Effective Microorganisms: A Biotechnology for Mankind

Teruo Higa
University of the Ryukyus, Okinawa, Japan

Good Morning everybody. First I would like to express my deep gratitude to Lt. General Chawal Kanchanakool, Director of Policy and Planning, of the Green Esarn Project of Royal Thai Military, Thailand, who generously accepted to be the Ceremony Chairman of this Conference, Khon Kaen University, and Sekai Kyusei Kyo Thai Kyokai, as well as many other people who endeavored to make this Conference possible.

I would also like to welcome the participants of this Conference from various countries. As I have described in the brochure of this Conference, the reason and purpose of holding this Conference originated from Kyusei Nature Farming, which was first advocated in 1935 by Mokichi Okada for saving the world. Okada also founded Sekai Kyusei Kyo, a religious organization in Japan, intending "to create paradise on earth by eradicating disease, poverty, and conflict."

In the 1930s, when chemical fertilizers and agricultural chemicals started being used generally, Mokichi Okada realized the harm of such chemicals through his own experience, and warned of the long-term adverse effects on farming systems that used these chemicals.

He predicted that "the farming method which neglects the power of soil, crops, and nature, damages the soil and the cultivation environment, and crops produced with such a method exert harmful influences on the mental and physical health of human beings, creating a new crisis for mankind."

To avoid such a crisis, he advocated the establishment of Kyusei Nature Farming, which does not depend on chemical fertilizers and agricultural chemicals. He stated that "the principle of Kyusei Nature Farming is to learn from the great power of nature, which is beyond human understanding, and to allow the power of the soil to be fully exhibited by taking good care of the soil."

Without his great courage and deep insight, it would not have been possible to give such a warning at a time when the use of chemical fertilizers and agricultural chemicals was thought to be the solution for the food problems of mankind.

Unfortunately Okada's prediction came true. Since Rachel Carson's book Silent Spring was published in 1962, problems caused by the random use and misuse of agricultural chemicals and chemical fertilizers have frequently been cited in industrialized nations. Consequently, the world began to seriously consider the harm of agricultural chemicals and chemical fertilizers as well as that of other chemicals and their contribution to environmental problems.

As a result, the whole world is now trying to solve such problems through legal restrictions as well as by developing safer agricultural materials and safer ways to use them. Much of the world's agriculture today, however, is based on a system which requires agricultural chemicals and chemical fertilizers, and thus, they are inevitably used as necessary evils.

Therefore, if one tries to adopt a farming method which does not use chemical fertilizers and agricultural chemicals to produce safe food, it is perceived as organic agriculture or primitive nature farming.

Various movements of organic agriculture are in progress around the world with the highest priority on the safety of food. Most of them, however, are established only in limited areas or special regions where necessary organic substances can be easily obtained. As such, these movements have only limited potential for replacing present agricultural methods of food production which are economical and productive for an expanding world population.

Kyusei Nature Farming was advocated in 1935 foreseeing such an impasse. The ultimate goal of Kyusei Nature Farming is to save mankind based on the correct view of nature and to secure the foundation of human existence through the production of abundant healthy food, which is the most fundamental requisite for Okada's ideal, that is, "to create paradise on earth by eradicating disease, poverty, and conflict." A typical scenario of the destruction of mankind is the occurrence of disease caused by food shortages or harmful food, poverty caused by disease, and conflict caused by disease and poverty.

The problem of the rapidly increasing world population is destined to cause global environmental disruption and cannot be solved by extending the present system of food production. An increasing number of people believe that the present situation will lead to the destruction of mankind even if no war occurs. As part of the solution, Kyusei Nature Farming must be an agricultural system which can eliminate such negative factors. There are several requirements which Kyusei Nature Farming must satisfy to become such a system.

The first requirement, “to produce superior food for maintaining and improving human health,” is based on the idea that one’s health depends on the safety and quality of food consumed throughout a lifetime. Various medical problems today can be related to the quality of food consumed. It is clear that agricultural methods which depend on chemical fertilizers and agricultural chemicals cannot solve this problem.

