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ORGANIC SEED AS BASIS FOR SUSTAINABLE AGRICULTURE

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The demand for organic products in the global market reached US$ 20B in 2001. In Europe, there is a very strong formal initiative for organic seed. Organic seed is a requirement in organic agriculture, according to the International Federation of Organic Agriculture Movements (IFOAM) and other international as well as local organic initiatives. An organic movement in the Philippines has launched an organic standard for certification this year.

For both local and international use, the criteria for organic seed currently are, and should be at the minimum, based on the principles set for organic production systems, ranging from organic plant breeding (for variety development) to seed utilization (for crop production and eventually processing and marketing). The paper expands the list of criteria to include pre-plant breeding steps, ie, genetic conservation especially by the informal sector. Biodynamic farming principles provide much of the basis of the organic agriculture criteria, while the use (as well as products) of genetic engineering is banned in varietal development, farm inputs and processing. Tissue culture and F_1 hybrid development especially through cytoplasmic male sterility are highly restricted in the production of organic seed.

Organic systems provide overwhelming advantages over non-organic systems. Benefits derived from and constraints related to organic seed and farming are given. Differences between opposite systems (ie, chemical or non-organic vs organic farming given the different forms) are presented in terms of effect on soil health/quality, product yield and quality (storability, losses, nutritional value, animal health, and vital energy). Three techniques (crystallography, chromatography and photon emission) which are well used in biodynamic agriculture, provide graphic comparisons of the products of two opposite systems (organic and chemical farming).

Mechanisms or biochemical/physical bases for better storability of organic products are further explored; the result points to the realm of the relatively new concept of 'glass'. Water in glass state and other natural substances (such as sugars) that enhance the glass state, can be contributory factors to the longer shelf-life of organic seed, other crop produce and processed food products.

The current use of formally produced/bred organic seed in the Philippines is low but if the contributions of indigenous and local seeds/breeds are included, the number improves considerably. The prospect of organic seed partly depends on the success of organic certification in the country, the demand abroad for organic seed and products, and the presence of local companies who will go into this business. A large part of this success, however, will be determined by how successful local initiatives will be in community seedbanking/genetic conservation, and by improved general awareness and willingness of consumers to pay for organic produce.

Keywords chemical farming, chromatography, community seedbanking, crystallography, non-organic systems, organic plant breeding, organic products, organic seed certification, organic seed, organic seed banking, photon emission, sustainable agriculture, water in glass state

INTRODUCTION

The basis of agriculture is the seed. Thus, the International Federation of Organic Agriculture Movements (IFOAM) requires organic seed for organic agriculture, and the European Union (EU) stipulates in its EU Regulation 2091/91 that organic production proceed from the use of organic seed (Biogene 2000).

Commonly, one would think that an **organic seed** is one that is produced through 'non-chemical' farming, or one that is not treated with chemicals. Being organic, however, whether applied to seed or crop produce, takes on a much wider and deeper meaning that cuts across disciplines and dimensions. This is also true for 'organic agriculture' and 'sustainable agriculture' (SA). Delving into organic seed while dealing with SA is considered necessary given the critical role of the seed in promoting SA (Fernandez 1992).

The demand for organic products in the global market has skyrocketed, reaching US$ 20B in 2001 according to the United States Department of Agriculture (USDA). Europe and the international organic movements now require 'organic seed' for organic produce certification. The main challenge is genetic engineering (GE) as a way to produce seed or variety. In the Philippines the issue on organic produce is brought alongside that of the testing of genetically modified organisms (GMOs), particularly Bt corn, as well as their commercialization.

GE is considered to be against organic farming principles (Biogene 2000). It cannot be considered an approach that is natural or produces products that are similar to those varieties that come out of conventional breeding. It is considered a one-dimensional and drastic intervention in a plant's genetic makeup, and one that destroys the plant's connection with the natural environment. GE isolates the cell from the plant therein. Tissue culture is used as a means to regain the organism, but already the interaction of the whole plant with the natural growing environment is bypassed.

GE is reductionist science, ie, it oversimplifies what is complex. There is insufficient knowledge of the risks of reductionist methods of science, especially GE, much less on the long-term performance of the products themselves.

The seed is the most basic input in agriculture; it is the beginning or source of a plant. Its practical purpose is for planting, propagation and multiplication. As such, a seed is any planting material, whether true seed (ie, product of fertilization) or not. Therefore, the one who controls the seed controls agriculture. With GE, the control of the seed shifts from farmers to big multinational corporations and this has major economic, environmental, socio-cultural and political implications. Only in special cases should genetic engineering be allowed, at the level of DNA diagnostic techniques, which enables selection at the DNA level. Such is a form of seed technology, but does not involve modification of DNA or genes to produce a new plant form or variety. However, special laws are required to supplement direct selection method in the field.

The paper presents organic seed within the framework of sustainable agriculture. It touches on international and local initiatives, the SA framework, issues and related concepts. Biodynamic agriculture as a template for organic agriculture and seed is introduced, and differences between organic and non-organic systems are defined. Parameters to differentiate the two systems are also given, including not only benefits or advantages but also physiological, biochemical, physical and agronomic parameters in favor of the organic.

ORGANIC CONCEPTS & ISSUES

Concept of 'organic'

There exists a wide range of definitions of the term 'organic'. Concepts put forward range from that which contains carbon and thus include manufactured chemicals and synthetic fertilizers, to those being, or having been derived from once living organisms. Other definitions include those that have had complex organization or are organized as a system of interrelated parts, reflecting that of living things. It is also used to refer to a system that has arisen internally and out of need and local initiative. Organic is also used to refer to a substance or approach that leads to enhancement of natural processes. Urea cannot be considered organic in the context that it defies many terms for organic (ie, it is synthetic and fossil fuel-based).

In general, one may describe organic farming or organic agriculture as using methods in tune with nature, enhancing the local ecosystem without adding synthetic substances. The USDA defines organic farming as a production system that avoids or largely excludes use of synthetically compounded fertilizers, pesticides, growth regulators and livestock feed additives (USDA 1980).

Organic agriculture (OA) can be considered to lie within a spectrum of conversion approaches toward SA (Hill 1985, cited by MacRae 1990). Some approaches restrict chemicals while others prohibit them completely (Fernandez 2000b). OA had originally been attached to a system that had benign management and design. At present, however, it has become a much stronger movement involving more countries, expanding principles and incorporating those of other deeper approaches to agriculture. Many of the current principles in organic agriculture movement have been derived from biodynamic farming (Diver 1996 & 2000).

