Chapter 3

Pollution Prevention, Best Management Practices, and Conservation

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Additional information is available at the end of the chapter

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Abstract

Farming imposes unenthusiastic externalities upon society. It effects by different sources such as loss of biodiversity, land erosion, nutrient overflow, more water usage and pesticides. Optimistic externalities include respect of nature, independence, free enterprise, and the quality of air. Natural methods decrease some of these costs. It has been proposed that organic farming can reduce the level of some negative externalities from (conventional) farming. Organic farming seems to be more appropriate as it considers important aspects such as sustainable natural resources and the environment. For sustainable agriculture, the most important key is the conservation of natural resources. As natural resources become increasingly short in supply, in the coming years the transition to a more resource-efficient economy must be a top priority. Agriculture is the most important sector for ensuring food security for next generations while decreasing the resource use and increasing resource recycling. Various studies have been conducted to compare organic and conventional farming systems and the result shows that organic techniques are less damaging than conventional ones because of the decreased level of biodiversity, less use of energy, and lesser amount of waste production. The researchers of various studies concluded that comparing conventional and organic farming demonstrated that organic agriculture poses lower environmental impacts. However, researchers believe that the perfect result would be the expansion of ways to produce the uppermost yields possible by the combination of these two farming systems and to develop the new system for environment, land, and sustainable forests. Biodiversity from organic farming provides assets to humans. Species found in organic farms increase sustainability by decreasing human inputs such as pesticides and fertilizers.

Keywords: Organic foods, externalizes, environment, impact assessment, conservation

1. Introduction

At present, across the world, industrialized and industrializing countries are consuming the earth's resources at an alarming rate. The world population is continually on the climb. More people on earth and changing their consumption pattern increase their essential requirements for more basic human needs like food, water, shelter and energy. This leads to suggest that an essential rethink of the way we manage our natural resources.

Rising means of agriculture farming is the reason that human lives in the world today. For survival these are the necessary means without which there would be famines all over the world. From many thousands of years agricultural farming was a natural process that did not harm the land it was done on. Farmers used such methods for agriculture that after passing of many generations soil would still be fertile as ever, while modern agricultural practices have started the process of agricultural pollution and this causes the degradation of land, environment and ecosystem due to by-products of agriculture. No particular cause can be credited to the extensive agricultural pollution we face today. Agriculture is a multifaceted activity in which the growth of crops and livestock has to be balanced completely. Agricultural pollution progression stems from the many stages their growth goes through.

To be well thought-out a best management practice, an action is required which increase the crop production while reducing the impact on environment. This means that for healthy crop using the best management like reducing the pesticide treatment. Soil plays a very important role for healthy crops and its management is very necessary, it may be challenged by intensive production of horticultural crops. Farming technologies degrade the natural resource base because they require high toxic chemicals. Organic farming rely on the management of soil organic matter to increase the physical, biological and chemical properties of soil for optimization of crop production. Soil management controls the supply of nutrients to the crops. Soil processes furthermore play a key role in suppressing the pests, weeds and diseases. Agricultural research based on technology should be developed by specialist and then transferred to the farmers through demonstration. Environmentally friendly farming system relies on minimal chemical use like pesticide and herbicide because they play an important role in erosion control. Several authors have already described the potential effects of conventional farming versus organic farming on soil erosion control (Lotter etal, 2003; Erhart and Hartl, 2010, Goh, 2011).

The International Federation of Organic Agriculture Movements standards suggested that by using the minimal tillage, crop selection criteria, maintenance of soil plant cover and other methods which reduce the soil erosion, organic farmers should reduce the loss of top soil cover for better production of crops. Conservation tillage should be adopted by organic farmers especially if they are located in areas susceptible to erosion (IFOAM, 2000). The nutrient contribution is very important in organic farming. By organic manure and rotation nitrogen fixed in the legumes and supplied to the crop. Tillage is also very important because it contributes in incorporation and distribution of nitrogen in the topsoil (Koepke, 2003). This chapter explores how organic farmers can utilize a range of management practices to develop and maintain the soil fertility in order to achieve these wider goals.

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1.1. Organic farming

In organic farming, food is grown and processed using no synthetic fertilizers, but pesticides derived from natural sources may be used in producing organically grown food (NOSB 1995). Organic farms reduce some of the negative impacts of conventional farming such as soil erosion and leaching of carbon and nitrogen [1-3]. Organic production has been practiced in the United States since the late 1940s. From that time, the industry has grown from experimental garden plots to large farms where products are formed and sold with specific organic labels. More than forty different state agencies currently certify organic food but their standards are different. According to the organic food production act of 1990, there would be a national list in which the synthetic and non-synthetic substances mentioned cannot be used in organic farming. Organic farming can contribute to protect the environment and nature conservation [4-5].

1.2. Principles of organic agricultural

- Organic farming or agriculture contributes to the health and well-being of plants, animals, soil, earth, and humans; it also provides the nourishment of ecological, physical, and social welfare as it provides chemical- and pollution-free food for humans.
- Equality is obvious in maintaining the integrity of the joint planet mutually amongst humans and further living beings. It is helpful in decreasing poverty and improves the quality of life.
- In the living ecological system, organic farming must be modeled because these methods fit the environmental cycles and equilibrium of the natural world.
- Natural farming should be accomplished in a vigilant and accountable way to promote the environment and generation at present and in the future.

