation water. Some solutions outlined below can potentially serve to address this issue:

Increase plantation of fruit trees.

Expand forested areas.

All existing dams small and large should be used for fish breeding and harvesting.

Develop agricultural based industries and timber factories in the rural areas to provide employment to small farmers and increase the percentage of value added goods for export.

Group small farms into larger units for cooperative farming using the latest irrigation and farming techniques and modern agricultural practices.

Increase the production of beans, lentils and edible oil seeds to reduce their imports.

Develop pastures for cattle farming and increase milk and meat production.

Big land holdings more than five thousand acres of area should be made available for co operative farming.

The level and standard of research should be enhanced in the existing agricultural universities of Pakistan.

PLANT PROTECTION

Plant protection is the science and practice of managing invertebrate pests and vertebrate pests, plant diseases, weeds and other pest organisms that damage agricultural crops and forestry. Agricultural crops include field crops (maize, wheat, rice, etc.), vegetable crops (potatoes, cabbages, etc.) and fruit and horticultural crops. It encompasses:

Pesticide-based approaches such as herbicides, insecticides and fungicides

Herbicides:

Herbicides also commonly known as weed killers, are pesticides used to kill unwanted plants Selective herbicides kill specific targets, while leaving the desired crop relatively unharmed. Some of these act by interfering with the growth of the weed and are often synthetic mimics of natural plant hormones. Herbicides used to clear

waste ground, industrial sites, railways and railway embankments are not selective and kill all plant material with which they come into contact. Smaller quantities are used in forestry, pasture systems, and management of areas set aside as wildlife habitat.
Some plants produce natural herbicides, such as the genus Juglans (walnuts), or the tree of heaven; such action of natural herbicides, and other related chemical interactions, is called allelopathy.
Herbicides are widely used in agriculture and landscape turf management. In the US, they account for about 70% of all agricultural pesticide use

An **insecticide** is a chemical used against insects. They include ovicides and larvicides used against the eggs and larvae of insects, respectively. Insecticides are used in agriculture, medicine, industry, and general home use. The use of insecticides is believed to be one of the major factors behind the increase in agricultural productivity in the 20th century.[1] Nearly all insecticides have the potential to significantly alter ecosystems; many are toxic to humans; and others are concentrated in the food chain.

The classification of insecticides is done in several different ways:

- Systemic insecticides are incorporated by treated plants. Insects ingest the insecticide while feeding on the plants.
- Contact insecticides are toxic to insects brought into direct contact. Efficacy is often related to the quality of pesticide application, with small droplets (such as aerosols) often improving performance.
- Natural insecticides, such as nicotine, pyrethrum, and neem extracts are made by plants as defenses against insects. Nicotine-based insecticides are still being widely used in the US and Canada, however they are barred in the EU.
- Plant-incorporated protectants (PIPs) are insecticidal substances produced by plants after genetic modification. For instance, a gene that codes for a specific Baccilus thuringiensis biocidal protein is introduced into a crop plant's genetic material. Then, the plant manufactures the protein. Since the biocide is incorporated into the plant, additional applications, at least of the same compound, are not required.
- Inorganic insecticides are manufactured with metals and include arsenates, copper compounds and fluorine compounds, which are now seldom used, and sulfur, which is commonly used.
- Organic insecticides are synthetic chemicals that comprise the largest numbers of pesticides available for use today.
- Mode of action—how the pesticide kills or inactivates a pest—is another way of classifying insecticides. Mode of action is important in predicting whether an insecticide will be toxic to unrelated species, such as fish, birds, and mammals.

For products that repel rather than kill insects see insect repellents.

Fungicides are biocidal chemical compounds or biological organisms used to kill or inhibit fungi or fungal spores. Fungi can cause serious damage in agriculture, resulting in critical losses ofyield, quality and profit. Fungicides are used both in agriculture and to fight fungal infections in animals. Chemicals used to control oomycetes, which are not fungi, are also referred to as fungicides as oomycetes use the same mechanisms as fungi to infect plants.

Fungicides can either be contact, translaminar or systemic. Contact fungicides are not taken up into the plant tissue, & only protect the plant where the spray is deposited; translaminar fungicides redistribute the fungicide from the upper, sprayed leaf surface to the lower, unsprayed surface; systemic fungicides are taken up & redistributed through the xylem vessels. Few fungicides move to all parts of a plant. Some are locally systemic, and some move upwardly.

Most fungicides that can be bought retail are sold in a liquid form. A very common active ingredient is sulfur, present at 0.08% in weaker concentrates, and as high as 0.5% for more potent fungicides. Fungicides in powdered form are usually around 90% sulfur and are very toxic. Other active ingredients in fungicides include neem oil, rosemary oil, jojoba oil, the bacterium Bacillus subtilis, and the beneficial fungus Ulocladium oudemansii.

Fungicide residues have been found on food for human consumption, mostly from post-harvest treatments. Some fungicides are dangerous to human health, such as vinclozolin, which has now been removed from use. A number of fungicides are also used in human health care.

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- Biological pest control approaches such as cover crops, trap crops and beetle banks

Biological control is a bioeffector-method of controlling pests (including insects, mites, weeds and plant diseases) using other living organisms. It relies on predation, parasitism, herbivory, or other natural mechanisms, but typically also involves an active human management role. It can be an important component of integrated pest management (IPM) programs. There are three basic types of biological pest control strategies: importation (sometimes called classical biological control), augmentation and conservation.

Natural enemies of insect pests, also known as biological control agents, include predators, parasitoids, and pathogens. Biological control agents of plant diseases are most often referred to as antagonists. Biological control agents of weeds include herbivores and plant pathogens.

A trap crop is a plant that attracts agricultural pests, usually insects, away from nearby crops. This form of companion planting can save the main crop from decimation by pests without the use of pesticides. Trap crops can be planted around the circumference of the field to be protected, or interspersed among them, for example being planted every ninth row.

usage

Trap crops, when used on an industrial scale, are generally planted at a key time in the pest's lifecycle, and then destroyed before that lifecycle finishes and the pest might have transferred from the trap plants to the main crop.

Examples of trap crops include:

Alfalfa planted in strips among cotton, to draw away lygus bugs, while castor beans surround the field, or tobacco is planted in strips among it, to protect from the budworm Heliothis.

Rose enthusiasts often plant Pelargonium geraniums among their rosebushes because japanese beetles are drawn to the geraniums, which are toxic to them.

Chervil is used by gardeners to protect vegetable plants from slugs.

Rye, sesbania, and sicklepod are used to protect soybeans from corn seeding maggots, stink bugs, and velvet green caterpillars, respectively.

Mustard and Alfalfa planted near strawberries to attract lygus bugs, a method pioneered by Jim Cochran

operation

Recent studies on host-plant finding have shown that flying pests are far less successful if their host-plants are surrounded by any other plant, or even "decoy-plants" made of green plastic, cardboard or any other green material. The host-plant finding process occurs in three phases.

The first phase is stimulation by odours characteristic to the host-plant. This induces the insect to try to land on the plant it seeks. But insects avoid landing on brown (bare) soil. So if only the host-plant is present, the insects will quasi-systematically find it by landing on the only green thing around. This is called an "appropriate landing". When it does an "inappropriate landing", it flies off to any other nearby patch of green. It eventually leaves the area if there are too many "inappropriate" landings.

The second phase of host-plant finding is for the insect to make short flights from leaf to leaf to assess the plant's overall suitability. The number of leaf-to-leaf flights varies according to the insect species and to the host-plant stimulus received from each leaf. But the insect must accumulate sufficient stimuli from the host-plant to lay eggs; so it must make a certain number of consecutive "appropriate" landings. Hence if it makes an "inappropriate landing", the assessment of that plant is negative and the insect must start the process anew.

