Adapting Nature Farming to Large-Scale Vegetable Production

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Abstract
Over the last decade, nature farming has been adapted for the large-scale production of vegetable crops at a farm in Lompoc, California. Successful management techniques include permanent beds, use of soil amendments and effective microorganisms. Specific practices such as soil fertility management, weed and insect control are described.

Background

Our attempts to adapt nature farming to commercial-scale vegetable production began in 1981 on a 10 acre farm in Camarillo, California. At Camarillo we developed our permanent bed system for large-scale production and were able to grow top quality produce with respectable yields.

The accomplishments at Camarillo led The Naturfarm to move in 1988 to a much larger site to provide a commercial-scale example of nature farming methods and the permanent bed system. On its 75 acres of cropland near Lompoc, California, The Naturfarm staff continue to fine-tune and develop the permanent bed system and other techniques, adapting the principles of nature farming to large-scale production of vegetable crops in the United States.

Basic Principles of Nature Farming

Nature farming is based on a philosophy and a spiritual way of life that acknowledges the earth and the soil as a living being. Nature farming seeks to enhance the life force of the soil and the plants growing in the soil; it avoids all practices that are unnatural, especially those that use pesticides and herbicides. The cultural practices that characterize nature farming are deliberately chosen to enhance the growth of desirable life forms. These practices can be separated by function: soil tilth, soil fertility, and pest management.

In nature farming we seek as much as possible to apply the patterns found in nature to the agricultural setting. Our desire to respect nature and preserve the natural soil structure and soil profile with its natural horizons led us to the idea of experimenting with equipment-managed permanent beds in the field. We felt that this technique could be very effective if transferred to large-scale production as a means of reducing compaction, preserving the natural soil profile, and nurturing soil life, thereby optimizing productivity and conserving energy.

Permanent Beds to Enhance Soil Tilth

Initial Bed Preparation

Initial bed preparation consists of a deep subsoiling followed by chisel plowing to break up soil compaction without inverting the soil. Rototilling then breaks up the clods, and a spike-tooth harrow smooths the surface. At the same time, a furrowing device mounted on the middle cultivating bar of the tractor creates permanent paths between the 80 inch wide beds. The tractor and all farm equipment will use these permanent paths during all subsequent field operations.

Bed Maintenance Between Crops

The permanent beds are maintained from crop to crop. After a crop is harvested, a forage harvester chops all remaining crop residues. If it is a heavy residue crop, the residue is chopped, blown into a wagon and hauled out of the field to be used in making compost. In the case of a light residue crop, it is chopped and left on the surface of the soil, forming a layer about 1/2 inch (1 to 2 cm) thick, evenly spread over the bed. Compost is spread on the beds at 3 to 5 tons per acre. Then the compost and chopped residues are rototilled into the top 3 to 4 inches (7 to 10 cm) of soil. This is followed by a thorough irrigation that includes the application of effective microorganisms (EM)* through the irrigation system. Throughout all of these operations, the tractor wheels, forage harvester wheels, and compost wagon wheels follow the same path so that the permanent bed, the central crop-growing area, is not compacted or driven upon by any of the farm equipment. In effect this provides a controlled-traffic pattern.

A week or so later, and after decomposition of the crop residues is well underway, we till again with spear-point cultivators mounted behind the tiller. They penetrate deeper than the tiller to prevent compaction and the development of a tiller-pan. They do not invert the soil, but rather create vertical channels into the lower soil profile. Next, the spike-tooth harrow and/or smooth harrow, mounted in the rear of the tractor, smooths the bed for planting crop seeds. A cross-section of the finished bed reveals a loose layer in the top 10 to 15 cm and firmer soil below, with channels to the lower profile allowing easy root penetration. After the preceding tillage operations, the soil profile approximates a natural soil, and becomes more natural as successive crops are grown and as a beneficial soil microflora is developed.

Soil Fertility Management

The Naturfarm's soil fertility program consists of the use of compost, cover crops and effective microorganisms (EM).

The forage harvester, used for chopping crop residues, is also used to collect materials for making compost. Dry grasses are mixed with fresh green-chop from the vegetable fields. The compost pile is layered: a layer of dry grass followed by a layer of fresh green-chop. Each layer is thoroughly watered, and EM 4 is applied to enhance the composting process. By the next day, the temperature of the compost pile has usually increased to approximately 150^{o}F (65.5^{o}C).

Mixed cover crops including nitrogen-fixing legumes and fibrous grasses are planted at least every two years to maintain and improve soil tilth and fertility. Sometimes they are incorporated directly into the soil and EM is applied to accelerate their decomposition. At other times, the biomass is removed for composting.

An effective way of applying EM on a large scale is using an injector tank which connects to the irrigation line. The concentrated EM solution is placed in the tank, and EM can then be precisely metered into the irrigation system and evenly spread over the growing area with overhead sprinklers.