1.3. Regulations for organic farming

The National Organic Program proposed some regulations that will ensure that organically labeled products meet consistent national standards.

- Any farm crop harvesting or handling operation that wants to sell an agricultural product as organically produced must adhere to the national organic standards.
- The national organic standards for production process address the methods, practices, and substances used in producing and handling crops, livestock, and processed agricultural products.
- Organically produced food cannot be produced using excluded methods, sewage sludge, or ionizing radiation.
- The organic crop production standards say that land will have no prohibited substance for 3 years before organic crop harvesting, no use of genetic engineering and ionizing radiation, soil fertility and crop nutrients will be managed, organic seeds and planting stock will be preferred, crop disease, pests, and weeds will be controlled.

- In the livestock standards, slaughtering of animals must be raised under organic management, organically raised animals may not be given hormones to promote growth, and all organically raised animals must have access to the outdoors, including access to pasture for ruminants.
- The handling standards say that all non-agricultural ingredients must be included on the National List of Allowed Synthetic and Prohibited Non-synthetic Substances.

1.4. Environmental benefits of organic farming

Organic farming considers the intermediate and enduring end product of farming interventions on the agro-ecosystem. Organic farming aims to manufacture food, whereas establishing an ecological equilibrium for prevention of soil fertility and other related problems. This method takes a positive move forward, as opposite to treating the problems when they come into view.

1.4.1. Soil

Soil structure practices such as crop rotations, symbiotic associations, and organic fertilizers are middle to organic practices. These promote soil fauna and flora by improving soil formation and structure. In turn, nutrient and energy cycling is increased and the retentive abilities of the soil for nutrients and water are enhanced, compensating for the non-use of mineral fertilizers. In soil erosion control such management techniques also play an important role. Crop export of nutrients is usually compensated by farm-derived renewable resources, but it is sometimes necessary to supplement organic soils with potassium, phosphate, calcium, magnesium, and trace elements from external sources [6-8].

1.4.2. Air

Organic farming reduces non-renewable energy use by decreasing agrochemical needs. It contributes to mitigating the greenhouse effect and global warming through its ability to appropriate carbon in the soil. Many running practices include recurring yield residues to the soil, use of crop rotations, returning of carbon to the soil for increasing the productivity, and increasing addition of nitrogen-fixing legumes. In many different studies, it was reported that the soils under organic farming have more carbon content as compared to other soils. The more organic carbon is retained in the soil, the more the mitigation potential of agriculture against climate change is higher [9-11].

1.4.3. Water

Pollution of ground water with synthetic fertilizers and pesticides is a major problem in many cultivation areas. Synthetic fertilizers are prohibited in organic farming, they are replaced by compost, animal manure, green manure (organic fertilizers), and through the use of greater biodiversity they contribute to enhance the structure of soil and water infiltration capacity. Risk of ground water pollution may be greatly reduced by properly managed organic systems.

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Organic agriculture is greatly expectant as an uplifting measure in those areas where pollution is a genuine dilemma [12].

1.4.4. Genetically modified organisms

The use of these within organic systems is not permitted during any stage of organic food production because their potential impact on health and environment is not entirely understood. Organic farming encourages natural biodiversity. The organic label provides an assurance that these organisms have not been used intentionally in the production and processing of organic products. In conventional farming, increasing the use of genetically modified organism and due to the method of transmission of these organism in the environment (through pollen), organic farming will not be able to ensure that organic products are completely free from genetically modified organism in the future [13-15].

1.4.5. Biological services

The collision of natural farming on usual resources favors connections that are vital for both organic production and nature protection within the agro-ecology. Biological services results include stabilization forming and conditioning of soil, nutrient and waste recycling, predation and habitats. Development of pollution-free agriculture systems depends upon the consumer's purchasing power to buy organic products [6-7].

2. Pollution prevention in organic farming

Getting higher resources of farming and cultivation is why humans live in this world. Farming is an essential resource of continued existence; the lack of these resources leads to famines all over the world. Organic farming was a natural process for the last several years that did not harm the land; many generations of crops have been produced without affecting the fertility of soil. However, modern farming practices have started farming pollution that affects the ecosystem, land, and environment. Farming is a multifaceted activity in which the growth of crops and livestock has to be balanced perfectly [16].

2.1. Causes of farming pollution

2.1.1. Fertilizers

In earlier days, fertilizers have been considered the source of pollution, but in modern days, they treat local pests with new persistent species that have existed for many years and they are loaded with chemicals that are not natural. When pesticides have been sprayed, it mixes with the water and seeps into the ground. Plants absorb the leftover pesticide, and as a result, local streams become contaminated. When these crops are eaten by animals, they are also affected [17].

2.1.2. Livestock

In the past, livestock (cattle, sheep, pigs, chickens) were fed with natural diets, which was supplemented by the waste left over from the crops, and farmers would like to keep them on land. Thus, the animals helped to maintain the farm health as well. But these days, livestock is raised in overcrowded areas, fed with unnatural diets, and sent to slaughterhouses regularly. They cause farming pollution by means of emissions [18].