Thus it was shown that clover used as a ground cover had the same disruptive effect on eight pest species from four insect orders. An experiment showed that 36% of cabbage root flies laid eggs beside cabbages growing in bare soil (which resulted in no crop), compared to only 7% beside cabbages growing in clover (which allowed a good crop). Also that simple decoys made of green card disrupted appropriate landings just as well as did the live ground cover.

Bettele bank

A beetle bank, in agriculture and horticulture, is a form of biological pest control. It is a strip planted with grasses (bunch grasses) and/or perennial plants, within a crop field or a garden, that fosters and provides habitat for beneficial insects, birds, and other fauna that prey on pests.

Usage

Beetle banks are typically made up from plants such as sunflowers, Vicia faba, Centaurea cyanus, coriander, borage, Muhlenbergia, Stipa, and buckwheats (Eriogonum spp.). Beetle banks are used to reduce or replace the use of insecticides, and can also serve as habitat for birds and beneficial rodents. For example, insects such as Chrysoperla carnea and the Ichneumon fly can prey on pests. The concept was developed by the Game & Wildlife Conservation Trust in collaboration with the University of Southampton.

Other important benefits can be providing habitat for pollinators and endangered species. If using local native plants, endemic and indigenous flora and fauna restoration ecology is supported

- Barrier-based approaches such as agrotextiles and bird netting
- Agro textiles
- A Technical textile is a textile product manufactured for non-aesthetic purposes, where function is the primary criterion.
- It is a large and growing sector and supports a vast array of other industries.
- Technical textiles include textiles for automotive applications, medical textiles (e.g., implants), geotextiles (reinforcement of embankments), agrotextiles (textiles for crop protection), and protective clothing (e.g., heat and radiation protection for fire fighter clothing, molten metal protection for welders, stab protection and bulletproof vests, and spacesuits).
- Over all, global growth rates of technical textiles are about 4% per year greater than the growth of home and apparel textiles, which are growing at a rate of 1% per year.
- In present market opportunities and in free quota system the importance of technical textile materials is increasing to accommodate the needs of requirement. Nowadays the most widely technical textile materials are used in filter clothing, furniture, hygiene medicals and construction material.
- Applications
- Nowadays it can be found in the market, technical fabrics which protect of:
- High temperatures (insulating, firefighters)
- Burns (flame, convective and radiant heat, firefighters, ATEX area)
- Electric arc flash discharge (plasma explosion, Electric companies)
- Molten metal impacts (foundries)
- Metal sparks (welding)

- Acid environment (petrochemical, gas, refineries, chemical)
- Bullet impact (military, security)
- Cut resistant (gloves, glass industry)
- Astronaut's suits
- These fabrics are made of different kind of fibers, because every blend apports different technical characteristics to the fabric:
- Meta-Para aramides – Nomex: high resistance, tear, tensile strength, expensive,
- Wool viscoses polyamide – marlan : repelency of molten metal, heat insulation, transparency.
- Glass fiber - High resistance, insulating.
- Modacrylic cotton – Marko wiki: Marko : electric arc flash protection, comfort, flame-resistant, multinorm, efficient, skin friendly, antistatic.
- Polyamide – Kevlar : extreme resistance, low ageing
- Bird netting
- **Usage**

Bird netting or anti-bird netting is a form of bird pest control. It is a net used to prevent birds from reaching certain areas.

Crop protection

Bird nets are used to prevent bird damage of vegetable and fruit crops as well as seedlings.

Fish protection

Bird netting may be used to protect fisheries and fish wildlife reserves from predator birds.

Building protection

Bird netting is one of the most effective and long lasting ways of bird proofing buildings and other structures against all urban bird species. It provides a discreet and impenetrable barrier that protects premises without harming the birds. Bird netting can be particularly effective for large open areas such as roofs and loading bays. Design considerations include the type and material of the fixings utilised and the bird species requiring exclusion

Animal psychology-based approaches such as bird scarers

A **bird scarer** is any one of a number devices designed to scare birds, usually employed by farmers to dissuade birds from eating recently planted arable crops.

They are also used on airfields to prevent birds accumulating near runways and causing a potential hazard to aircraft.

Scarecrow

Hawk kite

Helikites

- Biotechnology-based approaches such as plant breeding and genetic modification
- **Biotechnology** is the use of living systems and organisms to develop or make useful products, or "any technological application that uses biological systems, living organisms or derivatives thereof, to make or modify products or processes for specific use
- Depending on the tools and applications, it often overlaps with the (related) fields of bioengineering and biomedical engineering.
- Definition
- The concept of 'biotech' or 'biotechnology' encompasses a wide range of procedures (and history) for modifying living organisms according to human purposes — going back to domestication of animals, cultivation of plants, and "improvements" to these through breeding programs that employ artificial selection and hybridization. Modern usage also includes genetic engineering as well as cell and tissue culture technologies. Biotechnology is defined by the American Chemical Society as the application of biological organisms, systems, or processes by various industries to learning about the science of life and the improvement of the value of materials and organisms such as pharmaceuticals, crops, and livestock. In other words, biotechnology can be defined as the mere application of technical advances in life science to develop commercial products. Biotechnology also writes on the pure biological sciences (genetics, microbiology, animal cell culture, molecular biology, biochemistry, embryology, cell biology). And in many instances it is also dependent on knowledge and methods from outside the sphere of biology including:

Plant breeding

Plant breeding is the art and science of changing the traits of plants in order to produce desired characteristics. Plant breeding can be accomplished through many different techniques ranging from simply selecting plants with desirable characteristics for propagation, to more complex molecular techniques.

Plant breeding has been practiced for thousands of years, since near the beginning of human civilization. It is now practiced worldwide by individuals such as gardeners and farmers, or by professional plant breeders employed by organizations such as government institutions, universities, crop-specific industry associations or research centers.

International development agencies believe that breeding new crops is important for ensuring food security by developing new varieties that are higher-yielding, resistant to pests and diseases, drought-resistant or regionally adapted to different environments and growing conditions.

Genetic engineering, also called **genetic modification**, is the direct manipulation of an organism's genome using biotechnology. New DNA may be inserted in the host genome by first isolating and copying the genetic material of interest using molecular cloning methods to generate a DNA sequence, or by synthesizing the DNA, and then inserting this construct into the host organism. Genes may be removed, or "knocked out", using a nuclease. Gene targeting is a different technique that uses homologous recombination to change an endogenous gene, and can be used to delete a gene, remove exons, add a gene, or introduce point mutations.

An organism that is generated through genetic engineering is considered to be a genetically modified organism (GMO). The first GMOs were bacteria in 1973; GM mice were generated in 1974. Insulin-producing bacteria were commercialized in 1982 and genetically modified food has been sold since 1994. Glofish, the first GMO designed as a pet, was first sold in the United States December in 2003.

Genetic engineering techniques have been applied in numerous fields including research, agriculture, industrial biotechnology, and medicine. Enzymes used in laundry detergent and medicines such as insulin and human growth hormone are now manufactured in GM cells, experimental GM cell lines and GM animals such as mice or zebrafish are being used for research purposes, and genetically modified crops have been commercialized.

CROP ROTATION

ROTATION

Concept and importance of crop rotation:

Crop rotation is the strategy of raising crops from a piece of land in such an order or succession that the fertility of the land suffers minimally and the farmer’s profits are not reduced. This system is in contrast with practice of growing the same crop year to year. Crop rotation systems have been practiced in Pakistan from time immemorial and every farmer is quite familiar with it.

The main benefits of a scientific rotation are:

1. By rotating crops of different seasons, it is easy to control weeds. Some weeds (johnsongrass, nut grass) are much more troublesome in summer than in winter, and can be suppressed by growing rabi crops after summer fallowing. Similarly, some crops like potato and fodder (berseem,alfalfa) when included in rotation exert a useful weed smothering influence.

