Transition to Kyusei Nature Farming at the Naturfarm in Lompoc, California

J.M. Phillips
Nature Farming Research and Development Foundation
Lompoc, California, USA

Abstract

The property located near Lompoc. California that became the Naturfarm was farmed using conventional agricultural practices prior to being purchased for Kyusei Nature Farming. The conversion process began immediately upon purchase; the process itself became the subject of a study that was funded by the California Energy Commission and known as “The Naturfarm Conversion Project.” This study examined the transition to nature farming with respect to potential energy savings compared with conventional practices in three areas: soil fertility, tillage and pest control. The premise of the study was that considerable energy savings could be realized in nature farming as a system of sustainable organic farming practices because of the elimination of energy costs for chemical pesticides and fertilizers, and the heavy tillage practices of conventional agriculture. Nature farming practices at the Naturfarm are described in this paper and the results to date are presented.

Background

The process of conversion from conventional agricultural practices using chemical fertilizers and pesticides to Kyusei Nature Farming as a system of sustainable organic agriculture was the subject of a study funded by the California Energy Commission (CEC) and is known as the Naturfarm Conversion Project. The start-up transition began upon the purchase of the property in 1988. The farming system used at the Naturfarm was described at The First International Kyusei Nature Farming Conference (Meyer, 1991).

The nature farming system uses compost, cover crops, crop residues and the microbial inoculant EM (Effective Microorganisms) to maintain soil productivity and fertility. On-farm insectaries, known as “pest break strips”, are used as habitats to attract both harmful and beneficial insects. Weeds are controlled by various methods of mechanical cultivation. Tillage practices employ a controlled-traffic, permanent bed system resulting in reduced energy for tillage compared with conventional practices.

Preliminary results for the Naturfarm Conversion Project have been published as annual technical reports to the CEC (Phillips et al., 1990; Meyer, 1992) and in a preliminary status report of CEC projects published by the CEC (CEC, 1992).

In 1992, the Naturfarm system was adjusted to include more intensive use of EM, plus the addition of a fermented compost known as Bokashi in the fertility program. New cover crop mixes and species were evaluated. Tillage practices were modified to incorporate rotary spading for periodic deep tillage. New cultivation equipment and techniques were deployed, including flame weeding and the use of a multivator cultivator. The pest break strip system was renovated using a new insectary seed blend. Electric fencing was used to control feral pigs, a major pest of root crops and sweet corn in this area.

Future modifications will examine the use of transplants to foil birds and to increase production. A greenhouse was constructed for year round production of high premium vegetables and for production of transplants. The study is projected to continue through 1994 with the goal of producing a handbook describing the results and the recommended practices for use by farmers who are interested in undertaking the conversion process. This manual is also intended for use by extension agents and farm advisors who are assisting farmers in the transition process.

Transition to Nature Farming

To evaluate the transition to Kyusei Nature Farming we must define the term in order to know when we have achieved a successful conversion. Nature farming can be defined both descriptively and quantitatively. The principles of Kyusei Nature Farming began in Japan in 1935 under the guidance of Mokichi Okada (1882-1955), a Japanese naturalist and philosopher. The Nature Farming Model is based on the harmony and balance of natural ecosystems to sustain fertility, productivity, and biocontrol of pests. A key principle is the relationship between healthy plant growth and the presence of "living soil," i.e., soil that is alive with microbial life, earthworms and other soil organisms. Of course, nature farming does not rely on synthetic chemicals either as fertilizers or as insecticides, herbicides or plant growth regulators.

In a positive sense, nature farming incorporates the balancing mechanisms designed by nature. These include the regeneration of soil fertility using natural composts made from crop residues, and the use of cover crops, animal wastes and other sources of organic matter. Recommended practices include reduced tillage, organic mulches and cover crops to protect the soil from wind and water erosion, and windbreaks to control wind erosion. A nature farming system encourages the use of natural systems and cycles. Areas are set aside as habitats for beneficial organisms, insects and birds. But the creation of a "living soil" is the major tenet of nature farming and is the principal objective in the transition process.