Some disagreements exist on which would be the more appropriate term, 'organic' or 'sustainable,' for the various alternative aspects of agriculture. To some, OA is more advanced and realistic than SA because it deals with actual practices and application of principles, while SA is considered to be simply a floating concept and lacks grounding and realism. Many strong advocates of organic farming disliked the introduction and use of the term 'sustainable agriculture.' This is partly because the 'organic' and 'natural' essence of the term is removed, opening it to the utility of the chemical industry. It allowed the industry 'to dip their hands' into the organic agriculture movement (Rateaver & Rateaver 1993).

The USDA has been the subject of similar accusations, for having initiated the term 'organic' to 'make sure poison people get to be in on the gravy train' (Rateaver & Rateaver 1993). The agency is in fact regarded as consistently hostile to organic food production, bungling the national organic rule in 1997 and allocating less than 1% of its research budget toward organic agriculture food production (OCA 1999b). Thus, some advocates suggest to bypass 'organic' and invent a different term. The choice of term has traditionally been the way to go around rules and push an agenda into an otherwise unfriendly environment in industrialized countries. Efforts to circumvent the organic standards for example can be seen with the US Food and Drug Administration. It is currently looking into changing the current label of food that has been treated with nuclear irradiation, another no-no in organic farming (OCA 2000a, 2000d, 2000e). Specifically, it is considering whether to eliminate or modify the irradiation radura symbol, reduce the size of the label, or use alternative language such as 'cold pasteurization' instead of irradiation.

Issues & concerns

Lack of awareness on organics

One of the critical ways that could promote organic farming and improve demand is by increasing awareness of differences between organic and conventional seed and other products. Consumers to date are still largely undiscerning in what they eat. Consumption patterns of both adults and children are far from ideal, with all the junk, highly processed and imported but cheap goods that abound. Such foods are likely to be contaminated with chemicals or have poor (if they are not devoid of) nutritive value, despite the nutrient content or fortification claimed by manufacturers on food labels.

Thus, a critical element relevant to consumer readiness for organic farming is basic education. Current approaches to teaching are highly short on appropriate pedagogical techniques to make students learn how to learn, to be critical, integrative and be one with nature. Those who advocate or teach SA, or subjects within the framework, also still need to strongly link what they teach with what they do in other realms, or to appreciate the connection between the general impacts of one's lifestyle to organic agriculture. Education in the primary school and in the home level is far from being ideal in promoting organic agriculture. Schools are laden with inorganic and junk foods while homes are simply struggling to make ends meet. Healthy food only comes second to food that can simply fill up an empty stomach.

The Filipino cuisine is admittedly short on variety of plant-based food preparations. Cookery in the Philippines is unlike those of her Asian neighbors. Non-exposure to a variety of culinary preparations also limits the creativity to develop and utilize existing floral diversity. Filipinos' highly impressionistic psyche further limits the food choices to those which are foreign, in vogue, or sold by large multinational food chains.

Even in developed countries where there is rapid growth of the organic industry, the development of organic seed has lagged behind, partly because seed is not for consumption. It is unlike organic grain, which is the more direct concern of the organic food-buying public. But this sector is mostly not directly involved in farming (OCA 2000b), thus the remaining big gap.

Making the seed organic like the produce is, to some adaptors and advocates of organic agriculture, as critical because the amount of chemical inputs used in growing seed is proportionally greater than that of producing crops, and seed crops take longer to ripen and must mature dry in the field. With this, plants are expected to require more nutrients and protection from pests. For other organic enthusiasts, it is the use of genetic engineering in variety development and its uncertainties, and the greater control of multinationals of the agro-industry, that are equally if not more threatening. Unfortunately, it is not generally recognized that non-organic seed is much more organized, far-reaching, and even strongly linked with official national systems.

Unclear differences between organics & non-organics

Despite the many reviews that have been made, there still is a divided view on the existence of real differences between organic and non-organic systems, including seed. Some reported inconsistencies (Diver 1996, 2001, Lampkin 1990) contribute to the confusion. This may be traced back to incomparable or unrepresentative treatments and parameters, or even to insensitive tests. The initial bias of the critic also figures heavily on interpretation of differences. Those who are not believers of organics could always fault aspects of any demonstrated differences. Existing reports of no differences are often used as sweeping evidence of absence of difference, disregarding the existence of a wide body of highly credible literature portraying differences. Research methodologies may also differ and could affect results. Certain phenomena, such as nutrient interactions and compounding situations or practices like pesticide application or type of fertilizer, side by side soil type, weather, plant growth stage etc could contribute to variations in reports.

Existence of conflicting studies is often enough to convince anyone who is a skeptic or an unbeliever of organics, that any differences that can be demonstrated are not worth writing about, and are certainly not a reason to promote organic food. One needs only remember the saying that to the believer, no amount of explanation is necessary; to the non-believer, no amount of explanation is enough. Those who are convinced on the value of organic on the other hand, can readily cite studies and principles to support the existence of differences. To them, the little differences greatly matter. Those who believe in the validity and soundness of intuitive wisdom can also argue that anything closer to nature is definitely better.

In yet another perspective, consistent differences found in one or two aspects, even to a believer of organics, may not really matter, given that the contribution of a difference to overall health may be questionable. It may be too small to prove of any real benefit, given the already problematic consumption pattern, eating habits and overall lifestyle of people, especially those in the urban areas and in many developed countries. With the presence or absence of differences such as in nutritional health, however, it can be argued that what is more important is the contribution of organic systems to the long-term health of the soil and water, and the capacity to produce food sustainably. With or without nutritional differences, organic production provides many other benefits worth promoting. It conserves natural resources, solves rather than creates environmental problems, and reduces the pollution of air, water, soil and food (Diver 2001). Choosing organically grown produce for its contribution to the health of the soil and our capacity to produce food sustainably may ultimately be more important than its direct contribution to individual nutritional health.

Benefits derived from organic seed are also those of organic farming and the avoidance of negative impacts of non-organic or chemical farming. Advantages associated with organic farming are in terms of environmental health, nutrition and general quality of produce (including storability and yield), economics and productivity, plant/crop health, animal health, and usually by inference, people's health (Lampkin 1990, Granstedt et al 1997, OCA 1999a & 2000f, Worthington 1999, Pfeiffer 1999, Sandig 2000, Perez 2000, Diver 2001).

A growing body of scientific evidence indicates that organic food is indeed healthier for humans and animals than conventional produce, ie, 56% out of 1,230 published comparisons say organics are better than conventional food (Worthington 1999). Organically grown produce has higher levels of nutrients than conventional produce. Organic crops have a higher concentration of vitamins and far more secondary metabolites, which are naturally occurring compounds that help 'immunize' plants from external attack. Some of these are linked to lowered risk of cancer and heart disease in humans. The observed decline in feed, food and soil quality over time indicate that conventional farming have neither resulted in soil conservation nor produced nourishing food and feed (Lampkin 1990, OCA 1999a, Diver 2001). The accumulation of undesirable substances such as nitrates and their link to health problems in plants, animals and humans can be avoided with organic systems.