2.1.3. Weeds and pest

Reducing the natural species and growing unusual crops has become the standard in farming in different areas. The entry of new crops in the local market has resulted in new pest diseases and weeds that the population is not capable of fighting. As a result, local vegetation and wildlife are destroyed permanently. This simply adds to the process of farming pollution [19].

2.1.4. Contaminated water

One source of pollution is the use of contaminated water for irrigation. The water we use comes from ground water reservoirs that are clean and pure water. Other sources are polluted with organic compounds and heavy metals due to the disposal of industrial and agricultural wastes in local bodies of water. As a result, crops are exposed to that water and the process of agricultural pollution becomes harder to fight when such water poisons the livestock and causes crop failure.

2.1.5. Sedimentation

Soil has many layers but only the top layer supports farming. One common reason for the declining soil fertility is inefficient farming practices. Due to these practices, soil left open is eroded by water and wind. This soil is then deposited somewhere and causes sedimentation. This sedimentation causes soil rise in areas such as rivers, streams, ditches, and surrounding fields, and the process of agricultural pollution prevents the natural movement of water, aquatic animals, and nutrients to other fertile areas.

2.2. Effects of farming pollution

2.2.1. Effects on aquatic animals

Organic matter such as ammonia or fertilizers turned into nitrate decreases the level of oxygen in the water and causes the death of many aquatic animals. From animal wastes, bacteria and parasites can get into drinking water, which can cause serious health problems for a variety of aquatic life and animals. It is a hard issue to keep farming pollution in check as it seems. It is difficult to keep track of water levels, soil cleanliness, and industrial pollution. For the last few years, governments have become stricter about enforcing rules. Farmers are becoming aware about the damages and are looking for solutions; most of them are moving toward conventional farming. But for the process of farming pollution to be fully reigned in, there has to be a complete shift in the way cultivation is practiced.

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2.2.2. *Effects on health*

The main source of pollution in water and lakes is farming pollution. Fertilizers and pesticide chemicals are absorbed by ground water and end up in drinking water and cause severe health problems. Oils, degreasing agents, metals, and toxins from farm equipment cause health problems when they get into drinking water.

2.3. Pollution prevention practices

Pollution prevention means reducing the originating of wastes. This will include practices that conserve natural resources by eliminating pollutants through increased efficiency in the use of raw materials, energy, water, and land. Pollution prevention minimizes pollution at the source, so pollution is not created in the first place and never enters into the environment. Environmental prevention has involved controlling and treating the pollution, which in many cases we continue to create. It is helpful in reducing the risks on health and the environment in many ways, such as eliminating the risks associated with the release of pollutants to the environment, avoiding the shift of pollutants from one medium to another medium, and protecting the natural resources for future generations. Pollution prevention can be promoted through several ways such as using voluntary pollution reduction programs, engaging in partnerships, providing technical assistance, funding demonstration projects, and incorporating cost-effective pollution prevention alternatives into regulations. It also involves using systematic management methods such as grass and tree planting technology, improvement of medium and low farmland, and overall use of rural energy resources in order to deal with and improve the ecological environment [20].

3. Management practices in organic farming

In production methods, soil texture plays a bigger role. It influences when a producer can till, the types of tillage methods used, and the frequency of green manure crops. The production methods developed are suited to the climate and soil texture of their farms.

3.1. Healthy soil

In an organic farming system, soil health is the key to success. Soil health can be assessed qualitatively. Many producers look for a dark, rich-colored soil with earthy smell and good organic matter. Earthy smell indicates that the soil is rich of microorganisms, which are vital to soil health. Some take a note of wildlife attraction to the field; birds can be a good indication of earthworms and other organisms. Some producers note the color of leaves and the development of root systems as crops grow; yellow leaves indicate low nitrogen levels, red color and dead spots indicate a plant is under stress, and dark green color with slow growth indicates low nutrient levels. Weeds growing in the field indicate which nutrients are available in the soil; they require the same nutrients but in different amounts. Fertile soil is called healthy soil; it contains sufficient chemical nutrients (macronutrients and micronutrients) for plant growth.

Those needed in larger amounts are called macronutrients such as nitrogen, phosphorus, calcium, sulfur, and potassium. Among them, nitrogen is commonly limited to plants and it is abundant in air; few free-living microbes and rhizobium associated with legumes can fix the nitrogen from air. While other minerals can move into the soil from the underlying rocks. When products are removed from the farm ecosystem, nutrients are removed from the soil. Among them, nitrogen is removed in the largest quantities, but fortunately it can be replaced from the air. Fertile soils can be easily tilled and have good structure, it allows good penetration and absorption of nutrients. Biological fertility such as microbes cycle chemical nutrients available via the breakdown of plant residue and animal wastes. They form a symbiotic relationship with the plants that increase the amount of soil that plants are able to search the nutrients.