Nature farming, as taught by Mokichi Okada, is not a "do-nothing" farming method. Nature farming recognizes the key role of humans in a system of agriculture which is in harmony with nature. The use of appropriate technology to save human energy and to increase productivity is sanctioned. Human intelligence and aesthetics, science, art and spirituality play a creative and necessary role in nature farming. After all, the goal for the pursuit of any farming system must be to provide for the needs of human beings. According to the five principles of nature farming derived from the teachings of Mokichi Okada, nature farming includes a goal to provide for the needs of nature and the environment, as well as the goal for feeding an expanding human population (Higa, 1991).

Nature farming may be defined as a system of natural agriculture modeled on nature's own laws and principles. Kyusei Nature Farming incorporates appropriate technology, organic farming practices and the philosophy and teachings of its founder, Mokichi Okada. The result is the creation of a "living soil" to sustain crop growth and yield.

Living Soil

The term "living soil" seems at first to be a qualitative term, but the papers presented at this conference on soil quality as an index of sustainability in agriculture suggest that this term can also be measured quantitatively to some degree. Higa (1988) has shown that agricultural soils can be classified according to their dominant microbial life forms and that this is characteristic of the farming system being used. The relationship is outlined in Table 1.

Table 1. Microbiological Classification of Soils and Characteristic Farming Systems.

Soil Type	Dominant Microorganisms	Farming System
Disease-Inducing Soil	*Pathogenic* Fusarium, Pythium, Verticillium	Conventional
Disease-Resistant Soil	*Non-Pathogenic* Actinomycetes, Mycorrhizae, Trichoderma	Organic
Zymogenic Soil	*Nutrient-Sharing* Lactic Acid Bacteria, Yeasts, Fungi	Early Nature Farming
Nutrient-Synthesizing Soil	*Nutrient-Synthesizing* Rhizobium, Azotobacter Photosynthetic Bacteria	Mature Nature Farming

The classification of soils according to dominant microorganisms is a useful tool to define nature farming and to assess the transition process. It is also useful in understanding and defining the term "sustainable agriculture." The classification is based on observed and measured effects of populations of various kinds of microorganisms. This type of classification complements the usual physical and chemical analysis, i.e., classification of soil types by such factors as pH, alkalinity, acidity, salinity, CEC, nutrients, texture, and so on.

Conventional Agriculture: Disease-Introducing Soil

In conventional farming systems, soil-borne diseases are common, and populations of pathogenic microorganisms may be dominant and disruptive to crop production. Frequently a number of species of beneficial microorganisms are either suppressed or absent. These conditions are induced by the practices of conventional agriculture. The use of chemical fertilizers, insecticides, herbicides and synthetic plant growth regulators, and the practice of extensive disruption of the soil through heavy tillage results in severe damage to soil structure with consequent suppression of the beneficial microorganisms that characterize a living soil.

Research on beneficial soil organisms is now beginning to document the adverse effects of various common use chemicals in conventional agriculture. The results show that pathogenic organisms, which are more resistant to chemicals, proliferate in the soil and cause diseases that disrupt production. Thus, these soils can be classified as disease-inducing, and they are often associated with conventional farming systems.

Organic Farming: Disease-Resistant Soil

In organic farming systems, beneficial microorganisms are maintained by the proper and regular addition of various organic amendments including composts, animal manures, green manures, cover crops, crop residues, municipal wastes and food processing wastes. Beneficial microorganisms that may decline with chemical-based farming can often be re-established in degraded soils with these amendments. As the soil microbial diversity increases, conditions become more unfavorable for plant pathogens as nonpathogenic microorganisms begin to form communities and associations that compete for nutrients, niches and other resources. The soil becomes disease-resistant; this condition is characteristic of organic farming systems.

Early Stage of Nature Farming: Zymogenic Soil

In the natural soils of forests and prairies and in the soils of advanced organic farming systems, symbiotic associations of microorganisms develop that retain nutrients and energy in the system by cycling them between aerobic and anaerobic microorganisms. The anaerobic fermentation pathway is important in this cycling process that works in opposition to methanogenesis and ammonification; nitrogen, hydrogen and carbon are recycled into organic acids, sugars, alcohols and other substances that are readily utilized as substrates by other microorganisms. The term zymogenic is derived from the word "zymogen," a term for a non-catalytic substance formed by organisms as a stage in the development of an enzyme (Chambers, 1974).