Yield, storability & economics of organic seed

The most often cited misconception about SA is that it brings about low yields. In fact, much has already been published to show that SA is not less productive than chemical farming. Much better yields are reported for many different SA models while economic analyses of organic and non-organic systems point to the advantage of the former to support these contentions (Lampkin 1990, Fernandez 1992, Zamora 1999, Sandig 2000, Perez 2000, Mendoza 2001).

Studies on storage losses between organic and non-organic systems have also been reported. Storability of biodynamic farm products is greater than that in conventional farms (Lampkin 1990). Vegetables grown with organic fertilizers have also been found to have lower losses than those given mineral fertilizers (Diver 2001). Fresh or stored products generally have scored higher in taste tests (Lampkin 1990). This decline in taste or quality may be associated with changes in the chemical composition of the produce, including moisture content.

A local study (Parreño-De Guzman 2001) done on a mungbean (*Vigna radiata*) grown without fertilizer or with poultry manure, kakawate (*Gliricidia sepium*) and inorganic fertilizer, has shown that seed deterioration is fastest with those given inorganic fertilizer where the variety is adapted to low or no fertilization management. Consumer accounts of better storability of fresh produce and seed with organic culture also abound.

Organic Initiatives In Selected Countries

Organics in Europe

In the European Union, the policy on organic seed for organic agriculture has led to a very strong formal initiative for organic seed with the greatest demand in Western Europe. Europe is working on achieving a 30% share of organic farming in its entire agriculture by the year 2010. The EC Regulation 2092/91 on organic production requires the use of organic seed unless it can be proved that at the time of purchase, there is no stock of organic seed for the variety. If suitable organic varieties are not available, untreated conventional seed can be used, under a derogation that runs out at the end of 2003. Organic farmers are required to exclusively use organic seed or other plant propagating materials by the year 2004. The policy on organic seed also means the seed/variety must not have been produced through GE and other breeding techniques regarded as endangering the integrity of the organic produce (Biogene 2000).

Organics in the US

The US is now only starting to upscale its requirements for the organic seed, partly as a response to economic pressure in Europe. Given the industry and line agencies' attitude and track record toward organics, some are wary of this formal movement. Some contend it could be a way to go around the moratorium on GMO crop testing in Europe. However, there is good prospect for organic agriculture in the country itself. Organics are considered the 'third wave' in mainstream health foods because they are considered low and light, and because of the developments in nutraceuticals, ie, there are now health claims on them (OCA 2000).

The US Organic Seed Regulation (2001), as per organic standards of the USDA, provides that farmers use the organic seed where it is available. With this the price of organic seed is expected to be 25% more because of perceived higher risk (the usual misconceptions about SA) and for the reasons that breeding for more resistance (natural resistance) is more involved and takes time. However, some US seed companies now doing it (eg, NC+Hybrids, says Tonya Haigh, personal communication), have noted that yields of organically grown conventional crops did not meaningfully differ from the chemically grown ones and thus organic growers sold their produce at the same price as the conventional ones.

One caveat posed, given the opportunity to use non-organic seed in organic farming, is that seed users might be encouraged to switch to other varieties (ie, non-organic varieties) as they can claim the unavailability of organic seed. In the absence of effective organic seed enforcement, this can easily happen. Another caveat involves speed in that organics eat up to 20% of the time in getting certification of the organic seed supply, for example in verifying non-availability of such seed (OCA 2000b). These can very well happen, and are in fact happening, in Europe.

Organics in the Philippines

Several international entities deal with matters concerning organic products for regulation and/or production (Briones et al 1997, OCA 2000b). One of these is the International Federation of Organic Agriculture Movements (IFOAM), which started as a farmers' movement. The IFOAM advocates the development of self-supporting systems in the local and regional levels; thus, it has come up with international organic standards for certification which are to be adapted by each member country according to their own realities.

In the Philippines the organic market or industry is not well developed, although there is some movement (Briones et al 1997). In June 2001, the 'Philippines Organic Certification Standard' was launched at the National Organic Agriculture Conference in tandem with BioSearch, The Philippines and Asia's trade show on natural and herbal health products and services. It was organized by the Center for International Trade Expositions and Missions (CITEM), the export promotions agency of the Department of Trade and Industry. CITEM is the current chair of the standards and certification committee for organic produce in the Philippines. The initial draft of the Philippines Standards for Organic Production and Processing was prepared by FOODWEB, a local off-shoot of IFOAM and composed of NGOs and organic producers such as OPTA (Organic Producers and Traders Association, Philippines) and POGI (Philippine Organic Guarantee Inc).

In the Philippines less than one percent of produce is considered organic, as assessed by those in the organic industry. Those who are formally engaged in it are mainly altering the type of inputs used into 'more organic' ones. Some known organic producers, however, still use chemicals (pesticides) but choose those considered less toxic, less dangerous or more biodegradable. They rationalize that they have a policy of harvesting only after a certain lapse of time from spraying when the chemicals applied no longer pose a threat to health.

The market for organics in the Philippines is largely on vegetables. For other crops, the organic produce market is much less developed and is designed largely for export purposes.

With the low local demand and undeveloped market of organic produce, it is logical to expect the use of organic seed to be much lower than one percent. However, with a more active organic movement, the supply and demand of authentic organic products can improve. A great push for the local organic movement is the export potential or the commercial prospect of organic products. In general, however, only a very limited number of commodities are in focus.

Other problems that beset the organic movement in the Philippines are linked to problems of the commodity. Well defined are those of the vegetable industry (Briones et al 1997). They are parallel to those defined for SA (Viado 1997) and expressed in the First World countries as barriers to organic farming (OCA 1999a).

The demand and supply of organic seed in the Philippines is expectedly lower than that in Europe and the US, no matter how organic seed is defined. The required link between organic seed production and breeding, much less their definition, is still largely unknown to many organic enthusiasts. The links among organic food and feed, healthy soil, and human health are likewise still unappreciated by the general public.

Policies supporting organic agriculture are generally lacking, although some projects may be funded by line agencies, eg, organic vegetable research by the Department of Agriculture–Bureau of Agricultural Research (DA-BAR). Thrust in formal research and breeding is also still very much pro-Green Revolution. Development programs still push for hybrids and chemicals and are strongly biased towards use of GMOs. In contrast, efforts in organic farming are not coordinated while the public is generally unaware about technologies, benefits and advantages of organic farming and products. The cost and complexities involved in organic certification are also barriers that can easily discourage advocates and practitioners (Diver 2001). Misconceptions, discomforts or concerns about SA are essentially also those for organic agriculture (Fernandez 2000a).