3.1.1. Soil test

To check the level of soil fertility and nutrients, soil test may be needed. Soil test provide information about soil nutrients, pH, and organic matter. Some soil test results include macronutrients. These soil tests typically provide recommendations about fertilizers in farming. Soil testing can be beneficial for organic producers. Long-term changes in soil fertility help the producers to adjust soil management strategies such as crop selection, rotation, and green manure. Experienced producers do not feel the need to test the soil; they evaluate the health of the soil using production yield. For the soil test, it is very important that soil samples be collected and stored properly according to the instructions of the laboratory, especially in the case of soil biology, as soil organisms can die or multiply rapidly and this may invalidate the results. A few soil tests that are used by organic producers are as follows:

1. Soil food web Canada, Inc., measures the biodiversity (quantity of bacteria, fungi, and nematodes) in the soil, suggests optimal levels for different crops, and provides suggestions to increase the activity of soil.

2. Western Ag Innovations Inc. evaluates soil fertility by using a Plant Root Simulator probe. For this purpose, probes are placed in the soil for different time periods and measure the level of nutrient across the membrane. It will give a good estimate of nutrients available to the plants.

3. Kinsey's Agricultural Services analyze the soil sample by using the Albrecht system. Their recommendations are based on fertilizer preference, crop history, and type of operations.

4. ALS Laboratory group assesses the level of macronutrients and micronutrients in the soil. This test measures the level of nutrients that can be extracted, including organic matter, pH, and cation exchange capacity.

3.1.2. Soil biology

Soil biology can be encouraged by several methods. Many experienced producers suggest that green manure is one of the best methods to maintain the life of soil; other methods are animal manure and straw residue, selecting good rotation, and reducing tillage. Many farmers recommended that all straw be worked back into the soil to return the nutrients. They provide microorganism to increase the organic matter of the soil. Legume incorporation causes a change in microbial population toward greater metabolic activity and increases organic matter. Soil microorganisms are also affected by tillage; mostly producers try to keep less tillage operation and maintain some cover on all fields throughout the growing season. For this purpose, green manure is the best strategy as it covers the land and protects it from drying out. Organic producers must care and try to avoid methods that increase the soil erosion and kill soil microbes [21].

3.1.3. Soil organic matter

Organic matter is the key for maintaining water holding capability and soil health. Animal and plant residue, along with the soil organisms such as bacteria, fungi and nematodes, are the component of organic matter remains in the soil worked from year to year. As a result of climate and vegetation that existed before the land was broken, organic matter is formed. The four different divisions of soil organic matter are fresh organic matter, decomposing organic matter, stable organic matter, and living organism. When fresh organic plant material is added to the soil, microbes break it down and this moderately decomposed organic matter holds nutrients for growing plants. In the decomposition process, stabilized organic matter is the final product; it provides structure to the soil resulting in good aeration and water holding ability [22].

3.1.4. Soil applied

Some experienced producers use calcium, sulfur, gypsum, and rock phosphate after soil tests indicate low levels of nutrients. To improve the soil biology, microbial organisms are also used.

3.1.5. Foliar applied inputs

Some producers use foliar sprays as inputs on the plant when it is growing. These can be used to control the disease or to reduce the risk of disease. Most often, the intention is to feed the helpful organisms that reduce the risk of pathogens.

3.1.6. Manure and compost

Manure is an excellent organic fertilizer; its use is highly regulated by organic standards. To build the soil fertility many livestock producers use it. It can be used in different forms such as organic composted manure, deposition on crop land, and application of manure without being composted. For proper decomposition, it should be applied at a suitable time of the year and at a proper peak in the rotation. For more effectiveness, fresh manure should be incorporated soon to decrease the nitrogen loss and it should be applied in cool conditions; however, many producers will age manure for several years before putting it in the field, which is not so good [23].

Composting is one step forward to manure; it is a process that can be described as the aerobic decomposition of organic matter to produce a humus-like product called compost. In this process, microorganisms (fungi) are involved that convert the manure to humus, which is darker in color and has an earthy smell. Composting requires some machinery and effort to maximize the humus-producing potential of manure. To meet compost standards, producers must mange proper air, moisture, and temperature in the mass. Proper composting balance between carbon and nitrogen proportion is necessary. Careful planning is required when making an allowance for compositing animal wastes on farms. The location of the compost site matters a lot to avoid risks to ground water and nearby water sources. Enclosing livestock and collecting, transporting, and spreading compost and manure are costly and inefficient. The simple method adopted by some producers is that they allow livestock to graze crop land and put the fertilizers straight onto the field [24].

3.1.7. Nutrient amendments

A few producers use amendments such as seed inoculants and foliar spray on the green parts or soil. Organic amendments have very little reliable use. These products should be used carefully. Before using any amendment, it must be ensured that it is approved for organic production.

3.1.8. Seed inputs

Nitrogen fixation is very important for plant growth. For nitrogen fixation, rhizobial inoculants with legumes are used as they create an environment that favors the bacteria responsible for nitrogen fixation. They do not need seed inoculants, but some experienced producers suggest that if the inoculant is applied on or below the seed they give better results. Some additional products such as humates, mycorrrhizal fungi, and other microbes respond to crops differently, their response depending upon crop, crop cultivar, and management history.