Soil that has become zymogenic functions in a manner similar to the rumen of a healthy herbivore. That is, any available organic material is rapidly digested by fermentative microorganisms that, then, share the products of digestion with other microorganisms and with the host organism. It is at this stage that the soil becomes "living," and functions like a whole organism. It is capable of all the functions of a living organism: it can consume food, digest, assimilate and excrete; it can organize itself to protect its systems and functions from invasive diseases; it can grow and mature, and replicate itself. Living soil may be the oldest living thing. In a sense, it even may be said to be almost immortal; under normal circumstances, it does not die but constantly renews and regenerates itself.

Plants are one of the beneficiaries of this nutrient sharing that occurs in zymogenic soil. Mokichi Okada tried to explain this relationship, but the science of his day was not able to understand what he was trying to say. Research on nature farming has begun to demonstrate this phenomenon, and the creation of zymogenic soil characterizes the early stages of true nature farming. Normally it takes some time for this stage to be reached, usually a matter of three to four years, sometimes longer. It is associated with the rise of organic matter in the soil and by the microorganisms that dominate soil dynamics, chiefly lactic acid bacteria, yeasts and certain fungi, including actinomycetes and various species that form mycorrhizal associations with plants.

Mature Nature Farming: Nutrient-Synthesizing Soil

In nature farming, as the system matures, a stage is eventually reached where the soil becomes capable of nutrient synthesis, i.e., of generating enough nutrients to support healthy crops and high yields without the addition of outside inputs such as compost and manures, minerals or organic fertilizers. This is true living soil characteristic of mature nature farming systems. It may take some time to reach this stage; eight to ten years to several decades may be a reasonable period for development of this phenomenon. It is associated with the stabilization of organic matter at a high level, and with the proliferation of nutrient-synthesizing organisms such as *Azotobacter*, photosynthetic bacteria, *Rhizobium spp*., blue-green algae, and other species. It is also characterized by mature plant growth with a balance of annual and perennial species that work together to maintain the “living soil.”

Transition and Conversion

Transition and conversion are terms for related processes. Transition refers to the step-wise path taken to change from one system of farming to another. Conversion refers to the rather abrupt breaking point where the last of the practices associated with the old system are abandoned for new methods characteristic of the new system. Thus, farmers may take years to undergo transition from conventional farming practices to organic farming, dropping certain practices year by year until they reach the point where transition is complete and conversion to the new system takes place. This is the recommended strategy for an ongoing operation and it allows for a gradual buildup of the support systems, biologically and economically, to achieve a successful conversion.

Transition at start-up of a new operation is a special challenge. Usually it takes some time to understand the capabilities of the new farm, the fields, the soils, the climate and weather, and also to create facilities and infrastructure, train labor and management, and develop reliable markets. An abrupt total conversion from one farming system to another at start-up is problematical. Nonetheless, many who are entering farming today with .the intent of farming organically do so with a plan to abruptly convert to organic farming practices and to forego any use of synthetic chemicals.

The Naturfarm Experiences

The Naturfarm property was fanned conventionally for many years. After it was purchased in 1988, the use of all chemical fertilizers and pesticides ceased. A history of agrichemical applications was obtained from the former owners for the previous three-year period. After a one-year fallow period, the farm was certified organic by California Certified Organic Farmers (CCOF) under the then existing rules that allowed for a one-year transition period. Fortunately, a grant had been obtained from the California Energy Commission to study the transition process at the Naturfarm, and this study coincided with start-up of the farm.

Baseline insect and soil sampling began in early 1989. At the outset it was noted that the farm was essentially biologically “dead” as far as beneficial insects and soil life-forms were concerned. A certified entomologist made regular visits and reported the presence of substantial numbers of pest species, and the near total absence of a predator/parasite complex of beneficial species to control them.

Preliminary Results

The Naturfarm Conversion Project will continue to December, 1994. Preliminary results of the project are promising, and are presented as follows.]