As far as the first requirement is concerned, it has been fully proved that organic agriculture and conventional nature farming satisfy it. Except for a few special cases, however, these farming methods in their present state cannot be extended to agriculture as a whole and still be economically beneficial to both producers and consumers, partly because of the problem of obtaining enough organic substances.

The second requirement is “to bring economic and spiritual benefit to both producers and consumers.” Although farmers are well aware of the negative effects of using chemical fertilizers and agricultural chemicals, they have no other choices. When farmers cannot take pride in producing high quality food, agricultural production and marketing systems will decline. Furthermore, consumers can truly enjoy eating, which is the root of health and well-being, only if they have safe food.

The third requirement is “to be practiced by anybody and to be sustainable.” Since growing crops is the basis of life, a farming method cannot secure the foundation of human existence unless it can be practiced by everyone. If it requires its practioners to learn the complicated names of pesticides and fertilizers, or if it requires special training or special machines, only a limited number of people will adopt and apply a particular farming method . Such a situation will clearly produce new crises of world peace, as can be seen from the food production strategies of many developed countries. The requirement of sustainability is obvious. Satisfying it together with the second requirement leads to an agriculture which can be continued with pride, and which may also solve many of the problems which agriculture faces today.

The fourth requirement is “to conserve nature and to responsibly protect the environment.” The abuse of chemical fertilizers and agricultural chemicals pollutes not only fields but also rivers, the sea, and other environments, and is directly related to environmental pollution on a global scale. Such agriculture incausing a boomerang effect, and can be said to be suicidal. It is a known fact that the everlasting existence of mankind cannot be sustained without conserving natural resources and protecting the environment. However, there are few agricultural systems which can truly satisfy this requirement. On a global scale, environmental safeguards include prevention of increased atmospheric levels of carbon dioxide, destruction of the ozone layer, and desertification of fragile lands .

The fifth and ultimate requirement is “to responsibly produce enough food for the increasing world population.” Although it is extremely difficult to perfectly satisfy even one of the first four requirements, Kyusei Nature Farming, as intended by Okada, must fundamentally solve the problem of food supply and human health, in addition to satisfying the other four requirements. Some people assert, that it is only idealism. It is impossible to achieve it in reality. The only way to solve these problems is to control the world population and to establish stricter environmental standards. While such measures should also be taken, Kyusei Nature Farming cannot be the one Okada advocated unless it satisfies these requirements.

Okada specified a few conditions for Kyusei Nature Farming to satisfy those five requirements.

The first condition is to turn soil into a nutrient storehouse, that is, to establish a technique which increases soil fertility and the availability of plant nutrients. The second is to establish a technique

which enables soil to become like a skilled worker and to produce more crops as more consecutive plantings are made. The third is not to pollute the soil and to allow the power of soil to be fully expressed, in turn suppressing diseases and insects. He states that these conditions lead to paradisiacal agriculture, which does not require plowing and other labor-intensive practices.

We now realize that Kyusei Nature Farming, as advocated by Okada, is not a natural farming system in which no work is done and everything is left to nature. It is also fundamentally different from organic agriculture, which first returns to the ancient farming method of using no chemical fertilizers or agricultural chemicals, in seeking a new method of farming. In a broader sense, both nature farming in which everything is left to nature, and organic agriculture are possible ways whereby we might fulfill the requirements of Okada's Kyusei Nature Farming. We need to realize that in conventional nature farming many failures, misunderstandings, blame, and criticisms have occurred because associated problems were misunderstood, and there was no attempt to resolve them.

Based on Okada's philosophy, research has been conducted over the past 50 years. However, it was difficult to exceed the level of organic agriculture, and it has become clear that we now need a technical system which is fundamentally different from conventional agricultural techniques. You may wonder if soil can be made a storehouse of nutrients, allowing consecutive plantings, and if crops can be cultivated economically without plowing soil and without using chemical fertilizers and agricultural chemicals. It is extremely difficult with conventional agricultural techniques or with its extensions.

Conventional agriculture is a system which is dominated by approaches or symptomatic therapy, and which requires chemical fertilizers and agricultural chemicals. The largest mistake of this system is that it is based on inorganic chemistry, and it does not consider organic chemistry and vital biological phenomena in the soil.