3.1.9. Green manures

A green manure is a crop worked into the soil to provide nutrients to the organisms and ultimately to the crops. To sustain a healthy soil, the use of green manure in crop rotation plays an important role. Green manure is a legume that fixes nitrogen into the soil; availability of nitrogen depends on the growing condition, moisture, and inoculation. Producers recommended sweet clover, alfalfa, red clover, field pea, and faba bean for nitrogen fixation and oilseed and buckwheat to improve phosphorus availability.

3.1.10. Rotation of crops

Rotation is a planned sequence of crops, and organic producers consider it as the most important key in organic farming. A lot of scientific literature suggests that crop rotation is more beneficial than monocultures. The more variable the rotation, the more stable the yield. Resources can be used more effectively by rotating the crops with different characteristics. As we know, crops differ in their requirements of water, nutrients, and susceptibility to pests and diseases. The sequence of crops must be cautiously selected, which is well adapted to the fertility level, to avoid the disease potential that builds in crops. Rotation is planned according to the health of the soil such that crops that require tillage should be balanced with crops that

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build organic matter, and crops that utilize more nitrogen should be balanced with crops that supply nitrogen. Crop rotation is also very important in weed management. For different crops, different weed management practices are used. Each type of management practice is a disturbance that favors one weed species over the other. If annual crops are rotated with winter crops, then the disturbance pattern is varied and different species are disadvantaged at different times. This results in a more diverse weed community. This diversity can be beneficial as it increases the variety of food and shelter available to the beneficial organisms. Rotations are also crucial to insects and disease management. Insects and diseases are specific to a single crop; if they remain away for a long time from that crop, they are not able to increase to a dramatic level. Most producers consider rotation to be a work in progress that will change as the soil changes. A flexible rotation is recommended by most experienced producers to respond to changes in disease pressure, market, and contaminations by microbes. Organic producers take soil samples every couple of years and spend time in learning how they can improve the farming techniques.

3.2. Seeding

Seeding is the time when planning and reality come together. Most often, the weather determines when to seed, what to seed, and which equipment to use. The ideal time for seeding is when it grows in a weed-free environment. Weeds are much more competitive when the crop emerges, as compared to the established crop. Mostly producers are not able to buy new equipment for seeding; it is time to consider what can be done to give the best advantage to the crop. The time of seeding is very important; in wet years you can seed anytime, but in dry years, you must seed as early as possible. Try to avoid seeding in very hot temperatures; if you want to seed early, then notice the condition of soil; if you seed late, then control the weeds.

A number of factors are considered by producers for crop selection such as soil fertility, weed control, crop type, and previous crop in rotation, but experienced producers follow some criteria and then choose the variety of crop to plant. In this criteria, the varieties to select from are based on which ones grow well and have disease resistance, heritage varieties, high-quality crops such as wheat with high protein, varieties that are in demand in organic markets, and varieties that can give viable seeds for the next year. Producers identify the characteristics that are best suited to the organic production and then they seed. Organic producers think that heritage varieties are best because they are developed without chemical and fertilizer inputs. Under organic management, producers can perform and yield well.

Seed quality and seeding rate are very important in organic farming. Experienced producers do not consider it necessary to use certified seeds; some suggest it is important only when it was time to renew the seed. Some scientific studies confirm the advantage of high seeding rate. Higher seeding rate can increase the crops’ ability to cover land. Increasing seeding rate may be more important under conditions of higher fertility, when weeds may be more competitive. Crop emergence can be affected by seeding equipment. Organic farmers favor different types of seeding equipment. The most preferred seeding equipment that are used by organic producers are air seeder, disk seeder, double disk press drill, and valmar spreader. These are used for different seeds according to the climatic conditions.

3.3. Weeds

For new organic farmers, weed management is very threatening. Organic fields share the same weeds as other farms. For determining the weed community, some factors are important such as soil texture, environmental variables, and crop rotation. The most common weeds, such as wild oats, bluebur, stinkweed and wild buckwheat, are found on organic farms. Many producers suggest that tillage can be a powerful weed management tool especially before and during seeding. Weeds that emerge before the crop gain more of the resources and thus have much more effect on the crop than weeds that emerge later. A second option for weed control exists after seeding but before the crop emerges. Some successful weed control practices used by organic producers are the use of solid crop rotation, delayed seeding, seeding with high rate, spiking in the fall to control quack grass, and growing alfalfa and sweet clover to suppress weeds. It is also very important in weed management practices to know the ecology of weed management.

3.3.1. Ecological weed management

For weed management, most of the organic farmers rely on multiple plans. Ecological weed management promotes weed suppression, instead of weed elimination, by increasing crop competition and phytotoxic effects on weeds. A specific method such as crop rotation is one of the best methods used by organic farmers to control weed management. Organic producers suggest that small grains or legumes must be planted for at least one year out of every five years to maintain soil health. If the legume is plowed under as a cover crop in the fifth year, four years of row crops may be grown prior to the green manure crop year. The same crop cannot be grown in sequential years; due to this, soybean cannot be grown in the same field year after year. The ideal crop preceding soybeans is winter rye. Soybean fields are rotated to a small grain (oats, barley, wheat, or rye) or corn.