Energy Savings

Energy use at the Naturfarm is monitored for three areas of focus for the study, i.e. tillage, fertility and pest control, and will be compared with the available data for conventional agriculture. The interim results are summarized in two technical reports (Phillips et al., 1990; Meyer, 1992). A projection of per crop-acre energy savings for the Naturfarm compared with conventional agriculture is presented in Table 2 (Phillips et al., 1990). This projection was made at the outset of the project and represents the Naturfarm Conversion Project goals for energy consumption. These projections and comparisons are based on the experiences of the Camarillo Naturfarm (which preceded the current Naturfarm in Lompoc) compared with conventional agricultural practices reported for Ventura County by the University of California Cooperative Extension Service (Brendler, 1981).

Table 2 suggests that the Naturfarm method would result in the conservation of nearly 15 gallons of diesel fuel per acre compared with the conventional system, a savings of over 22 percent. The Naturfarm method is expected to be especially efficient with respect to energy savings for tillage and pest control (insects). Weed control is expected to be more costly for the Naturfarm since herbicides are not used and weeds are controlled by mechanical and hand cultivation. It is anticipated that this cost will decline over time as weed seed is eliminated by cultivation.

Table 2. Projected Per Crop-Acre Energy Consumption and Conservation Naturfarm Compared with Conventional Agriculture Expressed as Gallons of Diesel Equivalent.

Component	Energy Consumption		Energy Conservation	
	Conventional	Naturfarm	Difference	Percent
Tillage	17.00	9.01	7.99	47.00
Fertility	35.69	30.70	4.99	13.98
Insects	8.86	5.02	3.84	43.34
Weeds	5.02	7.07	-2.05	-40.84
Total:	66.57	51.80	14.77	22.19

Tillage

The Naturfarm uses a permanent bed, controlled-traffic, minimum tillage system which is projected to conserve 8 gallons of diesel fuel per acre (a savings of 47 percent) compared with conventional tillage practices (Table 2). In Nature Farming, deep tillage such as chiseling and moldboard plowing is avoided. Tractors always follow the same traffic patterns and wheel tracks. The permanent beds become increasingly soft and easy to till. This type of tillage is ideal for developing a living soil, as soil microorganisms and earthworms are not subject to undue disturbance, and the loss of soil moisture through surface evaporation is minimized. Tillage and bed preparation for the Naturfarm have become a simple two-step process involving rotary spading and use of a tiller-bed shaper. Crop residues and cover crops can be incorporated by chopping with a flail mower followed by spading. This is in contrast to conventional tillage practices that include deep soil disturbance by sub-soiling, deep plowing, disking, leveling and bed shaping.

The Naturfarm tillage method allows for the gradual accumulation of a surface layer of organically-enriched topsoil. This greatly enhances soil tilth. Interim results indicate that the Naturfarm tillage system can probably increase its projected energy-use advantage over conventional farming systems as the Naturfarm develops more effective conservation/reduced tillage methods.

Soil Fertility

The Naturfarm fertility system forgoes the use of chemical fertilizers and relies instead on organic inputs including cover crops, crop residues, compost and natural minerals such as gypsum and elemental sulfur. In addition, the use of microbial inoculants, especially Effective Microorganisms (EM) but also *Rhizobium* inoculants for various legumes, is a prominent feature of the Naturfarm soil fertility program.

Results of Strip Trials

In 1990 and 1991, a strip trial test area was set aside in Field W-3 at the Naturfarm to evaluate cropping system performance during transition. Studies on fertility treatments evaluated three amendments, i.e., EM, compost, and another microbial fertilizer, known as Bioflora, compared with an untreated control. EM and Bioflora were applied at rates according to the manufacturers recommendations. EM was applied at the rate of 1 gallon per acre in one application before the crop was planted and four times during the growth of the crop at two- to three-week intervals. Bioflora was applied at 15 gallons per acre in one application prior to planting of the crop. Compost was applied just prior to bed preparation. Crops grown in the strip trial test were green and red leaf lettuce, spinach, cabbage and Romaine lettuce. In addition to crop yields, other data were taken such as pre-primary cultivation weed counts, and weed counts at the end of the trial.

