

Biotic factors in Sustainable Agriculture and their Management

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The 20th century saw the development of a multitude of chemicals such as fertilizers, pesticides and growth stimulants to aid the modern farmer. These have greatly increased overall yields, but unfortunately have created new problems, including:

- Reliance of farmers on expensive chemicals
- Health concerns regarding the use of such chemicals
- Contamination of the environment

Controlling pests and diseases in plants

There are a number of different things that can be done to help to control pests and diseases within a sustainable agricultural system. The following will be discussed in detail below:

1. Cultural controls – the methods used to grow plants
2. Physical controls – the methods which physically interfere with pests or diseases
3. Sprays and dusts – natural products which control pests or diseases, some of them do so without undesirable side effects
4. Biological controls – where other organisms control the pest or disease, by such means as directly attacking the problem, by repelling it, or by attracting or luring pests to a place where they can be easily trapped or collected, and then destroyed or removed elsewhere
5. Companion planting – plants growing near one another can enhance or inhibit each other's growth and vigor
6. Legislation – Government laws, for example those covering quarantine can help to address a pest/disease problem
7. Genetic engineering – plants are now being bred that are genetically resistant to certain pests and diseases

Cultural controls: Choose healthy plants, Choose resistant plant varieties, Crop rotation, Timed planting, Irrigation, Mulching, Cleanliness and hygiene, Climate modification

Physical controls: Hand removal, Pruning, Hosing, Physical barriers, Traps, Repellent devices, Scarecrows, Scare guns, Bird wires

Sprays and dusts: Organic sprays and dusts, Pesticides

Biological controls: Antagonistic organisms, Predators, Attracting parasites, Trap or decoy plants, Pheromone traps, Beneficial plants,

Companion planting: Repellent plants, Attractant plants, Plants which affect the soil

Legislation: Chemical use, Quarantine

Genetic engineering: Different Biotechnological and breeding approaches



Chemical control

Some chemical sprays and dusts can be used within a sustainable framework, although obviously the less used, the better. In many cases the amount of chemical used to control pests and diseases can be significantly reduced by:

- Correct identification of the problem
- Correct timing of applications – ensuring that the chemical is supplied at the time when it will be most effective
- Using the most efficient application methods – thereby minimizing the amount of chemical required, and ensuring it gets most effectively to where the problem is
- Careful selection of the chemical/s to be used

Advantages of chemical control

- Reliable
- Low labour costs
- Covers broad areas
- Quick results

Disadvantages of chemical controls

- May kill non target organisms, including desirable species
- Sprayed areas are vulnerable to new pest infestations
- Loss of status as an organic farm
- May leave poisonous residue in the soil

Biological controls

There are three main approaches to biocontrol. These are:

1. The introduction of parasites and predators.
2. Conservation of existing natural enemies by changing spraying programs..
3. New natural enemies can be developed by scientists growing larger numbers of predators or parasites, or by adding additional numbers of natural enemies collected or purchased from elsewhere.

Advantages of biocontrol methods

- In contrast to many chemicals, antagonistic organisms don't damage plants
- No residues are left, as in the case of many chemicals
- It's less costly than using chemicals and, unlike chemicals where repeat applications are generally necessary, predators and parasites may offer continuous control as they continue to breed
- These organisms can spread, often very rapidly, controlling pests and diseases over large areas
- Pests and diseases are unlikely to build up resistance to these organisms, as is often the case when using chemicals
- These organisms are generally predators or parasites of specific pests or diseases and will not affect other organisms

Disadvantages of biocontrol methods

- They are often very slow acting in comparison to chemicals
- The degree of control is often not as high as with chemicals



- It is often very hard to find predators or parasites of some pests, especially ones that are specific to that pest or disease, rather than a number of organisms

The advantages certainly far outweigh the disadvantages in the long term if not in the short term, particularly in terms of the effects on the environment.

The advantages of genetically modified crops

- Resistance to pests or disease
- Reduced reliance on chemicals
- Longer shelf life

The disadvantages of genetically modified crops

- Plant varieties are usually owned by biotechnology companies. In many cases, farmers must pay a licensing fee to grow a particular crop
- Encourages reliance on limited number of crop varieties (loss of biodiversity)
- Loss of status as an organic farm
- Unknown side effects of eating genetically modified food

One of the first genetically engineered crops to be widely grown throughout the world was a variety of cotton resistant to the cotton boll worm. It includes genes from the insect toxic bacterium *Bacillus thuringiensis* (Bt). Use of this Bt variety of cotton has resulted in significant reductions in the use of insecticides.