3.3.2. Production practices

Organic farmers suggest some production practices for weed management such as variety selection where farmers select crop varieties (e.g., quick canopy-forming) that compete well with weeds within and between rows. As regards crop density, planting at the utmost modified population will provide the crop an enhanced competitive border over weeds. Closer row spacing generally has greater crop competition with weeds in row middles. For the rapid canopy, high germination rate seeds are more preferable. Date of sowing matters a lot; warm season crops are planted when the soil is warmed properly to facilitate the germination.

3.3.3. Physical tactics for weed management

These are the key factors to control weed management on all organic farms; it includes mulching, cultivation, and propane flame burning. Mulching is used in combination with manual labor in many horticulture operations for proper weed control. It is of two types, natural and synthetic mulches. These are used in organic operations along with polyethylene film and polypropylene landscape fabric. Mulch can be made from small grain and soybean

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straw. During decomposition, organic mulches add organic matter to increase soil porosity, water holding capacity, microbial populations, and cation exchange capacity. Straw mulch is used in organic horticultural operations, for example garlic, strawberry, and herb farms, to control weeds and protection from harsh environments.

Timely cultivation is critical in organic weed management. Depending on the crop, cultivation offers the least labor-intensive weed control method. Midwestern organic farmers used two to three row cultivations. First cultivation occurs at a slow speed, second cultivation usually is completed at mid-season at a faster speed, while third cultivation is again performed at a slow speed. Propane flame-burners have been added as an additional tool in their weed management toolbox by many organic farmers. When tillage with large machinery is not feasible, flaming is used during high field moisture, while in drier weather it is used in conjugation with cultivation.

3.4. Insects

The most experienced organic producers are serious about insect problems. During dry season the most common and problematic insect is the grasshopper. If the crop and soil were healthy, then there would be less insect problems. There are some specific recommendations for insects: for grasshoppers, use tillage to avoid egg laying, use foliar sprays, seed early and use alfalfa border; for lygus bugs, delay seeding; for wheat midge, select resistance varieties and delay seeding; and for aphids, keep an environment where predators flourish. Most producers do the best they can to control insects.

3.5. Tillage

In organic and conventional farming, soil erosion resulting from tillage is a major concern. Organic producers use more tillage; they use it for seed bed preparation, weed suppression, and for the incorporation of green manure. To prepare seed bed and to control weeds tillage, a harrow and cultivator is used; those who used disc seeders reported less cultivation because this method killed weeds. Some farmers used light tillage with harrow to control weeds before and after crop emergence. In a survey, organic producers were asked about the increase or decrease in their tillage operations, they replied that type of tillage had changed. At the beginning, organic producers used more tillage operations to control the weeds, but after that producers moved toward less tillage.

Tillage can be reduced, although it is the only method of terminating the green manure. Recently, producers have challenged the belief that tillage is needed for green manure termination through the method of rolling, mowing, and blading. One producer indicated that the wide-blade cultivator causes minimal disturbance to the soil and leaves much residue, so this was an effective way to terminate green manures while reducing the risk of soil erosion. Generally, tillage operations are used more in black soil where there is high weed pressure. Producers who used more tillage operations try to minimize erosion potential by understanding the condition of the soil.

3.6. Transition

A transition from conventional to organic farming is not an easy step; it takes time and requires a change in mind set. Some producers suggest that transition in the mind takes longer compared to the transition on the land. Producers learn more because new methods have come into practice such as green manure, rotation of crops, mechanical weed control, organic fertility management, and erosion reduction. Transition time is very important, because it provides time for the soil to become free from chemicals that remain in the soil due to conventional farming. Weed control and soil fertility is the top priority. It is an economically vulnerable time. Although the transition is difficult, organic farming made them feel empowered. New organic farmers recommend the following about tillage during the transition years: understand the soil; till in different directions in different years; for weed control, keep tillage to the minimum need; replace black fallow with weed fallow; try to avoid tilling light soils in dry years; and harrow the cereals when they are about four inches in height.

4. Conservation in organic farming

The most important key for sustainable cultivation is the conservation of natural resources, especially considering the decreasing conditional subsidies of the Common Agricultural Policy of the European Union for the coming years. If lower economic support compels farms to increase efficiency to reduce production costs, at the same time providings an interaction of agricultural activities with environment quality, suitable natural resources management will be a vital feature for farms.

4.1. Soil conservation

Soil is the production base of all agricultural systems and its conservation is the pillar of sustainability. Soil quality is affected by wind and water erosion and farming practices. Soil erosion is one of the factors of organic farming, so it is necessary to develop soil conservation practices. Conservation practices are usually those that decrease wind speed, reduce rate and amount of water movement, and raise soil organic matter levels. All these conservation managements are not employed to all situations; the management will depend upon the soil type, climate, topography, and type of farming in that area. Producers can use a number of conservation practices that are best for their farms. However, organic crop producers have to face great challenges because conservation practices that use herbicides are not an option. Some common organic crop production practices, such as post-emergent harrowing for weed control, are destructive to the soil. So producers may need to employ some additional conservation measures if practices such as post-emergent harrowing are used. To conserve the soil, some strategies are presented as follows.