Local formal institutions that are attempting to shift the seed system towards SA is limited. Many, including government agencies, even have conflicting programs, providing more if not exclusive support to the promotion of genetic engineering and products. Those who are doing something on organic agriculture are usually only at the level of input substitution or better management of inorganic inputs.

A group at IPB-UPLB (under the leadership of Rodel Maghirang) is doing local vegetable organic breeding, modifying cultural management systems and breeding criteria, which nicely fall under the list expressed for organic plant breeding (Wyss & Wiethaler 1999, Fernandez 2000b). They let their selections go through more organic or natural conditions, allowing weeds, pests and diseases, and ambient temperatures during growth and storage, to exert pressure on the crop. The resulting crops have turned out to be hardier in the field and the produce better in storage under ambient conditions than those from conventional management.

The Department of Agronomy of the College of Agriculture, UP Los Baños, has also been contributing to the development of informal, local or organic seed systems through advocacy and in teaching, research and extension/training (Fernandez 1999). Students are encouraged to work on problems that are within SA.

Not to be forgotten is the contribution of indigenous peoples to the system of local seed management. Although dwindling in population, with their practices being threatened by the intrusion of official/government development programs and economic trends, the indigenous peoples with their holistic practices still exist in areas within the country. Their indigenous knowledge systems provide good basis for practices and management systems that are within SA (Parreño-De Guzman & Fernandez 2001). Their seed and seed systems are *bona fide* organic when looked at the technical, socio-cultural, political, scientific and economic perspectives.

DIFFERENCES BETWEEN ORGANICS & NON-ORGANICS

Other than benefits to the environment and to health, differences between organics and non-organics may also be shown through other parameters and techniques. Lampkin (1990) has made a comprehensive review on parameters used to possibly differentiate substances or products that are organically and inorganically grown. Interestingly, biodynamic products are even compared against general organic farming, people highlighting the claim that biodynamics is more than just organics. It deals with formative forces, of levels of biological organizations and metabolic activities mostly beyond the common scientific measure. Some of these criteria are the following (Pfeiffer 1999, Diver 2001):

1. chemical and nutritional quality of product through presence and levels of undesirable substances such as pesticide residues, nitrates, toxins and other contaminants or of favorable ones such as essential minerals, vitamins, hormones and other compounds
2. Brix readings (for sugars) using refractometers, and atomic absorption and paramagnetism (for other substances)
3. taste/flavor and or feel after eating, most especially by health conscious individuals or yoga practitioners, or by hypersensitive individuals (eg, though skin reactions)
4. performance of product, such as storability, processing suitability, yield, dry matter
5. feeding responses of animals such as preference for, or avoidance of, certain food or feed stuff.

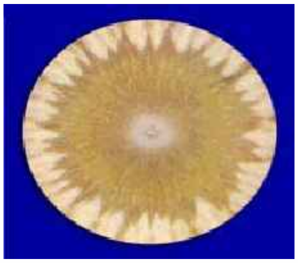
In biodynamic farming, tests that are commonly taken are dry matter, nitrate percentage, vitamin C, sugar, self-decomposition (including loss of dry matter), taste, color, smell, consistency, behavior of food during handling, preparation and others. More novel or 'sophisticated' techniques have also been used, although not commonly, to show differences between organic and non-organic systems (Lampkin 1990, Balzer-Graf 1999). These include image-forming techniques (copper chloride crystallization, circular chromatography, dark field microscopy, capillary dynamolysis, drop-picture method), physical/chemical techniques (counting photon emission from food samples, electrical conductivity, other electrochemical properties of food), microbiological and biochemical techniques, and polymerase chain reaction (PCR).

Crystallography, chromatography & photon emissions

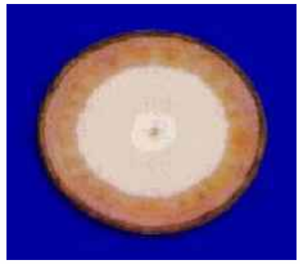
Most intriguing and popular yet relatively simple techniques to show differences between organic and non-organic products are crystallograms and chromatograms (Podolinsky 1988, Pfeiffer 1999). What other tests have not shown, chromatograms and crystallograms are able to show. Resulting patterns reflect the principles of organic life (or formative) forces, that of 'space, ordering/rhythm of articulation, time, polarity and unity, and relation between the above principles' (Balzer-Graf 1999). The technique shows that there are indeed differences in processed and

Box 1. Chromatograms depicting differences between organically and conventionally treated soils

Chemically treated soil



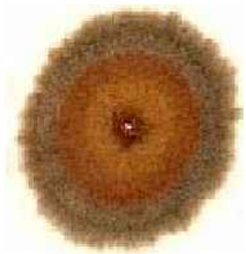
Organically treated soil



Corn – young green leaves grown on chemically treated soils

Corn – young green leaves used in Greenlife & Springreen, grown on organically treated soils

Source: Pfeiffer 1999



Soil - initial

Soil- manure applied

Soil - post harvest

Source: Perumal K & TM Vatsala

unprocessed products, and in organic and non-organic (synthetic) substances (eg, soil, milk, juice, sugar, food, vitamins/supplements) including seeds and seedlings (Box 1). Even products like grains and milk that are produced in different places, stored for some time, or have undergone some kind of processing, may show different formations (Podolinksky 1988). The less natural or fresh the products, the less organized the patterns are.

Chromatography and crystallography are not complicated relative to other tests, but considered highly sensitive to show differences in biological organization and general metabolic activity. They relate well with results on energy tests (ie, photon emission test, Lampkin 1990).

Nutrient & water absorption & seed storability

It is a commonly held belief that plants absorb nutrient the same way, and that seed development is too far back to reflect these differences between organic and inorganic production. Such belief is avidly opposed by scientists and practitioners who believe that plants do have different ways of absorbing nutrients, especially when given a choice and given more natural conditions, and that seed formation can indeed manifest these differences. The chromatographic and crystallographic patterns, as well as photon emission of products of seed/grains, attest to the existence of such differences. If one upholds the principle that everything in nature reflects the essence of what it is subjected to (eg, in biodynamic farming), then one can easily accept this thought. Proteins, carbohydrates and other substances may look and act the same in the usual chemical tests, but there certainly are differences that may not be discerned by the usual measures (eg, electron spins, bonding types and positions). This could be seen in more critical studies on products subjected to irradiation, microwave, and genetic engineering. Some point to an altered rotation of molecules which are mostly not studied in conventional determinations (Thomas 1997).