2. By planned, regular, and careful succession of crops, it is easy to keep plant diseases and insect pests under control. Some fungi and insect pests attack only particular genera or orders of plants, and become especially troublesome when such crops are grown on the same land every year. Rotation, therefore, offers an easy way to keep such pest in check.

3. By growing crops in a suitable order it is possible to maintain the fertility of the land. The reasons are:

a. As different crops remove different plant nutrients in different quantities from the soil, a proper balance of nutrients cannot be maintained if the same crop is grown year to year on the same land. Those nutrients which are removed in large quantities by that particular crop will be exhausted and the land will not be able to produce a decent crop, even though there may be plenty of other nutrients in the soil to grow other crops.

b. Differences in the root systems of various crops affect the quantities of nutrients removed from the soil. Shallow-rooted crops remove more plant food from the surface, while deep-rooted crops open up the subsoil and take food from the lower layers as well.

c. Leguminous crops have the property of fixing atmospheric nitrogen with the help of bacteria present in the nodules of their roots. Their inclusion in the rotation is therefore very helpful in maintaining fertility.

d. Soil fertility is closely linked with its humus content. This is very important in hot climates and also with extreme type of soils like sands and clays. By including green manuring crops in the rotation at regular intervals, the humus content of the soil can be kept up.

4. Growing a variety of crops with different sowing and harvesting periods enables the farmer to distribute his labour force more evenly. It also ensures some return on capital at different times of the year for domestic requirements and farm needs. Proper marketing of the commodity and availability to the consumers is assured.

Principles of crop rotation:

In view of the advantages of rotation, the following basic principles should be kept in mind while planning a scientific rotation programme.

1. Crops of the same natural order (family) should not follow each other.
2. Crops of the same type of root system (shallow or deep) should not follow each other.
3. Leguminous crops should be included in the rotation at least every three to four years.
4. Green manuring and forage crops should be given a place in the rotation at regular intervals.
5. Crops like potato, sugarcane, and seasonal vegetables which require more thorough cultivation than others should be included in the rotation, as their cultivation makes a very good preparation for the following crop.
6. Alternating crops susceptible to certain diseases with those that are resistant helps control pests and diseases.

Limitations of crop rotation:

Rotation can not be considerd a complete replacement for manures and fertilizers needed for the production of various crops. In the vicinity of large cities, where fruits, vegetables, and fodder crop are more remunerative than other crops, it is difficult to follow desirable rotation principles completely. In rainfed areas also, because of scarcity of water, rotation cannot be followed in some seasons of the year. Farming has become so commercially oriented that in the vicinity of sugar and ginning mills sugarcane and cotton are grown in close succession using high inputs.

Choice of rotation:

The choice of a crop rotation pattern is determined by the following factors.

1. Physical condition of the soil
2. Prevalence of weeds
3. Supply of plant food
4. Availability of desired quantity of good quality water
5. Economic and political conditions
6. Financial condition of the farmer

Choice of crop:

The choice and sequence of rotation crops depends on the nature of the soil, the climate, and precipitation which together determine the type of plants that may be cultivated. Other important aspects of farming such as crop marketing and economic variables must also be considered when deciding crop rotations.

Crop rotations may include two to six or more crop rotations over numerous seasons. A two crop rotation such as corn and soybean in cash grains or corn and alfalfa in forage systems use legumes to help fix nitrogen in the soil for utilization over the long term. Multiple cropping systems, such as intercropping or companion planting, offer more diversity and complexity within the same season or rotation. Carrots can be shaded by tomatoes and loosen soil below them. Double cropping is common where two crops, typically of different species, are grown sequentially in the same growing season. Winter rye and barley can be sown after oats or rice and harvested before the next crop goes in of oats or rice. These systems can maximize benefits of the rotation as well as available land resources.

More complex rotations commonly utilize people for greater use of on-farm nutrient management and additional farm products. A soil-feeding crop of clover could be replaced or aided by an application of manure to set up a field for a double crop of winter grains after potatoes. Soil building and pest population management benefits can be further utilized with different complexities of crop rotation. In general the complexity of a field’s rotation is limited by what soil, climate, and other environmental conditions permit. This also includes the current or desired management tools and goals of the farm

1. Incorporation of animals

In Sub-Saharan Africa, as animal husbandry becomes less of a nomadic practice many herders have begun integrating crop production into their practice. This is known as mixed farming, or the practice of crop cultivation with the incorporation of raising cattle, sheep and/or goats by the same economic entity, is increasingly common. This interaction between the animal, the land and the crops are being done on a small scale all across this region. Crop residues provide animal feed, while the animals provide manure for replenishing crop nutrients and draft power. Both processes are extremely important in this region of the world as it is expensive and logistically unfeasible to transport in synthetic fertilizers and large-scale machinery. As an additional benefit, the cattle, sheep and/or goat provide milk and can act as a cash crop in the times of economic hardship. Using some forms of crop rotation farmers can keep their fields under continuous production, instead of letting them lie fallow, as well as reducing the need for artificial fertilizers, both of which can be expensive.

A general effect of crop rotation is that there is a geographic mixing of crops, which can slow the spread of pests and diseases during the growing season. The different crops can also reduce the effects of adverse weather for the individual farmer and, by requiring planting and harvest at different times, allow more land to be farmed with the same amount of machinery and labour.
Agronomists describe the benefits to yield in rotated crops as "The Rotation Effect". **There are many found benefits of rotation systems:** however, there is no specific scientific basis for the sometimes 10-25% yield increase in a crop grown in rotation versus monoculture. The factors related to the increase are simply described as alleviation of the negative factors of monoculture cropping systems. Explanations due to improved nutrition; pest, pathogen, and weed stress reduction; and improved soil structure have been found in some cases to be correlated, but causation has not been determined for the majority of cropping systems.
Other benefits of rotation cropping systems include production costs advantages. Overall financial risks are more widely distributed over more diverse production of crops and/or livestock. Less reliance is placed on purchased inputs and over time crops can maintain production goals with fewer inputs. This in tandem with greater short and long term yields makes rotation a powerful tool for improving agricultural systems.

2. Disadvantages

Some crops are picky in the type of soil they need for maximum profitability. Crop rotation is centered around the needs of the soil and not of the crop. Planting picky crops on not-preferred soil will lead to a lower yield in a specific growing season.

3. Nutrients

Rotating crops adds nutrients to the soil. Legumes, plants of the family Fabaceae, for instance, have nodules on their roots which contain nitrogen-fixing bacteria called rhizobia bacteria. It therefore makes good sense agriculturally to alternate them with cereals (family Poaceae) and other plants that require nitrates. An extremely common modern crop rotation is alternatingsoybeans and maize (corn). In subsistence farming, it also makes good nutritional sense to grow beans and grain at the same time in different fields.

4. Pest control

Crop rotation is also used to control pests and diseases that can become established in the soil over time. The changing of crops in a sequence tends to decrease the population level of pests. Plants within the same taxonomic family tend to have similar pests and pathogens. By regularly changing the planting location, the pest cycles can be broken or limited. For example, root-knot nematode is a serious problem for some plants in warm climates and sandy soils, where it slowly builds up to high levels in the soil, and can severely damage plant productivity by cutting off circulation from the plant roots. Growing a crop that is not a host for root-knot nematode for one season greatly reduces the level of the nematode in the

soil, thus making it possible to grow a susceptible crop the following season without needing soil fumigation.
It is also difficult to control weeds similar to the crop which may contaminate the final produce. For instance, ergot in weed grasses is difficult to separate from harvested grain. A different crop allows the weeds to be eliminated, breaking the ergot cycle.
This principle is of particular use in organic farming, where pest control may be achieved without synthetic pesticides.