Integrated pest management

Chemicals kill pests and diseases effectively, but there can be problems if you don't use the right chemical or the right method. There are of course other ways to control pests and diseases, but other methods rarely give the same degree of control as chemicals. Nevertheless, the preferred option these days is usually to use a combination of control techniques. The concept is that:

- Nothing should be used to the detriment of the environment.
- Each different technique weakens the pest or disease that little bit more, the overall effect is cumulative, and may be quite effective.
- Expensive controls (e.g. some costly chemicals) are used in limited quantities, keeping costs lower.

This idea of using a combination of different control techniques which each contribute to the overall control is known as 'Integrated Pest Management' or 'IPM'. The principle of IPM relies upon creating, as far as possible, an environment where there is a balance between sustainable environmental practices and profitable farming.

Sustainable natural weed control

The generally accepted definition of a weed is any plant that, for some reason or other, is unwanted in a particular position. Any type of plant has the potential to be a weed.

Common reasons why people do not want species to grow include:

- Competition – weeds can compete with your desired plants for space, light, nutrients and moisture
- Safety – some plants may be poisonous or cause allergies (eg St John's wort, Bathurst burr, parthenium weed), others may have spines or spikes (eg giant devil's fig, currant bush and Chinese apple) or sharp grass seeds that can injure animals and humans (eg spear grass)
- Harbours or hosting pests and diseases – some plants may act as hosts or as attractants to pests or diseases, while others may provide a safe haven for pests such as rabbits and foxes



- Contamination – plant parts, particularly seeds, can get caught up in clothing, or can contaminate produce, such as grains, or get entangled in animal fur or fleece, or fibre crops (e.g. cotton), or in hay
- Interfere with cultivation – some plants can become entangled in machinery, making tasks, such as cultivation, mowing, or machine harvesting difficult, and possibly damaging machinery

Controlling weeds

Once it is determined that a particular plant or group of plants is a weed, we need to select a suitable method to control it. Chemical methods are the mainstay of weed control on most farms. Herbicides certainly give a quick result, but also have the following problems:

- They can be quite expensive
- There may be legal requirements with regard to their use and storage, and training of operators
- Chemicals can damage other plants, especially if they are applied in windy or hot conditions
- They can wash off in rain and either don't work, or they may run into other areas, causing damage to other plants
- High concentrations can poison the ground and, in extreme cases, prevent further plant growth
- Chemicals can be harmful to animal life including humans, domestic pets, birds, fish, and soil life
- The manufacturing processes involved in making the herbicides can cause pollution problems

Even in 'sustainable farming' methods such as conservation tillage, chemical use is common. It would be extremely difficult for most farmers at present to completely stop using such chemicals; however there are some non-chemical control methods that can be readily applied and which can significantly reduce the farmer's dependence on herbicides.

Ways to control weeds without chemicals

Check soil condition

The first step to control weeds is to improve your soil:

- Use soil ameliorants, such as lime or gypsum where necessary
- Add organic matter regularly (as a mulch or dug in before planting)
- Fertilize your plants regularly
- Improve drainage if necessary

Minimize sources of weed seeds

The next step is to control the source of weed seeds. If you stop weed seeds getting onto your property, you will stop most weeds from becoming established.

- Be careful not to bring any contaminated plants, soil or mulch (or anything else containing weed plants or seeds) onto your field. Materials, such as fresh manures or grass hay to be used as mulch, should be composted before being spread, to kill off as many as possible of the large numbers of seeds that they usually contain.
- Any machinery that has been used in areas with weed problems should be hosed down before being moved to a weed-free area.

Cultivation

Cultivation (i.e. digging or turning the soil with a spade, hoe or engine-driven cultivator) will disturb weed growth and, in the case of annual weeds, often kill the weed.

Mulching



A popular weed control method is to suffocate the weed (block out light) and/or put a physical barrier over it which it can't grow through. This is most commonly known as mulching. What mulching does is to kill weeds simply by smothering them. The weeds are deprived of light and in order for them to grow they have to break through the barrier formed by the mulch.

Biological weed control

This involves introducing natural predators into an area to attack weeds. It is a method which has been used occasionally with dramatic results, but which can backfire if the full implications of introducing something new into an environment are not understood.

Other weed control methods: Mowing / slashing, flooding, solarization, burning, changing soil pH, harvesting weeds, weed control with hot water.