Crop residues (roots, chaff, stems, and leaves) are the key source of organic matter replacement. These residues also contain nutrients such as phosphorus, sulfur, potassium, nitrogen, and micronutrients. They improve soil properties such as water infiltration, water storage, and particle aggregation. Among crops, the amount of residue produced and the rate of decay are

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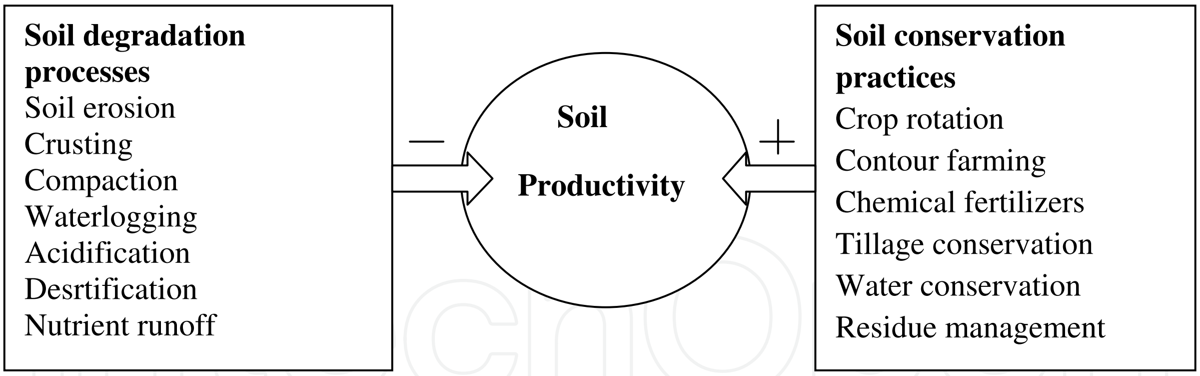

different. The combination of these two factors determines the quality of residue in relation to its value for soil conservation [25].

4.1.1. Forage crops

Forage crops contribute significant amounts of organic material to the soil and offer an alternative product in the form of hay, silage, or seed. Forage production for two to four years should also be considered as part of a normal crop rotation. Selection of forage species and management practices can be customized to specific problems such as drought, salinity, poor soil structure, low pH, and excessive soil moisture.

4.1.2. Stubble cutting

Moisture conservation is also important because the additional moisture will improve crop growth. It may also allow extending the rotation, which is another conservation practice. It can be enhanced by trapping more overwinter snow with "tall" or "sculptured" stubble. Tall stubble refers to stubble that is cut 12 inches high, while sculptured stubble refers to alternate swaths that are cut at normal height and taller.

4.1.3. Direct seeding

In organic farming, herbicides cannot be used. Organic crop production is not usually associated with direct seeding but some producers do put into practice direct seeding. However, organic producers possibly will think about this protection practice when low weed pressure and previous crop straw and chaff have sufficiently spread [26].

4.1.4. Balancing of rotational crops

An ideal rotation should be as diverse as possible; a diverse crop rotation can help soil nutrient availability because different crops remove different nutrients. Most commonly, sixteen essential nutrients are present in soil. In the rotation, growing legumes provides both nitrogen and non-nitrogen benefits to following crops. If legumes are inoculated properly, they fix 90% of their nitrogen necessity from the air and rest is obtained from the soil. However, during the growing season, nitrogen is exuded from legume roots and the legume residue decomposes and recycles the nutrients quicker than non-legume residues, thus more nitrogen is regularly accessible to the following crop than if a non-legume had been grown. When planning complementary rotational cropping, growth patterns of a variety of crops should also be taken into account. Crops with broad leaves such as polish canola, lentil, flax, and pea take out nutrients and moisture from more shallow rock bottom than cereals that belong to spring-seeded. Thus, winter wheat rooted deep uses moisture in the early growing season while the recurrent forages use nutrients and moisture from subsoil because they are deep rooted. Shallow-rooted crops are best adapted as compared to deep roots because they will not expand energy in search of moisture as compared to other crops. Medium root crops come into view as enhanced and modified to pursue shallow-rooted crops as they benefit from any moisture left at the depth, which is not used by the preceding shallow-rooted crop [27].

4.1.5. Total crop rotations

Summer fallowing is destructive to the soil because no new organic matter is returned to the soil during this year. Breakdown of soil organic matter increases due to tillage. Extending crop rotations is a conservation practice because it reduces the incidence of summer fallow. This practice can improve fertility, collective constancy, tilth, damp storage space, and conflict to soil erosion and deprivation, in addition to decreasing insects and disease problems. All these reported factors enhance yield productivity and have positive effects on soil sustainability. Decisions for cropping strategies would not be for a short duration but the long-term effects on the soil and environment should also be considered. A varied crop rotation should comprise pulses, seed oil, fall-seeded crops, and forages. Crop diversity level determines the implication of the rotational payback. During rotation, some selection and management of legume species is a vital aspect of achieving diversity and supplying nitrogen through symbiotic nitrogen fixation.