5 Soil erosion

Crop rotation can greatly affect the amount of soil lost from erosion by water. In areas that are highly susceptible to erosion, farm management practices such as zero and reduced tillage can be supplemented with specific crop rotation methods to reduce raindrop impact, sediment detachment, sediment transport, surface runoff, and soil loss.
Protection against soil loss is maximized with rotation methods that leave the greatest mass of crop stubble (plant residue left after harvest) on top of the soil. Stubble cover in contact with the soil minimizes erosion from water by reducing overland flow velocity, stream power, and thus the ability of the water to detach and transport sediment. Soil Erosion and Cill prevent the disruption and detachment of soil aggregates that cause macrospores to block, infiltration to decline, and runoff to increase. This significantly improves the resilience of soils when subjected to periods of erosion and stress.
The effect of crop rotation on erosion control varies by climate. In regions under relatively consistent climate conditions, where annual rainfall and temperature levels are assumed, rigid crop rotations can produce sufficient plant growth and soil cover. In regions where climate conditions are less predictable, and unexpected periods of rain and drought may occur, a more flexible approach for soil cover by crop rotation is necessary. An opportunity cropping system promotes adequate soil cover under these erratic climate conditions. In an opportunity cropping system, crops are grown when soil water is adequate and there is a reliable sowing window. This form of cropping system is likely to produce better soil cover than a rigid crop rotation because crops are only sown under optimal conditions, whereas rigid systems are not necessarily sown in the best conditions available.
Crop rotations also affect the timing and length of when a field is subject to fallow. This is very important because depending on a particular region's climate, a field could be the most vulnerable to erosion when it is under fallow. Efficient fallow management is an essential part of reducing erosion in a crop rotation system. Zero tillage is a fundamental management practice that promotes crop stubble retention under longer unplanned fallows when crops cannot be planted. Such management practices that succeed in retaining suitable soil cover in areas under fallow will ultimately reduce soil loss.

6. Additional soil improvements

The use of different species in rotation allows for increased soil organic matter (SOM), greater soil structure, and improvement of the chemical and biological soil environment for crops. With more SOM, water infiltration and retention improves, providing increased drought tolerance and decreased erosion. Soil aggregation allows greater nutrient retention and utilization, decreasing the need for added nutrients. Soil microorganisms also improve nutrient availability and decrease pathogen and pest activity through competition. In addition, plants produce root exudates and other chemicals which manipulate their soil environment as well as their weed environment. Thus rotation allows increased yields from nutrient availability but also alleviation of allelopathy and competitive weed environment.

Harvest

Harvest is the process of gathering mature crops from the fields. Reaping is the cutting of grain or pulse for harvest, typically using a scythe, sickle, reaper. The harvest marks the end of the growing season, or the growing cycle for a particular crop, and social importance of this event makes it the focus of seasonal celebrations such as a harvest festival, found in many religions. On smaller farms with minimal mechanization, harvesting is the most labor-intensive activity of the growing season. On large, mechanized farms, harvesting utilizes the most expensive and sophisticated farm machinery, like the combine harvester. Harvesting in general usage includes an immediate post-harvest handling, all of the actions taken immediately after removing the crop—cooling, sorting, cleaning, packing—up to the point of further on-farm processing, or shipping to the wholesale or consumer market.

Other uses

Harvest commonly refers to grain and produce, but also has other uses. In addition to fish and timber, the term harvest is also used in reference to harvesting grapes for wine. Within the context of irrigation, water harvesting refers to the collection and run-off of rainwater for agricultural or domestic uses. Instead of harvest, the term exploit is also used, as in exploiting fisheries or water resources. Energy harvesting is the process by which energy (such as solar power, thermal energy, wind energy, salinity gradients and kinetic energy) is captured and stored. Body harvesting, or cadaver harvesting, is the process of collecting and preparing cadavers for anatomical study. In a similar sense, organ harvesting is the removal of tissues or organs from a donor for purposes of transplanting.

Harvesting or Domestic Harvesting in Canada refers to hunting, fishing and plant gathering by First Nations, Métis and Inuit in discussions of aboriginal or treaty rights. For example, in the Gwich'in Comprehensive Land Claim Agreement, "Harvesting means gathering, hunting, trapping or fishing..." Similarly, in the Tlicho Land Claim and Self Government Agreement "'Harvesting' means, in relation to wildlife, hunting, trapping or fishing and, in relation to plants or trees, gathering or cutting."

Combine harvester

The **combine harvester**, or simply **combine**, is a machine that harvests grain crops. The name derives from its combining three separate operations comprising harvesting—reaping, threshing, and winnowing—into a single process. Among the crops harvested with a combine are wheat, oats, rye, barley, corn (maize), soybeans and flax (linseed). The waste straw left behind on the field is the remaining dried stems and leaves of the crop with

limited nutrients which is either chopped and spread on the field or baled for feed and bedding for livestock.
Combine harvesters are one of the most economically important labor saving inventions, enabling a small fraction of the population to be engaged in agriculture.

A **harvest festival** is an annual celebration that occurs around the time of the main harvest of a given region. Given the differences in climate and crops around the world, harvest festivals can be found at various times at different places. Harvests festivals typically feature feasting, both family and public, with foods that are drawn from crops that come to maturity around the time of the festival. Ample food and freedom from the necessity to work in the fields are two central features of harvest festivals: eating, merriment, contests, music and romance are common features of harvest festivals around the world.
In North America, Canada and the US each have their own Thanksgiving celebrations in October and November. Certain religious holidays, such as Sukkot, have their roots in harvest festivals.
In Britain, thanks have been given for successful harvests since pagan times. Harvest festival is traditionally held on the Sunday near or of the Harvest Moon. This is the full Moon that occurs closest to the autumn equinox (about Sept. 23). In two years out of three, the Harvest Moon comes in September, but in some years it occurs in October. The celebrations on this day usually include singing hymns, praying, and decorating churches with baskets of fruit and food in the festival known as Harvest Festival, Harvest Home or Harvest Thanksgiving.
In British and English-Caribbean churches, chapels and schools, and some Canadian churches, people bring in produce from the garden, the allotment or farm. The food is often distributed among the poor and senior citizens of the local community, or used to raise funds for the church, or charity.
In the United States, many churches also bring in food from the garden or farm in order to celebrate the harvest. The festival is set for a specific day and has become a national holiday known as Thanksgiving which falls on the fourth Thursday in November. In both Canada and the United States, it has also become a national secular holiday with religious origins, but in Britain it is both a Church festival giving thanks to God for the harvest and a more secular festival remembered in schools.
Harvest festivals in Asia include the Chinese Mid-Autumn Festival, one of the most widely spread harvest festivals in the world. In India,Makar Sankranti, Thai Pongal, Uttarayana, Lohri, and Magh Bihu or Bhogali Bihu in January, Holi in February–March, Vaisakhi in April and Onam in August–September are a few important harvest festivals.

Over harvesting

Overexploitation, also called **over harvesting**, refers to harvesting a renewable resource to the point of diminishing returns. Sustained overexploitation can lead to the destruction of the resource. The term applies to natural resources such as: wild medicinal plants, grazing pastures, game animals, fish stocks, forests, and water aquifers.
In ecology, overexploitation describes one of the five main activities threatening global biodiversity. Ecologists use the term to describe populations that are harvested at a rate

that is unsustainable, given their natural rates of mortality and capacities for reproduction. This can result in extinction at the population level and even extinction of whole species. In conservation biology the term is usually used in the context of human economic activity that involves the taking of biological resources, or organisms, in larger numbers than their populations can withstand. The term is also used and defined somewhat differently in fisheries, hydrology and natural resource management.

