Microorganisms, Genetic Engineering and IFOAM

Linda Bullard
Vice President, International Federation of Organic Agriculture Movements (IFOAM)

Abstract
From its inception there was an awareness within the organic agriculture movement that microorganisms play an important role in the farming ecosystem; however, the emphasis in the West has been mainly on ensuring that production methods preserve and maintain these life forms, rather than on their direct utilization. One notable exception is the bacterium *Bacillus thuringiensis*, which is widely used in various forms (such as pulverized for foliar application or injection directly into the plants) for control of caterpillars. *Rhizobium* is used to enhance nitrogen fixation. Obviously microorganisms continue to be used for baking bread, brewing beer, making wine and yoghurt, and many other types of food processing, as they have been for millenia.
The IFOAM Basic Standards for Organic Agriculture and Processing permit the use of microorganisms in organic farming and food processing, as long as they are not genetically engineered. The rejection of genetic engineering derives from the value that the organic movement places on the integrity and connectedness that characterizes living systems. In our view, genetic engineering is inherently contrary to the holistic approach because it is based on breaking the integrity of living organisms at the most fundamental level – the level of their genetic makeup.
The developers of Effective Microorganisms have given every assurance that this technology is not based on any form of genetic engineering. Nonetheless, there remains some resistance to the use of EM in particular in some parts of the organic movement. This paper looks into the source of these misgivings and offers some suggestions for overcoming them.

Introduction -A Way of Looking at Micro- Organisms
In a very real way, it was microorganisms which brought me to organic agriculture and to IFOAM in particular. This happened in 1992 while I was working at the European Parliament for the Greens, and the European Community, as it was called then was in the process of enacting its law to protect the use of the term organic by defining production and processing standards. I got wind that the European Commission, one of the institutions which runs the EU, had used an administrative trick to make it possible for genetically engineered microorganisms to be used in products sold as organic in the EU, and I was absolutely furious. In the end, the whole Parliament brought a legal action against the European Commission to try to get this “manipulation” revoked, and we took the case all the way to the high court of the European Union. Unfortunately, we lost on a technicality, but in the struggle, I met IFOAM and decided that it was more important to put my energy into building up organic agriculture rather than trying to tear down the biotechnology industry. Given that microorganisms played such a key role in my personal history, I guess it is not inappropriate for me to be here with you today, even though I am by no means an expert on the subject – you are going to hear from the expert next.
Nevertheless, I do have a particular way of looking at microorganisms, and I would like to begin by sharing it with you. It may very well be the same way that EM looks at them. We know that Life on Earth is divided up into two great superkingdoms: the microorganisms and everything else. The basic difference between them is that in the microorganisms, called prokaryotes, the genetic material just floats around free in the cell, whereas in all other life forms, called eukaryotes, the genetic material is bundled together in one part of the cell, called the nucleus, which is separated off from the rest of the cell by a membrane. The fact that the eukaryotes, like ourselves, had their genetic material closed off within the cell meant that a whole new mechanism was needed to drive their evolution, because genetic material could no longer be freely shared as it had been by the predecessor prokaryotes. The mechanisms which came into being to accomplish this was genetic isolation and differentiation by developing away from the point of origin. This gave rise to distinct species incapable of exchanging genetic material. The richness of life which today goes by the

name of “biodiversity” is the result of this type of evolution.
Meanwhile, the prokaryotes-which is our subject at this conference- continued to evolve in symbiosis with the eukaryotes on the basis of their old trusty motor of evolution, the free exchange of genetic material. With this type of evolution there was no development of distinct “species” properly-speaking; rather, the prokaryotes exist as a single, global superorganism composed of strains of cells defined by differing metabolic pathways – similar to the way that each human being is composed of cells which carry out different functions but all belong to the same, indivisible body. Whereas each eukaryotic species has a distinct genome, all bacteria shares common genome, which functions more like a vast global communications network available to all. This unitary society of bacteria has no equivalent in other living organisms. The reason I go into so much detail on this point is that it is precisely this characteristic of microorganisms – their global solidarity and information- sharing-which given them their miraculous creativity for rapid adaptation and problem solving. They are the very basis of our life support system today, supplying our atmospheric gases, maintaining soil fertility, decomposing dead organic matter, cleansing out water supply, and in general ensuring a liveable environment.