The current method of soil management is mainly based on the chemistry (acids, alkalis, and inorganic nutrients) and physics (air permeability, water permeability, and water-holding capacity) of the soil. The biology of soil is considered only through the application of organic substances for increasing humus. Therefore, the soil classification is also based on their chemistry and physics. There is no systematic classification of soils based on their biology.

It has become clear from our studies that the characteristics of soils depend largely on the microorganisms which inhabit them. Accordingly, we have classified soils into four types: disease-inducing soil, disease-suppressive soil, zymogenic soil, and synthetic soil.

The reason why conventional agricultural systems have limitations is that they are based on the inorganic approaches mentioned earlier, and that the soil management practices eventually transform farmland into disease-inducing (putrescent) soil. Soil putrefaction, that is, the putrefaction of organic substances plowed into soil, accompanied by malodors, is a phenomenon of organic substances decomposing into inorganic substances.

Putrefaction is also a phenomenon which produces unstable, intermediate products and a large amount of heat, while organic substances are decomposed into inorganic substances by microorganisms. Such intermediate products and heat are harmful to ordinary animals and plants, and cannot be utilized as useful energy. The ancient teaching that one should "use fully-decomposed compost" is based on this fact. This is also the reason why crops tend to be withered or infested with diseases and harmful insects if insufficiently decomposed compost is used.

Crops are frequently infested with disease and harmful insects when soils become putrescent. This is also the case when crops become unhealthy. This mechanism of disease occurrence is common to both animals and plants. Diseases and harmful insects exist in nature to decompose living things that have succumbed to various stress factors. Hence, crops are rarely infested with diseases or harmful insects when they are grown under suitable conditions. Some people believe that worm-eaten vegetables are safe because they are grown without pesticides. Such vegetables, however, are unhealthy and therefore cannot be good for the human body. The prevention of disease and insect infestations starts by purifying the cultivation environment. However, since most of the

microorganisms in nature are putrescent, conditions suitable for putrefaction are easily established if the cultivation environment remains undisturbed.
Chemical fertilizers and pesticides were viewed as an effective means of increasing food production on a limited amount of farmland. However, if they are not properly used, or are excessively used, they may damage intrinsic functions of the soil. The more chemicals are used, the more positive ions are accumulated, changing once healthy soil into a disease-inducing environment with frequent infestations of diseases and insects.
Accordingly, insects and microorganisms which did not cause significant damage to crops suddenly become pathogenic, and diseases and insects resistant to pesticides appear one after another. New pesticides are required, forming a vicious circle. The same phenomenon can also be seen in medicine.
Organic agriculture movements were motivated by efforts to correct such a situation by halting the use of chemical fertilizers and agricultural chemicals and changing conventional, chemical-based agriculture into organic agriculture. To secure the production of safe food, they first returned to the old agricultural method of using no chemical fertilizers or agricultural chemicals, and then started to establish a safe agricultural system different from conventional agriculture.
Generally, the productivity of infertile and degraded soils is restored by raising the humus content using fully-decomposed compost. At the same time compost functions as a soil conditioner to improve soil physical properties. When organic agriculture is practiced on poor farmland, soil fertility is gradually improved, and disease and insect infestations are reduced. It normally takes four to five years to achieve this.
A soil in which disease and insect infestations are suppressed is normally called a disease-suppressive soil. Most native forest soils are strongly disease-suppressive. If a forest is cleared leaving the surface soil intact, and crops are cultivated, they grow very well for the first few years when the disease-suppressive power of the soil is still effective. As the humus content decreases, and soil fertility declines, the soil becomes a disease-inducing soil, and diseases and insects begin to frequently infest crops.
Crop productivity can be increased without using chemical fertilizers and pesticides when soil is changed into a disease-suppressive soil by adding organic substances. This was considered to be the best management practice in the age when no agricultural chemicals were available. At present, organic agriculture still maintains the same philosophy.
I have so far described the fundamental philosophy of Kyusei Nature Farming, and problems of present day conventional agriculture. I would like to now describe a new technique which can overcome the problems of today’s agricultural systems, that is, the fundamentals of food production and environmental conservation which are based on the principles of creation.
The basic philosophy of this technique is to reestablish the balance of energy in nature without causing pollution. The decomposition of organic substances through putrefaction is a typical process causing pollution. The extent of environmental pollution is increasing worldwide because of the lack of understanding that in a broader sense the entropy increase (pollution) of the earth occurs because we do not purify harmful substances in a timely manner.
Although it is a principle of nature that any existing matter inevitably ages and degenerates; there is also a principle of regeneration according to which harmful substances decompose into more useful substances. The earth, which started from inorganic substances, can sustain so much life only because processes and systems have evolved that can transform harmful substances into harmless substances in a self-contained way, or as a self-multiplicative energy source.
Based on experiments we have conducted on the application of microorganisms to crops, it has become apparent that the effect of microorganisms largely differs, depending on soil conditions and methods of application. In particular, we found that zymogenic and synthetic microorganisms coexisting in soil suppressed the generation of heat and gas when fresh organic substances were plowed into the soil, and were extremely effective for the growth of crops and increased yields. As I mentioned before, if fresh organic substances are plowed into soil which has putrescent