Overexploitation can lead to resource destruction, including extinctions. However it is also possible for overexploitation to be sustainable, as discussed below in the section on fisheries. In the context of fishing, the term overfishing can be used instead of overexploitation, as can overgrazing in stock management, overlogging in forest management, overdrafting in aquifer management, and endangered species in species monitoring. Overexploitation is not an activity limited to humans. Introduced predators and herbivores, for example, can overexploit native flora and fauna.

Threshing is the process of loosening the edible part of cereal grain (or other crop) from the scaly, inedible chaff that surrounds it. It is the step in grain preparation after harvesting and before winnowing, which separates the loosened chaff from the grain. Threshing does not remove the bran from the grain.

Threshing may be done by beating the grain using a flail on a threshing floor. Another traditional method of threshing is to make donkeys or oxen walk in circles on the grain on a hard surface. A modern version of this in some areas is to spread the grain on the surface of a country road so the grain may be threshed by the wheels of passing vehicles.

Hand threshing was laborious, with a bushel of wheat taking about an hour. In the late 18th century before threshing was mechanized, it took about one-quarter of agricultural labor.

Industrialization of threshing began in 1784 with the invention of the threshing machine by Scotsman Andrew Meikle. Today, in developed areas, it is now mostly done by machine, usually by a combine harvester, which harvests, threshes, and winnows the grain while it is still in the field.

The cereal may be stored in a threshing barn or silos.

often held over multiple days and includes flea markets, activity booths, hog wrestling and dances.

Wind winnowing is an agricultural method developed by ancient cultures for separating grain from chaff. It is also used to remove weevils or other pests from stored grain. Threshing, the loosening of grain or seeds from the husks and straw, is the step in the chaff-removal process that comes before winnowing. "Winnowing the chaff" is a common expression

In its simplest form it involves throwing the mixture into the air so that the wind blows away the lighter chaff, while the heavier grains fall back down for recovery. Techniques included using a winnowing fan (a shaped basket shaken to raise the chaff) or using a tool (a winnowing fork or shovel) on a pile of harvested grain.

Winnowing can also describe the natural removal of fine material from a coarser sediment by wind or flowing water, analogous to the agricultural separation of wheat from chaff.

Crop processes and storage

Grain stores upto 30,000 tons with full cleaning, destoning, ventilation and temperature monitoring.

Specialized rice and pulses cleaning systems including a full range of processes:
Primary cleaning
Precision cleaning- gravity separators for light and heavey foreign material
Air washing to remove the adhered dust
Length grading- indented cylinders
Electronic color sorting
Conventional packing and form-fill-seal plastic

Specialized chilled floor storage for storage of maize for specialized processing including:
Intake
Primary cleaning
Floor store filling to a pre-determined level surface
Out loading system from the floor store
Specialized precision cleaning and grading
Dispatch in bulk, one tone IBC and 5o kg bags

Flour mills for specialized wheat flour production for whole meal and other style flours, full system with packing in conventional paper bags form-fill-seal.

Agro based industries

Cotton textile Industry

The **textile industry** or **apparel industry** is primarily concerned with the production of yarn, and cloth and the subsequent design or manufacture of clothing and their distribution. The raw material may be natural, or synthetic using products of the chemical industry.

Cotton manufacturing

Cotton is the world's most important natural fibre. In the year 2007, the global yield was 25 million tons from 35 million hectares cultivated in more than 50 countries. There are five stages

- Cultivating and Harvesting
- Preparatory Processes
- Spinning- giving yarn
- Weaving- giving fabrics
- Finishing- giving textiles

Synthetic fibres

Artificial fibres can be made by extruding a polymer, through a spinneret into a medium where it hardens. Wet spinning (rayon) uses a coagulating medium. In dry spinning (acetate and triacetate), the polymer is contained in a solvent that evaporates in the heated exit

chamber. In melt spinning (nylons and polyesters) the extruded polymer is cooled in gas or air and then sets. All these fibres will be of great length, often kilometers long.
Artificial fibres can be processed as long fibres or batched and cut so they can be processed like a natural fibre.

Natural fibres

Natural fibres are either from animals (sheep, goat, rabbit, silk-worm) mineral (asbestos) or from plants (cotton, flax, sisal). These vegetable fibres can come from the seed (cotton), the stem (known as bast fibres: flax, Hemp, Jute) or the leaf (sisal). Without exception, many processes are needed before a clean even staple is obtained- each with a specific name. With the exception of silk, each of these fibres is short being only centimeters in length, and each has a rough surface that enables it to bond with similar staples.

Sugar industry

Sugar is the generalized name for a class of chemically-related sweet-flavored substances, most of which are used as food. They are carbohydrates, composed of carbon, hydrogen and oxygen. There are various types of sugar derived from different sources. Simple sugars are called monosaccharides and include glucose (also known as dextrose), fructose and galactose. The table or granulated sugar most customarily used as food is sucrose, a disaccharide (in the body, sucrose hydrolyses into fructose and glucose). Other disaccharides include maltose and lactose. Chemically-different substances may also have a sweet taste, but are not classified as sugars. Some are used as lower-calorie food substitutes for sugar described as artificial sweeteners.

Sugars are found in the tissues of most plants, but are only present in sufficient concentrations for efficient extraction in sugarcane and sugar beet. Sugarcane is a giant grass and has been cultivated in tropical climates in the Far East since ancient times. A great expansion in its production took place in the 18th century with the lay out of sugar plantations in the West Indies and Americas. This was the first time that sugar became available to the common people who previously had to rely on honey to sweeten foods. Sugar beet is a root crop, is cultivated in cooler climates, and became a major source of sugar in the 19th century when methods for extracting the sugar became available. Sugar production and trade have changed the course of human history in many ways. It influenced the formation of colonies, the perpetuation of slavery, the transition to indentured labour, the migration of peoples, wars between sugar trade-controlling nations in the 19th century, and the ethnic composition and political structure of the new world.

The world produced about 168 million tonnes of sugar in 2011. The average person consumes about 24 kilograms of sugar each year (33.1 kg in industrialised countries), equivalent to over 260 food calories per person, per day.

Since the latter part of the twentieth century, it has been questioned whether a diet high in sugars, especially refined sugars, is bad for human health. Sugar has been linked to obesity, and suspected of, or fully implicated as a cause in the occurrence of diabetes, cardiovascular disease, dementia, macular degeneration and tooth decay. Numerous studies have been undertaken to try to clarify the position, but with varying results, mainly because of the difficulty of finding populations for use as controls that do not consume, or are largely free of any sugar consumption.

Types of sugar

Monosaccharides

Glucose, fructose and galactose are all simple sugars, monosaccharides, with the general formula $C_6H_{12}O_6$. They have five hydroxyl groups (−OH) and a carbonyl group (C=O) and are cyclic when dissolved in water. They each exist as several isomers with dextro- and laevo-rotatory forms which cause polarized light to diverge to the right or the left.
Glucose, dextrose or grape sugar occurs naturally in fruits and plant juices and is the primary product of photosynthesis. Most ingested carbohydrates are converted into glucose during digestion and it is the form of sugar that is transported around the bodies of animals in the bloodstream. It can be manufactured from starch by the addition of enzymes or in the presence of acids. Glucose syrup is a liquid form of glucose that is widely used in the manufacture of foodstuffs. It can be manufactured from starch by enzymatic hydrolysis.
Fructose or fruit sugar occurs naturally in fruits, some root vegetables, cane sugar and honey and is the sweetest of the sugars. It is one of the components of sucrose or table sugar. It is used as a high fructose syrup which is manufactured from hydrolized corn starch which has been processed to yield corn syrup, with enzymes then added to convert part of the glucose into fructose.
Galactose does not generally occur in the free state but is a constituent with glucose of the disaccharide lactose or milk sugar. It is less sweet than glucose. It is a component of the antigens found on the surface of red blood cells that determine blood groups.