Water and nutrients have different avenues to get into the plant system. Biodynamic farming strongly believes that root tissues/cells are specialized to take in one or the other, unless minerals are dissolved in water. Nutrients are preferred to be taken in from colloids, ie, humus. Absorption is thus not limited only to mineralized forms but to substances of higher molecular weights (Hodges 1991, Rateaver & Rateaver 1993). These substances (sometimes referred to as humic substances) are considered to greatly contribute to the plant's and the seed's resistance to adverse conditions. It is much the same way that resistance of man and animals are now known to be not only due to the vitamins and minerals, which are often obtained in processed forms. Other 'health' factors also contribute and these can be obtained if the nutrients are ingested in their more natural or raw state.

The absorption of substances larger than minerals is supported by a group of scientists who uphold the idea that cells can take in substances through endocytosis (Rateaver & Rateaver 1993). They question the absoluteness of the idea that nutrients are absorbed only in mineral form. The mechanism of such absorption is described, thus: 'Whole molecules of any size can be taken into cells, and clusters of molecules that are particles, by endocytosis (and fluid phase endocytosis) via coated pits: the cell membrane invaginates, trapping molecules in the cluster via the coated membrane surface, thereby forming vesicles to enclose such molecules and carry them through the cell, dropping them en route, and/or dumping unwanted or storage molecules in the vacuoles, finally returning to the cell membrane from which they came.'

Nutritional parameters in favor of organics

References or findings that point to no differences between organic and non-organic products exist but thorough reviews on differences also exist (Worthington 1999 & 2001). They point to advantages of organics, for example in terms levels of potential harmful substances or elements (aluminum, cadmium, lead, mercury, NO_3), or of potential beneficial elements (micronutrients, macronutrients and other substances in crops) (Lampkin 1990, OCA 1999a, Diver 2001). An important aspect dealing with conflicting results in nutritional studies is that just like in soil systems, interactions occur between and among nutrients (Lampkin 1990, Walters & Fenzau 1992). This means a web of effects actually occurs beyond what is being studied. Knowledge of absolute amounts of substances would not be enough because interactions among these are equally if not more important. They add complexity to plant, animal and soil responses.

An analysis of changes in mineral content of fruits and vegetables in the US show general decrease of up to one third of some minerals from 1963-1992 (Diver 2001). The period of study parallel with the intensification of chemical farming in the country. Surveys in US and Britain revealed declines in minerals and vitamins, such as vitamins A and C (OCA 1999a).

The presence of nitrate has been one of the more popular parameters used to indicate nutritional quality differences between organic and conventional farms. In a review by Lampkin (1990), it is shown that nitrate levels are very much higher in conventional farms than in organic farms. The latter farms' produce has also shown to have narrow protein to nitrate ratios. Nitrate accumulation has been cited as a leading cause of crop's attractiveness to pests and diseases (Chaboussou 1986, Patriquin et al 1995).

Discussion on nutritional parameters may also be extended to genetically engineered crops. An in-depth study has indicated that they may be less nutritious (OCA 1999c) than conventionally bred ones. This can be expected given that the genome has been artificially altered and thus struggling to adjust to a highly foreign gene combination. This is also manifested in low yields found among GMO crops in the US (OCA 1999b). Biodynamics is now exploring detection of nutritional value of GMO products through crystallography and chromatography.

THE ORGANIC SEED

Sustainable agriculture framework

An early framework initially defined for sustainable agriculture had five dimensions or features. These are: ecological soundness, economic viability, social justice, humaneness and equitability, cultural appropriateness, and being grounded on holistic, integrative science and approaches (Fernandez 1992, Zamora 1992). Two other dimensions were later added (Perlas 1993) ie, 'appropriate technology' and 'full development of the human potential' which, conceptually, may be subsumed under the five original dimensions.

The mainstream or formal seed system has to be revisited considering that many of its features do not fall within the SA framework (Fernandez 1992, Louwaars 1996). It is still mainly based on chemical inputs, monocropping system, clones and hybrids, if not open-pollinated or pureline varieties. Many varieties have been developed abroad and are limited in genetic diversity (ie, they are homogenous). The parents are also very closely related and non-diverse. These modern varieties have been in fact selected for maximum yield given optimum chemical and high external inputs. They can have wide or general adaptability especially when given the special package of inputs and care.

Criteria for organic seed

Following the framework of SA mentioned above, a 'sustainable seed' may then be considered as one that embodies all the dimensions of SA. This term, however, has not caught on. Organic seed on the other hand, has become a movement in itself, especially in Western Europe. Some patches of initiatives can be found in the US (http://www.ncorganics.com). In the organic agriculture movement, the seed's 'being' is no longer limited to its utility as planting material. The seed has become a representation of the essence of organic agriculture. Organic seed is not just one that has been produced, grown or managed using organic inputs and practices, but one that encourages organic farming through the movement's accepted principles.

To Bargyla Rateaver (personal communication), the list of criteria for organic seed includes not only use of organic inputs and prescriptions for soil conditions but also conditions related to the mother plant, including those during pollination/fertilization, fruit and seed development. The criteria also include harvest and post-harvest seed management to maintain a certain quality. The spelled-out criteria for seed quality are clearly outside the realms of conventional seed systems (Wyss

& Wiethaler 1999, OCA 2000c).

In the absence of a well-formulated list of specific standards for organic seed, principles and practices in organic or ecological crop production may be invoked. Organic seed production should follow the principles of ecological farming such as biodiversity, living soil, recycling, natural resource conservation, appropriate pest management and appropriate genetic resources and varieties. Banned are practices that lead to accumulation of heavy metals and other pollutants. Basic slag, rock phosphate and sewage sludge have high heavy metal content and other unwanted substances and thus are not allowed. Management of manure and rotations are encouraged. Non-synthetic minerals, fertilizers (ie, supplements and other brought-in fertilizers of biological origin) are not considered replacements for nutrient recycling. Those allowed should be applied in their natural composition. Direct and/or routine use of readily soluble chemicals and all biocides whether naturally occurring, nature-identical or not, is avoided. The system veers away from the simplistic NPK concept and works with natural cycles (Lampkin 1990). Soil protection practices need to be installed to prevent erosion, salinization, excessive and improper water use, and pollution of ground and surface waters. Hormones and antibiotics are not allowed. Animal and fish rearing as well as ways to process these and of crop products, and their marketing, also have prescribed ways and means to make them organic (IFOAM 1998).