Some preliminary results of these strip trial tests are presented in Table 3 (Trial 1) and Table 4 (Trial 3). The effects of EM, compost and Bioflora on the yield of Romaine lettuce (mean heads per plot) are reported. It is noteworthy that Trial 1 was preceded by a cover crop of rye and common vetch while Trial 3 was not. Yields were generally higher for both EM and Bioflora inoculants when applied with a cover crop or with compost. Studies on the interaction of cover crops, compost, bokashi, EM and organic mulches are continuing at the Naturfarm.

Pest Management

The management and control of pests is always an important consideration in farming. At the outset of the Naturfarm Conversion Project, it was expected that pest control would be one of the most difficult problems to overcome because of the unique aspect of the interpretation of the Nature Farming philosophy that no pesticides or biocides, organic or conventional, would be used in the project. This meant that all pest control problems had to be solved by cultural practices, crop management decisions, and biological controls. The results thus far, have been illuminating and encouraging, especially with respect to in-sect control. The experiences with this approach will be thoroughly covered in the final project report. Some interim results follow.

Table 3. Results of Strip Trials Comparing the Effects of EM, Bioflora and on the Yield of Romaine Lettuce (Trial 1, Harvested August 1990)

Treatment	Mean Heads Per Plot	Statistical Significance	
		0.05%	0.01%
BF + Compost*	171.7	a	a
EM + Compost*	157.3	a	ab
Compost:*	154.3	a	ab
EM + Compost	152.3	ab	ab
Compost	144.3	abc	abc
EM	140.0	abc	abc
BF + Compost	120.5	bcd	bc
BF	117.2	cd	bc
Control	103.8	d	c

LSD .05 = 30.0; LSD .01 = 40.2

Means followed by the same letter are not significantly different from each other according to Duncan's Multiple Range Test.

EM = Effective Microorganisms

BF = Bioflora

*Compost applied at a rate of 5 tons/acre/year, compost in other treatments was applied at a rate of 5 tons/acre/crop.

Table 4. Results of Strip Trials Comparing the Effects of EM, Bioflora and Compost on the Yield of Romaine Lettuce (Trial 3, Harvested July 1991).

Treatment	Mean Heads Per Plot	Statistical Significance	
		0.05%	0.01%
EM + Compost	392.2	a	a
BF + Compost	351.3	ab	ab
Compost *	351.0	ab	ab
Com post	349.3	ab	ab
Control	343.3	abc	ab
EM + Compost*	315.8	bcd	b
BF	296.2	cd	b
EM	291.5	d	b
BF + Compost*	290.7	d	b

LSD .05 = 45.5; LSD .01 = 61.1

Means followed by the same letter are not significantly different from each other according to Duncan's Multiple Range Test.

EM = Effective Microorganisms

BF = Bioflora

*Compost applied at a rate of 5 tons/acre/year. Compost in other treatments was applied at a rate of 5 tons/acre/crop.

Insects

Control of insect pests was a major concern of the Naturfarm Conversion Project. A series of "pest break strips" was designed and planted to alfalfa with some pasture grass as a nurse crop to serve as on-farm insectaries and insect habitats. Each pest break strip was from five to seven beds wide and established at inter-strip distances of 350 feet across the farm. The beds comprising the pest strips were developed when the permanent beds were laid out and planted with the first series of commercial vegetable crops. Early plantings of vegetable crops were hit hard by such common pests as aphids and cabbage looper. As the pest break strips began to function, releases of beneficial insects, such as ladybugs, lacewings and *Trichogllamma* sp., began to combine with indigenous populations of natural predators and parasites and to provide effective biological control. Management practices that help to keep the pest break strips attractive to both pests and biological control species are regular mowing and irrigation.

At the start of the project, regular field sampling indicated low numbers of insects overall, especially of beneficial insects and spiders. Within the first year, overall insect numbers soared and beneficial insects and spiders became prominent. Aphids, thrips, loopers, beet armyworms and many other common pests of vegetables were brought under effective biological control without the use of sprays. At the present time, only three pest species have not been controlled effectively with the pest break strips. These are the western flea beetle, the spotted cucumber beetle and corn earworm. Nevertheless, the results overall are remarkable considering the fact that many pests attack vegetables. Control of the remaining pest species is being attempted by cultural/management practices such as crop planning and planting dates to avoid the time of peak activity of the pest.