Disaccharides

Sucrose, maltose and lactose are all compound sugars, disaccharides, with the general formula $C_{12}H_{22}O_{11}$. They are formed by the combination of two monosaccharide molecules with the exclusion of a molecule of water.
Sucrose is found in the stems of sugar cane and roots of sugar beet. It also occurs naturally alongside fructose and glucose in other plants, particularly fruits and some roots such as carrots. The different proportions of sugars found in these foods determines the range of sweetness experienced when eating them. A molecule of sucrose is formed by the combination of a molecule of glucose with a molecule of fructose. After being eaten, sucrose is split into its constituent parts during digestion by a number of enzymes known as sucrases.
Maltose is formed during the germination of certain grains, most notably barley which is converted into malt, the source of the sugar's name. A molecule of maltose is formed by the combination of two molecules of glucose. It is less sweet than glucose, fructose or sucrose. It is formed in the body during the digestion of starch by the enzyme amylase and is itself broken down during digestion by the enzyme maltase.

Lactose is the naturally occurring sugar found in milk. A molecule of lactose is formed by the combination of a molecule of galactose with a molecule of glucose. It is broken down when consumed into its constituent parts by the enzyme lactase during digestion. Children have this enzyme but some adults no longer form it and they are unable to digest lactose.

Production

Sugar beet

A pack of sugar made of sugar beet.

Sugar beet (Beta vulgaris) is an annual plant in the Family Amaranthaceae, the tuberous root of which contains a high proportion of sucrose. It is cultivated in temperate regions with adequate rainfall and requires a fertile soil. The crop is harvested mechanically in the autumn and the crown of leaves and excess soil removed. The roots do not deteriorate rapidly and may be left in a clamp in the field for some weeks before being transported to the processing plant. Here the crop is washed and sliced and the sugar extracted by diffusion. Milk of lime is added to the raw juice and carbonatated in a number of stages in order to purify it. Water is evaporated by boiling the syrup under a vacuum. The syrup is then cooled and seeded with sugar crystals. The white sugar which crystallizes out can be separated in a centrifuge and dried. It requires no further refining.

Sugarcane

Sugarcane (Saccharum spp.) is a perennial grass in the family Poaceae. It is cultivated in tropical and sub-tropical regions for the sucrose that is found in its stems. It requires a frost-free climate with sufficient rainfall during the growing season to make full use of the plant's great growth potential. The crop is harvested mechanically or by hand, chopped into lengths and conveyed rapidly to the processing plant. Here it is either milled and the juice extracted with water or the sugar is extracted by diffusion. The juice is then clarified with lime and heated to kill enzymes. The resulting thin syrup is concentrated in a series of evaporators after which further water is removed by evaporation in vacuum containers. The resulting supersaturated solution is seeded with sugar crystals and the sugar crystallizes out, is separated from the fluid and dried. Molasses is a by-product of the process and the fiber from the stems, known as bagasse, is burned to provide energy for the sugar extraction process. The crystals of raw sugar have a sticky brown coating and can either be used as they are or can be bleached by sulphur dioxide or treated in a carbonatation process to produce a whiter product.

Refining

Sugars; clockwise from top left:
White refined, unrefined, brown, unprocessed cane

Cane sugar requires further processing to provide the free-flowing white table sugar required by the consumer. The sugar may be transported in bulk to the country where it will be used and the refining process often takes place there. The first stage is known as affination and involves immersing the sugar crystals in a concentrated syrup which softens and removes the sticky brown coating without dissolving them. The crystals are then separated from the liquor and dissolved in water. The resulting syrup is either treated by a carbonatation or a phosphatation process. Both involve the precipitation of a fine solid in the syrup and when this is filtered out, a lot of the impurities are removed at the same time. Removal of colour is achieved by either using a granular activated carbon or an ion-exchange resin. The sugar syrup is concentrated by boiling and then cooled and seeded with sugar crystals causing the sugar to crystallize out. The liquor is spun in a centrifuge and the white crystals are dried in hot air, ready to be packaged or used. The surplus liquor is made into refiners' molasses. The International Commission for Uniform Methods of Sugar Analysis sets standards for the measurement of the purity of refined sugar, known as ICUMSA numbers; lower numbers indicate a higher level of purity in the refined sugar.

Producing countries

The five largest producers of sugar in 2011 were Brazil, India, the European Union, China and Thailand. In the same year, the largest exporter of sugar was Brazil, distantly followed by Thailand, Australia and India. The largest importers were the European Union, United States and Indonesia. Currently, Brazil has the highest per capita consumption of sugar, followed by Australia, Thailand and the European Union.

World sugar production (1000 metric tons)

Country	**2007/08**	**2008/09**	**2009/10**	**2010/11**	**2011/12**
Brazil	31,600	31,850	36,400	38,350	35,750

World sugar production (1000 metric tons)

Country	2007/08	2008/09	2009/10	2010/11	2011/12
India	28,630	15,950	20,637	26,650	28,300
European Union	15,614	14,014	16,687	15,090	16,740
China	15,898	13,317	11,429	11,199	11,840
Thailand	7,820	7,200	6,930	9,663	10,170
United States	7,396	6,833	7,224	7,110	7,153
Mexico	5,852	5,260	5,115	5,495	5,650
Russia	3,200	3,481	3,444	2,996	4,800
Pakistan	4,163	3,512	3,420	3,920	4,220
Australia	4,939	4,814	4,700	3,700	4,150
Other	38,424	37,913	37,701	37,264	39,474
Total	**163,536**	**144,144**	**153,687**	**161,437**	**168,247**

Forms and uses

Rock candy crystallised out of a supersaturated sugar solution

Granulated sugars are used at the table to sprinkle on foods and to sweeten hot drinks and in home baking to add sweetness and texture to cooked products. They are also used as a preservative to prevent micro-organisms from growing and perishable food from spoiling as in jams, marmalades and candied fruits.

Milled sugars are ground to a fine powder. They are used as icing sugar, for dusting foods and in baking and confectionery.

Screened sugars are crystalline products separated according to the size of the grains. They are used for decorative table sugars, for blending in dry mixes and in baking and confectionery.

Brown sugars are granulated sugars with the grains coated in molasses to produce a light, dark or demerara sugar. They are used in baked goods, confectionery and toffees.

Sugar cubes are white or brown granulated sugars pressed together in block shape. They are used to sweeten drinks.

Liquid sugars are strong syrups consisting of 67% granulated sugar dissolved in water. They are used in the food processing of a wide range of products including beverages, ice cream and jams.

Invert sugars and syrups are blended to manufacturers specifications and are used in breads, cakes and beverages for adjusting sweetness, aiding moisture retention and avoiding crystallization of sugars.

Syrups and treacles are dissolved invert sugars heated to develop the characteristic flavors. Treacles have added molasses. They are used in a range of baked goods and confectionery including toffees and licorice.

Low calorie sugars and sweeteners are often made of maltodextrin with added sweeteners. Maltodextrin is an easily digestible synthetic polysaccharide consisting of short chains of glucose molecules and is made by the partial hydrolysis of starch. The added sweeteners are often aspartame, saccharin, stevia or sucralose.

Polyols are sugar alcohols and are used in chewing gums where a sweet flavor is required that lasts for a prolonged time in the mouth.

In winemaking, fruit sugars are converted into alcohol by a fermentation process. If the must formed by pressing the fruit has a low sugar content, additional sugar may be added to raise the alcohol content of the wine in a process called chaptalization. In the production of sweet wines, fermentation may be halted before it has run its full course, leaving behind some residual sugar that gives the wine its sweet taste.