In the Philippine context, the social dimension figures highly in the discussion of organics. Those who wish SA to be fully implemented would like to see organic seed and resulting crop produce fully controlled by the farmers beginning from collection, leading to maintenance and enhancement, up to distribution and marketing. A large share of the profit from these produce must go, not to traders, but to the farmers who labor hard to produce and finally carry the products to the distribution point. Organic seed is one that represents the efforts of the farmers more than the final form of seed or grain itself (Guilaran 2001). This highlights the farmers, what and why they do what they do, rather than the final output, which is the variety or the seed material. This also underscores the value of process- rather than outcome-orientation in SA.

A list of criteria for sustainable or organic seed comes from MASIPAG farmer's perspective (Guilaran 2001) (Box 2). The list describes traditional seed as well as improved local seed. It will be noted that, among other things, the farmers want their seed locally adapted, their yield to be comparable or better than HYVs, and not genetically modified.

In a much expanded list, I give my own synthesis of criteria that I propose to describe an organic seed (Box 3). It is a collation from various sources including ideas from PABINHI and MASIPAG farmers (Fernandez et al 2001) and other references. It covers practices that trace back to genetic conservation, especially the informal sector approach of community seedbanking and germplasm management in their natural

Box 2. Sustainable or organic seed, MASIPAG farmers' perspective (Guilaran 2001)

CRITERIA	TRADITIONAL VARIETIES/SEEDS	IMPROVED LOCAL VARIETIES/SEEDS
Genetic/varietal diversity	Parents diverse, seedlot composed of multilines, field adapted to multiline planting	Does not promote monocropping
Adaptation	Locally adapted	Locally adapted or location-specific
Resistances	Horizontal resistance	Relies more on horizontal rather than vertical resistance
Production & quality	Seeds can be grown locally, of high quality (e.g.,, viable)	Comparable to or much better than HYVs
Response to organic system	Grows well under organic production	Good to excellent when produced organically
Breeding ,improve-ment of seed performance	With desirable traits for local breeding, done by farmers	Improved or bred by farmers themselves, improved thru use of local varieties & natural process of hybridization, not genetically tampered with (no GMO contamination, not developed thru genetic engineering), varieties are stable & reusable, not for monocropping but for diversification etc, done by farmers
Reasons for use	Mainly for food, medicine etc to meet local needs	Mainly for food, medicine; to meet local needs; not commercialized, affordable
Yield, income	Provide decent yield and income	Provide decent yield and income
Market	Marketable, meets consumer needs & taste	Marketable, meets consumer needs & taste
Availability, distribution	Not for commercial sale but can be available thru seed exchange or barter	Available in greater quantities for adequate adaptability trials
Intellectual Property Rights	Not patented in any way	Not patented in any way

state. It treads into the path of crop improvement and plant breeding, thus the emergence of organic plant breeding as a movement. Alternative breeding objectives and methodologies have emerged (Wyss & Wiethaler 1999, Cherfas 1999, Guilaran 2001). It includes adaptability to a general or diverse environment (including integration with animals), to recycling, small space and availability to the farmer and household preferences.

An organic seed must be genetically diverse, lend itself to recycling and be certified organic (at least in countries that have the certification system in place). It must not be hybrid and never have been produced from genetic engineering nor contaminated with GMO. Varieties must follow the prescribed breeding method and criteria to become organic, and their seed during breeding must also be certified/ascertained to be organic. Protoplast fusion of cytoplasmic male sterile (CMS) lines

Box 3. A synthesis of criteria for organic seed, highly expanded (PG Fernandez 2001)

GENERATION OF ORGANIC SEED			UTILIZATION OF ORGANIC SEED	
Genetic Conservation	Breeding/ Crop Improvement	Seed Production/ Multiplication/Propagation	Crop Production	Crop Processing/ Distribution
• Germplasm maintained under natural conditions and through community seedbanks • farmer controlled/ managed	• adaptable to local conditions, local parents • *diverse parents; managed by farmer-friendly breeding methods* • Conventional breeding (eg, population breeding); restricted for in vitro; no protoplast fusion, no induced mutation; no GE • parents grown organic for at least: - 1 generation for annuals or - 2 growing seasons for perennials • if institutional, given to farmers for testing at early stage of breeding (eg, F_2, F_3) • tested in resource-poor farmer's fields • selection criteria according to farmer's culture (compatible with farmers'/community's culture); adaptability, pest resistance/tolerance • horizontal, polygenic resistance (ie, not just to one type of pest and disease) • can produce seed and in sufficient quantity/decent seed yield (not sterile) • does well under low and organic inputs • variety not strictly Distinct, Uniform and Stable • multiline, pureline, OPV (open-pollinated varieties); clones are limited/restricted; no hybrids (otherwise parents have been grown organic for several generations); no CMS (cytoplasmic male sterile) hybrids without restorer genes; reusable seeds • not patented (or given any other form of IPR) • farmer controlled/managed • according to standards of organic systems; pass organic inspection/certification bodies	• local "organic" inputs • *local cultural practices* • *non GMO* • *uncontaminated with GMO, pesticides, NO_3^-'s etc* • follow or adapted to ecological agriculture principles: - biodiversity, which includes genetic/varietal, species, ecosystem, cultural, functional - *integrated (components including animal integration)* - soil health - recycling; managing energy and resource flows - conservation of natural resources - appropriate pest management - appropriate variety/species (taps synergy and complementarity in genetic resources) • *good seed quality (germination, vigor, authenticity, cleanness, adaptability to local soil and climatic conditions, resistant to pests and diseases etc)* • plants grown in local, natural, healthy soil • plants allowed natural interaction with other species and environment • plant fully mature when bearing fruits/seeds • fruits fully mature upon harvest • seeds fully mature upon extraction • processed and stored properly • good purity (according to farm standards and heterogeneity of variety and seedlot) • energy conservation, minimized use of external energy, eg, for processing, grading, storing, germination testing and health management • "detoxed" (grown in organic system over several generations) • not controlled or traded by trans-national corporations or big, monopolistic private companies • not stored long in bulk • not produced in very large quantities to cause displacement of other varieties • adapted to ambient storage • not traveled long distances • not expensive if for sale (reasonably priced) • exchanged freely but responsibly • farmers get their fair share of the proceeds • farmer controlled/managed • "certified" organic; true to label	• avoid use of prohibited practices/inputs (use only allowed practices/inputs; limit use of restricted practices/inputs • follow IFOAM standards (as modified for the country) including: - *no GMO/product* - *no irradiation (products)* - *no sewage sludge* - *no sewage sludge mulches from factory farms/other farms* - *no antibiotics; hormones/ growth promoters* - *no synthetic chemicals; pesticides* - *no toxic "inert" ingredients* - *no food processing off-site* - *no factory farm style intensive confinement of farm animals (as manure source)* - *no products labeled "organic" if 70% of ingredients are modified organic, or labeled "natural foods" and with 50% organic ingredients even if rest is GE, irradiated etc* - *uncontaminated with GMO* • decent crop yield • organic feed production • farmers get fair share of produce/profit • include other practices listed under seed production • "certified" organic; true to label	• follow IFOAM standards as adapted for the country • satisfy household food security • shared with others • farmer controlled/ managed • excess may be marketed but controlled to avoid genetic erosion or displacement of genetic diversity • local, village/ community level processing • good market but with fair trade • farmer-friendly technology/ system • quality food and feed • farmers get good farm gate price • traders/middlemen do not get unfairly high profit • "certified" organic; true to label *Collated from various sources. Those entries italicized under each category are minimum standards of IFOAM—PG Fernandez 2001*