microorganisms, harmful gas and heat are generated, affecting crops. However, we have observed that if microorganisms in soil are predominantly zymogenic, organic substances plowed into soil are transformed into amino acids and saccharides (carbohydrates) which are useful to plants, and can be recycled as a source of organic energy.

Familiar examples of products produced in such processes are fermented food, such as miso (soybean paste), soy sauce, and fermented soybeans, and fermented feed, for example, silage for livestock. Unlike putrefaction, fermentation is the process in which organic substances are transformed into useful water-soluble substances through the process of decomposition. In this process, protein is transformed into amino acids, while starch, cellulose and lignin, are transformed into saccharides.

If soil is putrescent, organic substances release their energy into the air in the form of gas and heat, which cause pollution, and are then decomposed into inorganic substances, returning the soil organic matter to a low equilibrium level. On the other hand, if the soil is zymogenic, organic substances are stored in the form of water-soluble energy, and used as organic energy by plants, producing no gas or heat, and, therefore, causing no pollution. Since energy once fixed in plants is reused in this process without being transformed into carbon dioxide or water, the process can function as a technique to suppress the energy loss, due to carbon dioxide and heat pollution, or a technique to recover it. That is, the energy of the earth is recovered through agricultural production and stored as food. Since most of the energy once fixed as organic substances can be reused in this process, theoretically, food shortages will not occur if the population of the world increases at the present growth rate.

This process can be simply realized by artificially changing the microflora in soil to those of the zymogenic type through the application of zymogenic microorganisms to the soil. Although this technique has drawn attention in the area of food and feed, no one ever thought of applying it to crop cultivation because the phenomenon is extremely exceptional in nature.

The main microorganisms working in this process are synthetic types such as photosynthetic bacteria and nitrogen-fixing bacteria. Photosynthesis is the process by which water is split into oxygen and hydrogen inside chlorophyll using sunlight as energy. Oxygen is released into the air and hydrogen is used to reduce carbon dioxide, producing saccharides or carbohydrates. Photosynthetic bacteria do not use water as a hydrogen source to reduce carbon. But they can use heat or sunlight as energy and hydrogen from other sources, such as methane gas, indole, skatole, methyl mercaptan, and various organic acids. These compounds are produced during the decomposition of organic substances. Photosynthetic bacteria perform incomplete photosynthesis.

In this way, harmful heat and other intermediate products of putrefaction are recycled for the synthesis of organic substances by photosynthetic bacteria, resulting in no net production of heat and gas. These photosynthetic bacteria are often found in the jungles and forests of the humid tropics and they have a high reproductive ability. In particular, if they exist symbiotically with nitrogen-fixing bacteria in the rhizosphere, plants grow extremely well without fertilizers. This happens because organic substances synthesized by photosynthetic bacteria are absorbed as organic energy sources by plants.