Use of Micro Organisms In Organic Agriculture
Although human beings began to domesticate plants and animals for agriculture perhaps as long as 10,000 years ago, the domestication of bacteria for agricultural applications only began in the past few decades. Within organic agriculture there has been an awareness from the beginning that microorganisms play an important role in the farming ecosystem. The organic approach begins with the soil, and it was long understood that one prerequisite for soil health is the activity of microorganisms which break down the constituents of organic matter into mineral molecules that can be absorbed by plants. The principal types of these soil bacteria are *Actinobacteria*, *Bacillus*, *Clostridium*, *Flavobacterium* and *Pseudomonas*. Organic farmers are known especially for taking advantage of, and sometimes enhancing, the activity of aerobic bacteria in that most essential of organic activities, composting. But the emphasis in the West has been mainly on the ensuring that organic production methods do not inhibit the natural activity of these life forms, rather than on their direct application.
One notable exception is the bacterium *Bacillus thuringiensis*, which is applied directly by organic farmers in areas such as the United States for control of caterpillars in crops such as potatoes, cotton, and brassicas. It is sold in various forms, as foliar sprays or even injection directly into the plants. *B.t.* has been a mainstay of sustainable agriculture since the sixties, with current sales in the United States totaling $60 million annually. It produces a number of proteins which are toxic to certain insects, mostly in the larval stage. When the caterpillars ingest these toxins their digestive systems are disrupted, and they die.
Nonetheless, there remains an a *priori* resistance to its use within some parts of the organic movement. Where does this resistance come from?
A large part of the reason is no doubt just reluctance to try something new, especially something that can’t be seen and that is still so little understood. Furthermore, microorganisms started out with a strike against them, because the first ones to be identified were the renegades which cause disease in crops, animals, and humans. As a result, they are often regarded as dangerous germs and pathogens, as primitive and parasitical.
Another source of the scepticism may be the holistic thinking itself which characterizes the organic movement. This is a movement which grew out of an understanding that the ecological balance is fragile and can be upset by too much of even a good thing. In addition, we are well aware of the experience with exotic organisms being important as “biocontrols” to solve a problem and then getting out of hand and becoming the problem themselves.
Then there is a general approach in organic agriculture that the use of inputs of whatever kind should be limited. Even *B.t.* is never used routinely as a means of pest control but only as a last resort. One criticism I have heard is that EM may be extremely useful in solving some of the

problems resulting from intensification in industrialized agriculture and urban centers, but that good management of practices on a properly functioning organic farm would have prevented these problems from occurring in the first place.

Some apprehension could be related to a perception that EM uses "secret formulae" or lacks transparency.

And finally, a major reason for resistance to using microorganisms in organics may be that for many people, such as myself, their first encounter with a microorganism in agriculture was a genetically engineered microorganism. In fact, ALL of my encounters with microorganisms in agriculture were genetically engineered microorganisms UNTIL I encountered EM. That very first encounter was at the same time my first concrete lesson in ecology. The being in question was a bacterium called *Pseudomonas syringae*, which has the miraculous ability to catalyze the formation of ice. The first commercial genetic engineers in the United States got the bright idea that if they could delete the gene responsible for this activity and then replaced the naturally-occurring bacteria with the crippled one on strawberry plants, for example, it would lower the temperature at which the plants would suffer frost damage. Sounds like a great idea, What they didn't take into account was the fact that the little *Pseudomonas syringae* was also responsible for nucleating ice crystals in the atmosphere, necessary to the formation of rain. So, if the genetically engineered bacterium which could no longer do that were to be applied on a wide scale and eventually replaced the naturally-occurring strain, it could result in severe disruptions of the weather patterns and even cause droughts.

Because microorganisms share a common gene pool, they are the easiest organisms to engineer genetically. So it is not really surprising that the question persists, "How can we be sure that the EM microorganisms are not genetically engineered?" It should be remembered that the organic movement has been built up on the basis of a global guarantee system backed up by the most rigorous requirements of inspection and certification. Our producers and especially consumers are in the habit of demanding proof. Yesterday the proof they wanted was that organic products were produced without synthetic chemicals. The proof they want today is that there has been no recourse to preparations of another bacterium, Rhizobium, which are occasionally applied directly to the soil around the roots of leguminous plants, where they enhance atmospheric nitrogen fixation.

Obviously microorganisms also continue to be used for baking bread, brewing beer, making wine and yoghurt, and many other types of food processing in the organic sector, as they have been for millenia.