are not allowed, so are other tissue culture applications that lead to forms that are highly detached from the natural processes and environment.

Among indigenous peoples a seed may only be organic (or sustainable) if it has passed through the hands of the local people, and if it has undergone the rigors of their environment and culture. To be sustainable, their seed must have have passed certain tests which in many cases only the women can operationalize, since they are the planters themselves (Parreño-De Guzman & Fernandez 2001). Selection of varieties for various criteria may be made only by women, while some paranormal selection procedures (eg, through dreams, shamans) may even be invoked. Maintenance and safekeeping of the seed also more commonly falls into the hands of women.

Seed storability with glass compounds, water & sugars

Water is the central substance in seed metabolism, storability and survival (Leopold & Vertucci 1989). It is one of the most intriguing compounds and still not yet fully understood (Rateaver & Rateaver 1993). It has many facets, sometimes exhibiting seemingly conflicting behavior under different conditions. This is seen, for example, when water changes in state from solid to liquid and from liquid to gas. In seed technology, water presents its intriguing character in the practice of seed invigoration. Recently the phenomenon of glass became an added dimension in discussions about water.

Water in seed is the most important factor affecting seed storability and deterioration. Rules of thumb of seed storage had been proposed (by Harrington 1973) while various viability equations had been developed (by Ellis 1988) to predict seed performance at different levels of moisture, temperature and other factors. Recently, however, it has been reported that it is not the moisture content per se, but the relative humidity that is more important in seed deterioration during storage (Walters et al 1997, cited by Farrant & Walters 1998, Parreño-De Guzman & Fernandez 2001). Seed that have the same thermodynamic properties may have different moisture content although they may have equilibrated to the same relative humidity. A more recent classification of seed storability in response to different seed moisture (and vapor pressure) levels has been proposed (Vertucci & Farrant 1995). Type 2 water is the one that figures most in seed storage under usual conditions. This water is considered to be in 'glassy' state.

Glass is an amorphous solid state of a substance that is currently considered the key to seed longevity of orthodox seed (Walters 1998b). Although solid, it does not have a structure, but it is less fluid than rubber which is also an amorphous solid (Walters 1998b). It is considered to be the predominant form of water during seed maturation and desiccation. Seed moisture content during this phase is approximately between 8 and 25% moisture content (dry basis) (approximately -12 to -150 MPa) (Vertucci & Farrant 1995). It is the phase of water in the seed considered most responsible for seed deterioration during storage. Water in orthodox seed (desiccation-tolerant types) becomes glassy during seed maturation. In recalcitrant seed (desiccation-sensitive type) such water state is not achieved. Extending storability of both types of seed is now being discussed by enhancing the glass states of substances in the seed.

More evidence is coming out that state changes of amorphous solids such as glass is also responsible for recalcitrant seed behavior (Walters 1998a). The behavior of recalcitrant seed is considered to be more like perishable biological materials. In recalcitrant seed deterioration, recrystallization of glass especially under low temperature is believed to be a critical phenomenon. Sucrose and raffinose oligosaccharides as in orthodox seed, also play a stabilizing phenomenon. Certain types of sugars (eg, sucrose, raffinose, and larger oligosaccharides) are associated with seed maturation. They increase glassiness of water in seed by disrupting normal crystal lattices or lowering the chain order/disorder transition temperature of dry phospholipid to a wet one (ie, referring to membrane). These sugars are generally absent in recalcitrant seed but are reported to increase with orthodox seed maturation. However, other substances which are now being studied to increase longevity of recalcitrants are thought to act through glass state enhancement.

Glasses, like rubbers and syrups, is a viscous amorphous state often attributed to sugar composition with sucrose being the most important component because it readily forms glasses (Farrant & Walters 1998). Such may explain the difference between orthodox and recalcitrant seed because glasses form during maturation of orthodox but not of recalcitrant seed (Vertucci & Farrant 1995). Oligosaccharides are also considered important because they inhibit sucrose crystallization and water content near its glass transition.

Glasses in seed can be composed not only of sugars and long-chain carbohydrates, but also of amino acids, gums and proteins (Walters 1998a). Late embryogenesis abundant protein in combination with sugars, may be important in the formation of viscous states observed in orthodox seed (Walters et al 1997, cited by Farrant & Walters 1998). The review of Sun & Leopold (1989) provides a further role of sugars in orthodox seed, thus:

> *Desiccation-tolerant organisms almost always contain large amounts of soluble sugars. In angiosperm seed, large amounts of sucrose, raffinose and stachyose are accumulated during the seed maturation. Sugar can maintain the structural integrity of membranes and proteins under dry conditions. Sugars also prevent*

damage by the increase level of chaotropic ions such as Na^{+}, K^{+} or Cl^{-} within the cytoplasm during water withdrawal. Soluble sugars particularly sucrose, raffinose and stachyose are considered to be major vitrifying agents in plants.

Sucrose, which is found commonly present in most mature and dry seeds, is suspected to serve as the chemical agent of desiccation tolerance in seed, with the large oligosaccharides serving to keep the sucrose from crystallizing (Koster & Leopold 1988). Sugar is regarded important not only as solvent in chemical reactions but as a stabilizer of structure. Sucrose particularly is an effective membrane protectant with the hydroxyl groups probably replacing water by hydrogen binding to the phospholipid head groups of the membrane. Alternatively, sucrose can form an amorphous glass during drying. In this state, the hydroxyls of the sugars could be free to bind to the membrane.