Future research will examine the use of barriers to possibly ward off these pests and the use of transplants to evade feeding damage at the susceptible stage following germination all emergence. These insect pests have not seriously affected yield and quality of most of the crops grown at the Naturfarm. This is an encouraging result that should be noted by farmers contemplating transition.

Diseases

In general, the use of disease resistant varieties whenever available has limited the impact of plant diseases at The Naturfarm. Blue mold (*Peronospora effiisa*) is prevalent on spinach if susceptible varieties are grown. Downy mildew (*Bremia lactucae*) sometimes attacks leaf lettuce. Cucurbits are often attacked by downy mildew (*Pseudoperonospora cubensis*) and powdery mildew (*Spaerotheca fuliginea*), but usually this is late in the crop cycle and has little or no affect on yield. Beet cyst nematode (*Heterodera schachtii*) was observed on red beets and green cabbage in the first two years but has not affected recent crops. Many factors are involved in keeping disease losses as low as possible, including the use of resistant varieties, rotation with cover crops and non-host crops, and the use of EM, bokashi and compost to inoculate the soil with beneficial microorganisms.

Weeds

Control of weeds at the Naturfarm has been difficult and costly. Annual species such as Mexican-tea (*Chenopodium ambrosiodes*), lambsquarters (*Chenopodium album*), shepherds purse (*Capsella bursa-pastoris*), London rocket (*Sisymbrium irio*), cheeseweed mallow (*Malva parviflora*), purslane (*Portulaca oleracea*) and mustard (*Brassica kaber*) have caused crop losses and yield reductions. Considerable time and expense have been expended on mechanical cultivation and hand weeding. Some cover crops, especially Sudan grass, have suppressed weed growth. When turned under at about 45 days growth, Sudan grass releases allelopathic chemicals that help to suppress weeds and soil insects. With careful cultivation over time and through the use of weed suppressive cover crops, we expect that the weed seed bank in the soil will be reduced. If so, the cost and time required for weed control should decrease accordingly.

In the strip trial test area, data were taken on emergent weed counts just prior to primary cultivation. At the end of the cropping season, surviving weeds were counted just prior to mowing and turning under the residue. These data provide interesting information about the seasonal cycles of different weed species, the preferences of certain weeds for certain soil types, and the weed species that can persist in row crops such as red leaf lettuce under hand and mechanical cultivation. Buttonweed or cheeseweed mallow, as it is also known, persisted in the clay loam soil area and purslane persisted in the sandy loam soil area at the end of the crop. Both of these species can produce prostrate, spreading growth forms and this may be a factor in surviving cultivation practices. The clay loam soil type was preferred by lambsquarters, Mexican-tea, and buttonweed while the sandy loam soil was preferred by pulslane and nutgrass. Primary cultivation weed counts did not show a consistent pattern through the trials for any of the treatments. Additional studies are planned to determine whether there is a consistent pattern of a “weeding effect” by EM, or whether it simply demonstrates seasonal moisture and temperature effects on weed seed germination.

Vertebrate Pests

Vertebrate pests have contributed to crop losses that at times have been severe at the Naturfarm. Feral pigs, horned larks and western pocket gophers have caused large amounts of damage. Other birds, deer, and mice and other rodents have caused comparatively minor damage. Many control measures have been tried. Just prior to carrot harvest, pigs regularly destroyed the crop. Hunting and trapping did not stop them. Finally, an electric fence was erected around one field and was successful in keeping the pigs out. Electrical fencing has since been erected around the entire farm and has eliminated losses and damage by pigs.

Horned larks migrate into the area in great numbers during the fall. They can cause as much as a 50 percent loss of young seedlings, especially in crops like lettuce, cabbage and broccoli at the two or three true leaf stage. Aluminum tape attached to the sprinklers has not frightened them off. Neither has loud noises nor other scare tactics. Bird netting was considered but thought to be too expensive and too disruptive to farm operations such as cultivation. The solution may be in the use of transplants grown past the susceptible stage. Another suggested approach is to grow some sacrifice or trap crops to lure them from the cash crops. Future research will seek a genuine solution to this problem, perhaps as a combined approach of transplants and other methods.