As far as I know, however, such applications have tended to ignore the essential characterisitc of bacteria – that these beings adore team work. EM, it would appear, does take this personality trait of bacteria into account. In general, I think it is possible to say that in the West at least, despite the awareness that microorganisms are essential elements in the farming ecosystem, their actual utilization is extremely weak. Thus, the potential for EM is great.

IFOAM'S Position on Micro- Organisms And Genetic Engineering

The IFOAM Basic Standards for Organic Agriculture and Processing permit the use of microorganisms in organic farming and food processing, as long as they are not genetically engineered. The rejection of genetic engineering by the organic movement derives for the value that we place on the integrity and connectedness that characterize living organisms and the systems in which they function. Because genetic engineering required breaking this integrity at the most fundamental level, it can never be reconciled with the principles and practice of organic agriculture. Thus, the position against genetic engineering in organic agriculture is at its heart an ethical stand, independent of questions of safety.

IFOAM not only permits the use of microorganisms in organic agriculture, we are also actively committed to protecting this great resource for the future. Toward that end just last month IFOAM joined forces with Greenpeace and numerous organic organizations in the United States in filing a petition against the U.S. Environmental Protection Agency's policy for authoring plants genetically engineered to contain a toxin-producing gene from *Bacillus thuringiensis*. Out petition charges that the large scale planting of these *B.t.* crops (and already over 3 million acres in the U.S. are planted with transgenics) will lead to the development of *B.t.* resistance in target insects within a short time, thus robbing organic farmers of one of their most important tools of biological pest control. The reason why the B.t engineered crops will lead to resistance, whereas the microorganisms did not, is that the bacteria to the plants, which constantly secrete a single form of the toxin in high doses that persist much longer in the environment. Another likely negative environmental consequence of large scale cultivation of the *B.t.* plants is horizontal gene transfer to wild relatives, creating superweeds and further accelerating resistance development. In addition, recent research has demonstrated conclusively that *B.t.* plants can destroy non-target beneficial insect predators. This is just a sample of the ecological disaster that can result when genetic engineers and chemical corporations start thinking they are smarter than bacteria, who have followed a harmonious ontological and evolutionary development for three and a half billion years and arrived at a state of maturity-unlike genetic engineers.

Barriers to the use of Micro- Organisms in Organic Agriculture

The developers of Effective Microorganisms have given every assurance that this technology is not based on any form of genetic engineering. In addition, results of many years' experience have proved its effectiveness in numerous agricultural applications: "synthetic biologicals"- in other words, genetic engineering. Indeed the demand for proof is the source of the organic market, and we must respect it if we want to stay in business.

Some Suggestions for Over-coming Barriers to Use of EM in Organics

The concerns outlines above are legitimate and should be addressed if organic agriculture worldwide is to benefit from the problem-solving potential of EM. A couple of specific suggestions that might help overcome reticence about using EM in organic farming:

1. The EM organization could support research in long-term environmental impact assessment and monitoring to accompany applications of EM in various agricultural settings. Engage in joint research efforts with organic institutes or even individual farms to conduct demonstration projects and gather data specifically under organic conditions.
2. Submit EM products to genetic identification testing in order to provide an additional guarantee to organic producers and consumers that no genetically engineered components are present.

Conclusion

This year IFOAM is celebrating its 25th anniversary, and on numerous occasions we have been taking the opportunity to reflect on our history. In the introduction to the new edition of our Directory of members, the IFOAM President and I have written, " The pioneers of organic agriculture who came together in 1972 to found IFOAM represented a truly revolutionary movement. Now that this movement has come of age, we must take care to guard the innovative spirit of our founders: While remaining true to our basic principles, we must nonetheless stay as open to new ideas as they were, push forward research and experimentation in close cooperation with organic practitioners, and extend the wholistic way of life into ever more fields…" This commitment to staying open to new ideas and pushing forward research is why IFOAM has supported the last three international conferences on Kyusei Nature Farming and EM. Clearly, the work you are doing is the revolutionary front of our time.

To conclude, I just want to say that one thing I am sure I have in common with Professor Higa, Kyusei Nature Farming, and EM is an overwhelming sense of awe and admiration for bacteria and all they give us. Your important efforts are teaching the world to respect these highly intelligent and highly evolved beings and demonstrating how to work in partnership with them, rather than trying to manipulate them, allowing "them to use their communications network to find solutions for the Earth's life-promoting possibilities and to stabilize its environment."

References

My view of microorganisms comes from the work of Sonea, Sorin and Maurice Panisset. A New Bacteriology, Jones and Bartlett Publishers, Inc. (Boston, Massachusetts, USA), 1983.