Consumption

In most parts of the world, sugar is an important part of the human diet, making food more palatable and providing food energy. After cereals and vegetable oils, sugar derived from sugar cane and beet provided more kilocalories per capita per day on average than other food groups. According to the FAO, an average of 24 kilograms (53 lb) of sugar, equivalent to over 260 food calories per day, was consumed annually per person of all ages in the world in 1999. Even with rising human populations, sugar consumption is expected to increase to 25.1 kilograms (55 lb) per person per year by 2015.

Data collected in multiple nationwide surveys between 1999 and 2008 show that the intake of added sugars has declined by 23.4 percent with declines occurring in all age, ethnic and income groups.

World sugar consumption (1000 metric tons)

Country	**2007/08**	**2008/09**	**2009/10**	**2010/11**	**2011/12**	**2012/13**
India	22,021	23,500	22,500	23,500	25,500	26,500
European Union	16,496	16,760	17,400	17,800	17,800	17,800
China	14,250	14,500	14,300	14,000	14,400	14,900
Brazil	11,400	11,650	11,800	12,000	11,500	11,700
United States	9,590	9,473	9,861	10,086	10,251	10,364
Other	77,098	76,604	77,915	78,717	80,751	81,750

World sugar consumption (1000 metric tons)

Country	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13
Total	**150,855**	**152,487**	**153,776**	**156,103**	**160,202**	**163,014**

The per capita consumption of refined sugar in the United States has varied between 27 and 46 kilograms (60 and 100 lb) in the last 40 years. In 2008, American per capita total consumption of sugar and sweeteners, exclusive of artificial sweeteners, equalled 61.9 kilograms (136 lb) per year. This consisted of 29.65 kg (65.4 lb) pounds of refined sugar and 31 kg (68.3 lb) pounds of corn-derived sweeteners per person.

Addiction

Sugar addiction

Sugar addiction is the term for the relationship between sugar and the various aspects of food addiction including: "bingeing, withdrawal, craving and cross-sensitization". Some scientists assert that consumption of sweets or sugar could have a heroin addiction like effect.

Hyperactivity

There is a common notion that sugar leads to hyperactivity, particularly in children, but studies and meta-studies tend to disprove this. Some articles and studies do refer to the increasing evidence supporting the links between refined sugar and hyperactivity.The WHO FAO meta-study suggests that such inconclusive results are to be expected when some studies do not effectively segregate or control for free sugars as opposed to sugars still in their natural form (entirely unrefined) while others do. One study followed thirty-five 5-to-7-year-old boys who were reported by their mothers to be behaviorally "sugar sensitive". They were randomly assigned to experimental and control groups. In the experimental group, mothers were told that their children were fed sugar, and in the control group, mothers were told that their children received a placebo. In fact, all children actually received the placebo, but mothers in the sugar expectancy condition rated their children as significantly more hyperactive. This suggests that the real effect of sugar is that it increases worrying among parents with preconceived notions.

Medicinal usage

Sugar is effective in wound cleaning. In 2013, Murandu et al. found clinically that sugar is an antibiotic, and pouring granulated sugar on necrotic wounds can help ulcers heal faster.

Measurements

Different culinary sugars have different densities due to differences in particle size and inclusion of moisture.
The Domino Sugar Company has established the following volume to weight conversions:

- Brown sugar 1 cup = 48 teaspoons ~ 195 g = 6.88 oz
- Granular sugar 1 cup = 48 teaspoons ~ 200 g = 7.06 oz
- Powdered sugar 1 cup = 48 teaspoons ~ 120 g = 4.23 oz.

Bulk density

- Dextrose sugar 0.62 g/mL (= 620 kg/m^3)
- Granulated sugar 0.70 g/mL
- Powdered sugar 0.56 g/mL
- Beet sugar 0.80 g/mL

Tobacco industry

Tobacco is a plant within the genus Nicotiana of the Solanaceae (nightshade) family. There are more than 70 species of tobacco. Products manufactured from dried tobacco leaves include cigars and cigarettes, snuff, pipe tobacco, chewing tobacco and flavored shisha tobacco. Further uses of tobacco are in plant bioengineering and as ornamentals, and chemical components of tobacco are used in some pesticides and medications.

The chief commercial species, N. tabacum, is believed to be native to tropical America, like most nicotiana plants, but has been so long cultivated that it is no longer known in the wild. N. rustica, a species producing fast-burning leaves, was the tobacco originally raised in Virginia, but it is now grown chiefly in Turkey, India, and Russia. The addictive alkaloid nicotine is popularly considered the most characteristic constituent of tobacco but the harmful effects of tobacco consumption can also derive from the thousands of different compounds generated in the smoke, including polycyclic aromatic hydrocarbons (such as benzopyrene), formaldehyde, cadmium, nickel, arsenic, tobacco-specific nitrosamines (TSNAs), phenols, and many others. Tobacco also contains beta-carboline alkaloids which inhibit monoamine oxidase.

Tobacco cultivation is similar to other agricultural products. Seeds are sown in cold frames or hotbeds to prevent attacks from insects, and then transplanted into the fields. Tobacco is an annual crop, which is usually harvested mechanically or by hand. After harvest, tobacco is stored for curing, either by hanging, bundling or placing in large piles with tubular vents to allow the heat to escape from the center. Curing allows for the slow oxidation and degradation of carotenoids. This allows for the agricultural product to take on properties that are usually attributed to the "smoothness" of the smoke. Following this, tobacco is packed into its various forms of consumption, which include smoking, chewing, snuffing, and so on. Most cigarettes incorporate flue-cured tobacco, which produces a milder, more inhalable smoke. Use of low-pH, inhalable, flue-cured tobacco is one of the principal reasons smoking causes lung cancer and other diseases associated with smoke inhalation.

In consumption, it most commonly appears in the forms of smoking, chewing, snuffing, or dipping tobacco. Tobacco had long been in use as an entheogen in the Americas, but upon the arrival of Europeans in North America, it quickly became popularized as a trade item and a widely abused drug. This popularization led to the development of the southern economy of the United States until it gave way to cotton. Following the American Civil War, a change in demand and production techniques allowed for the development of the cigarette. This new product quickly led to the growth of tobacco companies.

The usage of tobacco is an activity that is practiced by some 1.1 billion people, and up to 1/3 of the adult population. Rates of smoking have leveled off or declined in developed countries, but continue to rise in developing countries.

According to the World Health Organization (WHO), tobacco is the single greatest cause of preventable death globally. In a 2008 report, WHO estimated that it causes 5.4 million deaths per year. Tobacco use leads most commonly to diseases affecting the heart, liver and lungs, with smoking being a major risk factor for heart attacks, strokes, chronic obstructive pulmonary disease (COPD) (including emphysema and chronic bronchitis), and cancer (particularly lung cancer, cancers of the larynx and mouth, and pancreatic cancer). Also, because of the powerfully addictive properties of tobacco, tolerance and dependence develop.

vegetable ghee industry are the agro-based industries in Pakistan.

Environmental pollution and health hazards

Ozone (O3)

Nature and Sources of the Pollutant: Ground-level ozone (the primary constituent of smog) is the most complex, difficult to control, and pervasive of the six principal pollutants. Unlike other pollutants, ozone is not emitted directly into the air by specific sources. Ozone is created by sunlight acting on nitrogen oxides (NOx) and volatile organic compound (VOC) emissions in the air. There are literally thousands of sources of these gases. Some of the more common sources include gasoline vapors, chemical solvents, combustion products of various fuels, and consumer products. They can originate from large industrial facilities, gas stations, and small businesses such as bakeries and dry cleaners. Often these "precursor" gases are emitted in one area, but the actual chemical reactions, stimulated by sunlight and temperature, take place in another. Combined emissions from motor vehicles and stationary sources can be carried hundreds of miles from their origins, forming high ozone concentrations over very large regions. Approximately 50 million people lived in counties with air quality levels above EPA's health-based national air quality standard in 1994. The highest levels of ozone were recorded in Los Angeles. High levels also persist in other heavily populated areas like the Texas Gulf Coast and much of the Northeast.