The food industry also regulates water and uses sugar to improve the longevity of its products. The concept of glasses (and rubbers) has been introduced into the food science literature to explain the shelf-life of dried and intermediate moisture foods where RH may exceed about 75% (Walters 1998a). Water acts as plasticizer of glass in food, loosening the intermolecular connections within the glassy matrix allowing the molecules to relax (or move). Given sufficient water, aqueous glasses convert to rubbers. In dried seed, there are likely to be many constituents of the amorphous matrix, which explains why the plasticization by water is extremely complex. Cellular constituents within the seed may influence glass by altering its fragility. They may, therefore, be considered factors of seed quality, accumulated and lost during seed development and germination, ultimately controlling seed longevity.

The function of glass in biological and food systems may be described as one that protects macromolecules from coming in contact with each other, reduces movement and metabolic activity. Outside such state molecules may move more freely and have greater activity, or at the other end, come in close contact with each other leading to destructive self-propagating processes (Walters 1998a).

Other storability-enhancing factors in organics

Higher contents of certain sugars, amino acids, minerals and vitamins in organic products than in those conventionally grown ones can very well be a major factor in better storability of organic produce. They can affect the seed directly or indirectly aside from enhancing the glass state of substances in the produce. They can also serve as antioxidants which are already known to increase longevity of biological systems and produce. They can also extend the organizational integrity of the product as reflected in the greater vital energy of the produce (eg, in biodynamic farming). The absence or lower amounts of heavy metals or other toxic substances that are known to accumulate in the produce from conventional farming can also contribute to the better quality of organic produce.

The higher levels of nitrates and other soluble N forms in conventional produce can affect seed/grain stability. These affect succulence of tissues and of moisture levels in the produce. Such moisture contents may or may not be easily detectable given current techniques. The study of Lappay (2000) shows that initial seed moisture from a mungbean grown with organic or no fertilizer can be lower than one with inorganic fertilizer . Lower moisture and/or higher dry matter contents have also been reported in organic than in non-organic produce (Grandstedt et al 1997).

Organics and water relations may also be reflected in soil matter. Cocannouer (1956) contends that the poorer the soil the more water is needed to get enough nutrient to supply the leaves. Produce takes up an astonishing amount of water to become water-filled fruit and vegetables of low quality. With soil rich in organic matter, where chemicals have not been used, a much lesser amount of water is needed to satisfy the plants' requirements and produce good quality harvests.

Seed health & soil health under organic system

For some, the idea that a healthy soil will be translated into a healthy seed or grain is too difficult to imagine. But this will not be difficult to accept if we believe that indeed, organic plants and grains bring benefits to final consumers.

The relation between soil health and resistance of plants, animals and humans has been described in many books (Eckstein 1944, Pfeiffer 1999). One discourse has described this resistance through metabolism that consists of two parts. The first one is that which is 'external', which is comprised by plants and their fruits, the composition of the soil in which plants grow, and the transportation, storage and preparation of foodstuff (Gerson 1990). The second part is known as 'internal' metabolism, which consists of all the biochemical transformations that take place when foodstuff enters the animal body and supports the nutrition and growth of cells and tissues.

Soil 'sickness' can be due to, among others, imbalance of nutrients, absence of microorganisms and other biological entities or their combination. Presence of toxins and ions (in excess) such as NH_4^{+}, Cl^{-} has also been commonly cited to weaken the soil and its inhabitants.

In biodynamic farming the soil is considered the deliverer of the cosmic vital force to the plant. This underscores the soil as a basic element in plant growth. Hydroponics and tissue culture will have to find their place in this belief- and knowledge-systems.

Differences in micronutrients spell the resistance in humans, animals and plants to pests, diseases and general weakness (Pfeiffer 1999). Differences in seed health (vitality, vigor, pest and resistance) likewise, can be due to such. Enzyme systems are affected by micronutrients since they need these nutrients for their normal functioning. Weak enzyme activities can lead to weak structures and other metabolic activities and eventually low seed health.

Biodynamics as template for organic agriculture & seed

Biodynamic agriculture has been the source of many provisions and principles of the organic agriculture movement. For example, it requires that the seed must also be biodynamically produced where the seed is adapted to the farm and culture. Such an organic seed also needs to be organically bred. The whole breeding process should take place under organic conditions and principles to get perfectly adapted plants.

In practice the biodynamic agriculture movement is one with the most number and highly advanced initiatives in breeding new varieties for organic agriculture. It also very strongly recommends preserving the vital elements of the products even beyond production phase to make them truly nourishing. Practices in biodynamic farming may be found in Diver (1996 & 2000) and Bauer & Henatsch (2000). They are related to celestial signs and phenomena (Podolinsky 1990), humus influences and use of biodynamic (BD) preparations (Diver 1996 & 2000), which are to be applied on the soil, the compost or the plant. Among the time-tested approaches in SA (MacRae 1990), BD farming is one where there large number of research or publications can be found.

The major impetus in organic plant breeding in the more developed countries is the resistance to genetic engineering and the fact that most of what are currently available are conventionally bred varieties not suitable for organic agriculture (Wyss & Wiethaler 1999, Cherfas 1999). Although genetic engineering is not accepted as a strategy in organic plant breeding for the production of new varieties, it may be used for varietal selection or as marker. Other less sophisticated biotechnology techniques such as protoplast fusion for CMS lines are likewise not allowed. Parents for varietal development are also required to have been grown with organic inputs or have been grown for several generations under organic management for their adaptation. Tissue culture, which is a tool in genetic engineering, is likewise restricted in organic plant breeding.

Initiatives in the formal seed sector or seed systems that follow some of the criteria in organic breeding exist. One mode already distributes the early filial generations of seed to farmers (Cecarelli et al 1994 & 1996, Weltzein et al 1996). There are other variations and these are recognized under the discussions of participatory plant breeding now also in the CGIAR and FAO arena (eg, Weltzein et al 2000).

Many informal breeding initiatives exist all around the world. Locally, there are a number of networks that are active in this field. Farmers themselves do the selection and hybridization of crop varieties such as rice and corn (Vicente 2001, Fernandez 2001). They have criteria which do not conform with those of conventional breeding. Such criteria match very well those of the organic agriculture movement.

CONCLUSION

The proposed list of criteria for organic seed broadly touches on disciplines or steps before and after seed production/multiplication. This widened scope makes it ever harder for any practitioner to shift to organic seed as an input in production. However, local or indigenous seed is also considered organic, given the framework presented. These should therefore improve organic seed sourcing. Organic seed should be used to support local systems more than supporting organic production systems that prioritize export and commercialization.

Whether for export or self-reliance, organic seed is a way towards soil rehabilitation and enhancement, environmental protection, regaining and enhancing good human health, and people/farmer empowerment. It is no longer a matter of choice to go either organic or inorganic. Despite existence of non-conclusive evidence in some studies in favor of organics, the problems that are associated with inorganics should already be reason enough to push programs toward the SA framework.

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