Weed Management

The basic concept in weed management is to sufficiently reduce the number of weeds to allow good crop development and eliminate reseeding which always makes weed management more difficult. Total eradication of all non crop plants is usually impractical and not necessarily desirable. Weeds can provide benefits in both pest and fertility management by serving as alternate host or trap crops for beneficial and/or harmful insects, and by accumulating nutrients for recycling.

Preplanting Weed Germination

When the seedbed is ready for planting, and before planting crop seeds, preplanting weed germination is encouraged. The field is sprinkler irrigated to germinate weed seeds near the surface. Then, the spike-tooth harrow is used with its teeth set to penetrate only about one inch (3 cm) to avoid bringing new weed seeds to the surface. The roots of the young weed seedlings are exposed and they quickly wither and die. This preplanting weed germination technique vastly reduces weed pressures in the following crop.

Planting

Precision planters are used to plant vegetable seeds in 2 to 5 parallel rows (depending on the type of crop), allowing future cultivation of the entire bed at one time.

Primary Cultivation

For precise cultivation of small-1eaved vegetables, a double disk cultivator is very effective. It can be used when the crop is at a very young stage since it throws material away from the plant row and prevents burying the young seedlings. The double-disk cultivators can even be used without preplanting weed germination if weed pressure is not too great, because cultivating can be done when the weeds are very young and can be easily controlled. This saves time, water, and energy.

Large-leaved vegetables, like squash, have an initial plant size that is too large for the disks. A configuration of knives and sweeps are used to eliminate weeds between the rows.

Thinning

Following the primary cultivation, the crops remain on 2 to 5 inch wide (5 to 13 cm) bands of noncultivated soil. During hand thinning this band is cut through with a hoe when any weeds remaining in the row are removed, leaving plants spaced for growing to maturity. Crops that are not thinned (beets, spinach, carrots, etc.) are hand weeded as it becomes necessary.

Secondary Cultivation

Before reaching the harvest stage, there may be one or two other cultivations. Depending on crop type and size, a configuration of knives and sweeps are used to cultivate the soil between the crop rows. This removes or prevents a second generation of weed growth.

Roguing

Hand hoeing of weeds missed in the foregoing operations, and those which sprout in the rows after thinning, is practiced where necessary. This provides the crop with sufficient space if there is heavy weed pressure, and prevents reseeding of weeds.

Additional Methods

An alternate method for large-seeded crops (beans, squash, corn, etc.) is to plant them approximately 3 inches (7 cm) deep following the preplanting weed germination, and then irrigate them thoroughly. As soon as possible, the spike-tooth harrow is used to kill germinating weeds in the surface soil and to create a dry mulch of loose soil above the germinating crop seeds. The crops can then emerge easily through the loose mulch and establish themselves with very little pressure from annual weeds.

Insect Management

The nature farming philosophy views pests and diseases as symptoms of an ecological imbalance or toxic condition. This could be the result of past practices (e.g., toxic condition due to previous use of agricultural chemicals), or current management practices that are pushing the farm ecosystem out of balance. A pest outbreak or infestation, or an air- or soil-borne disease is a natural ecological reaction indicating the need to restore the farm to a more favorable ecological balance.

The first line of defense in the nature farming pest management program is the creation of a fertile, healthy soil and farm ecosystem that supports the growth of healthy, vigorous crops, and provides a biological system of checks and balances. Techniques utilized include: selection of crop varieties appropriate to the climate and soil of the farm and resistant to certain insects and diseases; intercropping; creation of an on-farm insectary using break strips of alfalfa and mixed pasture species as habitats for beneficial insects and as trap crops for pests; mechanical removal of pests using a *Cycle-vac* insect vacuum; beneficial insect releases to supplement those that occur naturally on the farm; and applications of effective microorganisms (EM). If intolerable levels of economic damage begin to occur, organically-allowable biocides (such as pyrethrins, soaps, etc.) would be used. However, we have not chosen to use any of these to date.

* EM (Effective Microorganisms) is a group of mixed cultures of microorganisms that have been developed and patented by Dr. Teruo Higa of the University of the Ryukyus in Japan for the purpose of improving soil tilth and fertility, and of increasing crop yield and quality.

Each formulation (EM 2, EM 3, EM 4) is dominated by a different group of organisms that collectively can achieve specific results. EM 2 and EM 3 are used on growing crops to help make nutrients available from organic matter and soil minerals, EM 2 is a complex culture solution dominated by yeasts, photosynthetic bacteria, and ray fungi; EM 3 is 95 percent photosynthetic bacteria. EM 4 is used to help decompose crop residues and other forms of organic matter added to the soil. EM 4 is dominated by Lactobacillus bacteria. Research on the use of EM is underway in the U.S. and elsewhere. EM has been extensively researched in Japan and is used by many farmers there.