Health and Other Effects:

Scientific evidence indicates that ground-level ozone not only affects people with impaired respiratory systems (such as asthmatics), but healthy adults and children as well. Exposure to ozone for 6 to 7 hours, even at relatively low concentrations, significantly reduces lung function and induces respiratory inflammation in normal, healthy people during periods of moderate exercise. It can be accompanied by symptoms such as chest pain, coughing, nausea, and pulmonary congestion. Recent studies provide evidence of an association between elevated ozone levels and increases in hospital admissions for respiratory problems in several U.S. cities. Results from animal studies indicate that repeated exposure to high levels of ozone for several months or more can produce permanent structural damage in the lungs. EPA's health-based national air quality standard for ozone is 0.12 ppm (measured at the highest hour during the day). Ozone is also responsible for several billion dollars of agricultural crop yield loss in the U.S. each year. Ozone also damages forest ecosystems in California and the eastern U.S. Click here for more information on the health effects of ozone.

In 1997, the EPA promulgated a new ozone national ambient air quality standard of 0.08 ppm (8 hour averaging time).

Nitrogen Dioxide (NO2)

Nature and Sources of the Pollutant: Nitrogen dioxide belongs to a family of highly reactive gases called nitrogen oxides (NOx). These gases form when fuel is burned at high temperatures, and come principally from motor vehicle exhaust and stationary sources such as electric utilities and industrial boilers. A suffocating, brownish gas, nitrogen dioxide is a strong oxidizing agent that reacts in the air to form corrosive nitric acid, as well as toxic organic nitrates. It also plays a major role in the atmospheric reactions that produce ground-level ozone (or smog).

Health and Other Effects:

Nitrogen dioxide can irritate the lungs and lower resistance to respiratory infections such as influenza. The effects of short-term exposure are still unclear, but continued or frequent exposure to concentrations that are typically much higher than those normally found in the ambient air may cause increased incidence of acute respiratory illness in children. EPA's health-based national air quality standard for NO2 is 0.053 ppm (measured as an annual average). Nitrogen oxides are important in forming ozone and may affect both terrestrial and aquatic ecosystems. Nitrogen oxides in the air are a potentially significant contributor to a number of environmental effects such as acid rain and eutrophication in coastal waters like the Chesapeake Bay. Eutrophication occurs when a body of water suffers an increase in nutrients that reduce the amount of oxygen in the water, producing an environment that is destructive to fish and other animal life.

Particulate Matter (PM-10 and PM-2.5)

Nature and Sources of the Pollutants: Particulate matter is the term for solid or liquid particles found in the air. Some particles are large or dark enough to be seen as soot or smoke. Others are so small they can be detected only with an electron microscope. Because particles originate from a variety of mobile and stationary sources (diesel trucks, wood stoves, power plants, etc.), their chemical and physical compositions vary widely.

Health and Other Effects:

In 1987, EPA replaced the earlier Total Suspended Particulate (TSP) air quality standard with a PM-10 standard. The standard focuses on smaller particles that are likely responsible for adverse health effects because of their ability to reach the lower regions of the respiratory tract. The PM-10 standard includes particles with a diameter of 10 micrometers or less (0.0004 inches or one-seventh the width of a human hair). EPA's health-based national air quality standard for PM-10 is 50 micrograms per cubic meter (measured as an annual average) and 150 micrograms per cubic meter (measured as a daily average). In 1997, EPA promulgated a PM-2.5 standard which includes particles with a diameter of 2.5 microns or less. These smaller particles have the best chance of reaching the lower respiratory tract. The health-based national ambient air quality standard for PM-2.5 is 15 micrograms per cubic meter (measured as an annual average) and 65 micrograms per cubic meter (measured as a daily average).

Major concerns for human health from exposure to particulate matter are: effects on breathing and respiratory systems, damage to lung tissue, cancer, and premature death. The elderly, children, and people with chronic lung disease, influenza, or asthma, tend to be especially sensitive to the effects of particulate matter. Acidic particulate matter can also damage manmade materials and is a major cause of reduced visibility in many parts of the U.S.

Sulfur Dioxide (SO_2)

Nature and Sources of the Pollutant: Sulfur dioxide belongs to the family of sulfur oxide gases (SO_x). These gases are formed when fuel containing sulfur (mainly coal and oil) is burned, and during metal smelting and other industrial processes.

Health and Other Effects:

The major health concerns associated with exposure to high concentrations of SO_2 include effects on breathing, respiratory illness, alterations in pulmonary defenses, and aggravation of existing cardiovascular disease. Major subgroups of the population that are most sensitive to SO_2 include asthmatics and individuals with cardiovascular disease or chronic lung disease (such as bronchitis or emphysema) as well as children and the elderly. EPA's health-based national air quality standard for SO_2 is 0.03 ppm (measured on an annual average) and 0.14 ppm (measured over 24 hours). Emissions of SO_2 also can damage the foliage of trees and agricultural crops. EPA has a secondary SO_2 national ambient air quality standard of 0.50 ppm (measured over 3 hours) designed to prevent this type of environmental deterioration. Together, SO_2 and NO_X are the major precursors to acid rain, which is associated with the acidification of lakes and streams, accelerated corrosion of buildings and monuments, and reduced visibility.

Lead (Pb)

Nature and Sources of the Pollutant: Smelters and battery plants are the major sources of the pollutant "lead" in the air. The highest concentrations of lead are found in the vicinity of nonferrous smelters and other stationary sources of lead emissions.

Health Effects:

Exposure to lead mainly occurs through inhalation of air and ingestion of lead in food, paint, water, soil, or dust. Lead accumulates in the body in blood, bone, and soft tissue. Because it is not readily excreted, lead can also affect the kidneys, liver, nervous system, and other organs. Excessive exposure to lead may cause anemia, kidney disease, reproductive disorders, and neurological impairments such as seizures, mental retardation, and/or behavioral disorders. Even at low doses, lead exposure is associated with changes in fundamental enzymatic, energy transfer, and other processes in the body. Fetuses and children are especially susceptible to low doses of lead, often suffering central nervous system damage or slowed growth. Recent studies show that lead may be a factor in high blood pressure and subsequent heart disease in middle-aged white males. Lead may also contribute to osteoporosis in postmenopausal women. EPA's health-based national air quality standard for lead is 1.5 micrograms per cubic meter [measured as a quarterly average].

Carbon Monoxide (CO)

Nature and Sources of the Pollutant: Carbon monoxide is a colorless odorless poisonous gas formed when carbon in fuels is not burned completely. It is a byproduct of motor vehicle exhaust, which contributes more than two-thirds of all CO emissions nationwide. In cities, automobile exhaust can cause as much as 95 percent of all CO emissions. These emissions can result in high concentrations of CO, particularly in local areas with heavy traffic congestion. Other sources of CO emissions include industrial processes and fuel combustion in sources such as boilers and incinerators. Despite an overall downward trend in concentrations and emissions of CO, some metropolitan areas still experience high levels of CO.

Health and Other Effects: Carbon monoxide enters the bloodstream and reduces oxygen delivery to the body's organs and tissues. The health threat from CO is most serious for those who suffer from cardiovascular disease. Healthy individuals are also affected, but only at higher levels of exposure. Exposure to elevated CO levels is associated with visual impairment, reduced work capacity, reduced manual dexterity, poor learning ability, and difficulty in performing complex tasks. EPA's health based national air quality standard for CO is 9 parts per million (ppm).