Western pocket gophers can be very damaging. Since we do not use poisons, the chief control method has been by trapping. This can be very effective when an area has been freshly tilled. Gopher activity is easy to spot in freshly tilled beds and traps can be set in active burrows with considerable effectiveness. Raptors such as hawks and owls, and other predators such as farm cats and dogs, bobcats and coyotes catch a fair share of gophers and other rodents. The presence and activities of such predators precluded the use of poison baits. In general, the numbers of vertebrate pests have been reduced to acceptable levels in most areas of the farm.

Conclusion

This paper presents some of the preliminary results of the Naturfarm Conversion Project. The transition process from conventional farming to nature farming will conclude in 1994. A manual and workbook on the transition will comprise the final report of the project. It is hoped that this study will serve as a guide for farmers who are considering such transitions. The results show that many of the problems farmers dread the most can be readily overcome by nature farming and organic methods. Problems with tillage, soil fertility, insects, diseases, weeds and vertebrate pests have effective organic solutions. It is our recommendation that the transition process at the Naturfarm be monitored and studied for at least an additional five-year period. By that time, the development of zymogenic and nutrient synthetic soil that characterizes a successful transition to nature farming should be readily apparent.

Acknowledgements

Support for this research by the Rural Assistance Program of the California Energy Commission is gratefully acknowledged. The sponsorship of the Naturfarm and the work of the Nature Farming Research and Development Foundation by Sekai Kyusei Kyo, Atami, Japan is gratefully acknowledged. The contributions of the CEC Naturfarm Conversion Project Team Members is also gratefully acknowledged, especially Ricardo Amon, California Energy Commission; Everett J. “Deke” Dietrick, Rincon-Vitova Insectaries, Inc.; and Paul Dilger, Ag Consultants. Special thanks are due to Dr. John C. Phillips at Cal Poly, San Luis Obispo, who assisted with the statistical analyses of data from the Strip Trial Test Area. Dr. Teruo Higa provided technical advice throughout this project on nature farming and the use of EM technology, and his assistance has been invaluable. Last1y, Harlyn and Jim Meyer designed and initiated the CEC Naturfarm Conversion Project and served as the initial NFRDF Project Manager and Cooperating Farmer, respectively. Their contributions and service over many years, both to nature farming and to the organic farming movement in California, are widely recognized and appreciated.

References

Brendler, R.A. 1981. Costs and Practices for Row Crops in Ventura County. University of California, Cooperative Extension Service, Ventura, California.

California Energy Commission (CEC). 1992. Farm Energy Assistance Program, Draft Status Report, July. Alternative Farming Systems Projects: Naturfarm Conversion Project. California Energy Commission, Sacramento, California.

Chambers. 1974. Dictionary of Science and Technology, Vol. 2. W. & R. Chambers, Ltd., Edinburgh, Scotland. 1292 p.

Higa. T. 1988. Considering Agriculture from the Principle of Creation-Role of Kyusei Nature Farming for the Future of Mankind. Lecture given in a Seminar for Japanese Dietmen. (Available from the Nature Farming Research and Development Foundation, Lompoc, California).

Higa, T. 1991. Effective microorganisms: A biotechnology for mankind. p. 8-14. In J.F. Parr, S.B. Hornick. and C.E. Whitman (ed.) Proceedings of the First International Conference on Kyusei Nature Farming. United States Department of Agriculture, Washington, D.C., USA.

Meyer, H. 1991. Adapting nature farming to large-scale vegetable production. p. 16-19. In J.F. Parr, S.B. Hornick, and C.E. Whitman (ed.) Proceedings of the First International Conference on Kyusei Nature Farming. United States Department of Agriculture, Washington, D.C., USA.

Meyer, J. 1992. Project Report, December. Naturfarm Conversion Project. Nature Farming Research and Development Foundation, Lompoc, California.

Phillips, J.M., J. Meyer, and V. Wegrzyn. 1990. Annual Technical Report Naturfarm Conversion Project. Nature Farming Research and Development Foundation, Lompoc, California.