4.1.6. Tillage

During tillage crop residue, conservation is affected by the equipment type, speed, depth, and frequency of tillage, as well as soil and climatic factors. Limiting all these factors conserves crop residue and soil moisture. It has been difficult to convince researchers and extension services that rigorous tillage does not allow for soil and water conservation and decreases soil natural content. Tillage may be defined according to conservation farming as the integration of agronomic practices with the aim of conserving, improving, and efficiently using natural possessions [28]. On yield consistency, the farmers' point is correct but the reason of low yield in conservation tillage systems is only associated with the first few years of the changeover period between conservation practices and intensive tillage. Energy can be saved by adopting the method of reduced tillage and greater savings can be achieved by no-tillage [29]. Greater benefits can also be noticed in relation to environmental aspects; large amounts of crop residues on the soil surface reduce water runoff and nutrients loss [30].

In tillage operations during shallow tillage, crop residue accumulates near the soil surface and it will be most effective in reducing wind and water erosion by improving infiltration and reducing evaporation. Reducing tillage speed generally reduces crop residue burial. Residue

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conservation is significantly influenced by tillage equipment type; for instance, a wide-blade cultivator preserves considerably more remainder than a cultivator that is considered better than a discer. The addition of harrows to a field increases the amount of remnants buried, while adding a rod weeder to a cultivator does not considerably affect deposit lessening. The need of each tillage operation should be carefully considered according to the type of soil, but tillage should be avoid under wet soil conditions as this can degrade soil structure and significantly decrease surface residue levels [31].

4.1.7. Wind barriers

4.1.7.1. Annual crop barriers in crops

Taller annual crops have been used as barriers to a restricted degree in low residue-producing crops. A divider is placed in the seedbox so that two rows of wheat are seeded every seeder width. At harvest, the lentil is combined and the barrier strip left standing to trap snow and prevent wind erosion during the upcoming winter.

4.1.7.2. Strip cropping

In strip cropping, alternating strips of crop and summerfallow consists at an angle perpendicular to the prevailing winds. According to the soil, texture strip width varies. Wind erosion is more common in sandy soils as compared with clay and loam soils. Strip cropping works well for loam and clay soils where increase stripping will considerably decrease the potential for wind erosion. In sandy soil types, too many strips are essential to be convenient. When establishing strip widths, the size of field equipment should be kept in mind. This practice is more common in drier areas; however, it can be used in wetter areas where the pattern of strip formation is changed to avoid water erosion.

4.1.7.3. Cover crops

Rotations should also comprise the use of cover crops to protect the soil from water and wind erosion throughout susceptible periods, for instance, summer fallow when normally position stubble does not exist. Cereal yield should be seeded between August and September; fall frosts will be able to kill plant material and remain on the soil surface until spring planting, providing valuable soil protection. Winter wheat, fall seeded cereal may be used in a parallel fashion. In the following spring, these crops may be removed by tillage or used for short-term livestock grazing, or grown to maturity in the case of winter wheat or fall rye [32].

4.1.7.4. Shelterbelts

It can effectively decrease wind velocity for a distance of 20 or more times than their height. They effectively control wind erosion when planted at the right angles to current winds. The effectiveness of shelterbelts depends upon maintenance, in addition to height. They may also be helpful for increasing crop yields.

4.1.7.5. Perennial grass barriers

These are two rows of grass planted at right angles to current winds to decrease wind erosion, entrap snow, and reduce evaporative losses. Placement of barriers depends on soil type; these are closest on sands, moderately spaced on clays, and utmost apart on loams. Barriers may be placed further apart if other soil conservation practices are also being used. Tall wheatgrass is a weak participant with most field crops and will not spread beyond the seeded rows. It also grows high enough without accommodation to trap snow, helping in soil moisture renewal.

4.1.8. Green manure

The assimilation of any green vegetative material into the soil is called green manure. In crops, it adds organic matter to the soil and improves soil health. The extent of soil improvement depends on the type and quantity of plant material returned to the soil. Biennial or perennial legumes as green manure give great benefits to soil with poor level of organic matter but the time of implanting these legumes matters a lot. Grain legumes, such as pulses, can be used as green manure effectively because their annual growth habit will not contribute in nitrogen fixation as biennial or perennial legumes. However, they are more flexible to an accessible crop rotation. Non-legume crops can also be used as a green manure crop [33].

4.1.9. Animal manure

Animal manure, such as livestock and poultry, provides not only nutrients to plants but also affects soil tilth and particle aggregation. Organic matter contained in manure act as binding agents in stabilizing soil structure. The addition of manure changes the soil structure and this surely affects water infiltration, water holding capacity, and aeration, as well as resistance to wind and water erosion. Manure nutrient value depends upon some factors such as animal type and age, type of feed, amount of straw, and method and time of storage. In the manure, some micronutrients are helpful to prevent the plant deficiency symptoms from happening. The rate of manure application recommended by different soil testing laboratories that test the animal manure for nutrient content depends upon the availability of soil type, slope, location, and different construction practices. For the prevention of environmental contamination, rates of manure application should not exceed what a crop can use in one growing season. Following manure application to prevent nitrogen loss, it should be incorporated as quickly as possible into the soil for proper plant growth [34].

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