If soil is changed to a zymogenic and synthetic soil in which zymogenic microorganisms and synthetic ones coexist, not only can the organic substances be effectively used, but the soil fertilizes itself under optimum humidity and temperature conditions. Since such soil can synthetically or zymogenically transform harmful substances produced in natural processes, putrescent decomposers and disease-producing bacteria cannot establish themselves.

Agriculture is said to be a fight against diseases, insects, and weeds. As I have already mentioned, it is possible to suppress the infestation of diseases and insects by enhancing the disease-suppressive power of soil and by further changing the soil to a zymogenic and synthetic soil. It has already been shown that this principle can be applied to weeding.

Herbicides exert the worst influence in the soil, such as environmental pollution and the destruction of the life sphere of microorganisms. However, herbicides are used because they save a large

amount of labor, and thus, are said to be necessary evils.

If zymogenic and synthetic microorganisms are introduced into soil, weed seeds simultaneously germinate without going through dormancy. In fields which used to be infested with a large amount of weeds, weeds grow like turf. If these weeds are plowed into soil with a tractor, weeding thereafter is hardly necessary. For paddy fields, this method of weed control is much more effective than with herbicides.

Furthermore, perennial herbs and bulbous plants ferment and wither if their roots are plowed up and wounded, and they totally disappear from the field after a few plantings. The aboveground parts of weeds, which are plowed into soil at the same time, become water-soluble in soil and serve as fertilizers. Thus, we cannot but thank weeds.

In this way, the problem of obtaining organic substances is also solved, and the fertilization of soil can be easily done if a proper combination of weeds and green manure crops is considered.

It has also been shown that the production rate of humus is increased two to three fold, lowering the soil bulk density and thereby improving its tilth, air permeability, water permeability, and water-holding capacity. These results lead directly to nonplowing cultivation as well as simpler farming operations.

The consecutive planting of tomatoes in my laboratory is now in the 18th planting. Furthermore, nonplowing cultivation is now in the practical stage, and producing considerably better results than cultivation with plowing, since the soil microflora and fauna are stabilized.

The application of effective microorganisms is not limited to agriculture. They are now utilized to abate malodors in wastes, to treat and process sewage, and to purify water in rivers and lakes.

Environmental pollution and food production problems on a global scale are now threatening mankind. To solve these problems, it is necessary to further learn from nature and to develop various kinds of technologies such as Kyusei Nature Farming, following Okada’s philosophy of saving the world. It is necessary that research scientists and engineers fully realize that any technology or biotechnology can be truly beneficial to mankind only if it is used to develop and maintain the health and well-being of mankind.

Finally, I would like to express my deep gratitude to Sekai Kyusei Kyo, which offered tremendous support to the realization of this Conference, and Mr. Yasushi Matsumoto, the president of Sekai Kyusei Kyo, who is present here today, as well as to Mr. Yamaguchi, Mr. Morishita, and Mr. Kosugi, Dietnan of Japan, and Mr. Kaieda, a former Dietnan of Japan, who came here all the way from Japan to support this Conference. Thank you.

An Analysis of National Courts Involvement in International Commercial Arbitration; Can International Commercial Arbitration Be Effective without National Courts? Chinwe A. Mordi. DOI: 10.4236/ojps.2016.62009 3 272 Downloads 4 628 Views Citations. Pub. Higa T (1991) Effective microorganisms: A biotechnology for mankind. In: Parr JF, Hornick SB, Whitman CE (eds). In: Proceedings of 1st Kyusei Nature Farming. USDA, Washington, DC, October 17â€“21, pp 8â€“14. Higa T, Parr JF (1994) Beneficial and effective microorganisms for a sustainable agriculture and environment. INFRC (International Nature Farming Research Center), Atami. Google Scholar. Effective microorganisms (EM) are various blends of common predominantly anaerobic microorganisms in a carbohydrate-rich liquid carrier substrate (molasses nutrient solution) of EM Research Organization, Inc., The efficacy of EM on agricultural crops has been studied throughout the world. A review article (2013), which studies the nature of EM and the effect of EM on growth, yield, quality, and protection of vegetable plants, has concluded â€œin 70% of published studies, it was concluded that EM had a