Sustainable Agriculture: Views and Experiences from the Ground

SUSTAINABLE AGRICULTURE: THE MINDANAO BAPTIST RURAL LIFE CENTER (MBRLC) EXPERIENCE

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Sustainable agriculture is an immense topic of which numerous books have been written. It has become a buzzword and byword used by Government Organizations (GOs), Non-Government Organizations (NGOs) and even People's Organizations (POs) and a rallying cry for the funding of projects, programs, etc. Very few project proposals from any sector are submitted without the word "sustainable." But what is this word and what does it really mean?

This paper will take a simple look at the word "sustainable" and how it applies to our agricultural systems in the Philippines. It will also delve into one NGO's experience (the Mindanao Baptist Rural Life Center) and try to analyze strengths and weaknesses of its so-called sustainable technologies and programs such as the Sloping Agricultural Land Technology systems or SALT.

A SHORT DISCUSSION ON WHAT IS MEANT BY SUSTAINABLE AGRICULTURE

The word "sustain" literally comes from a Latin word meaning "to hold up from under." This implies the "supporting" of a thing such as a system, program, etc. by making sure that there is adequate "holding up" resources. From Webster's Dictionary, sustain can be defined as:

- To keep in existence; maintain; prolong
- To supply with necessities or nourishment
- To support from below; to keep from sinking
- To endure or withstand
- To experience or suffer

Therefore the word "sustainable" refers to anything such as a program or system that can "hold up," "maintain," "support" or "carry on" for an indeterminate period of time.

The word "agriculture" is an old word coming from the two words "agri" meaning "land" and "culture" meaning "cultivation" or "care." Thus, agriculture simply means "caring for or cultivating the land" and connotes man's involvement in "land care." It was originally applied to early civilization and man when they became less nomadic and became settled producers instead of hunters and gatherers. The word "agriculture" was used to imply that people began to care for and utilize the land for food production.

Sustainable agriculture in modern terms can be defined as food and income generation from the land in a way which "holds up from under" the sustainable land use. A very similar concept is land use achieving acceptable production combined with the conservation of resources on which that production depends thereby permitting the maintenance of the productivity. Thus sustainable land use equals acceptable production plus conservation of resources upon which production depends (Young, 1989). A way of looking at it in an equation form is:

Sustainability = Productivity + Conservation

Mathematically, sustainability can be expressed as being indirectly proportional to the probability of abandonment. Simply stated, the higher the probability of abandonment of any agriculture system, the lower the probability that the system is sustainable. Therefore, an agricultural system with an 80 % chance of abandonment would only be 20 % potentially sustainable. This is represented in Figure 1.

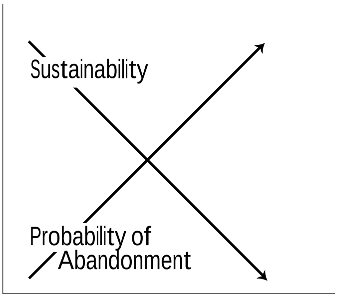

FIGURE 1
Relationship of sustainability to probability of abandonment

LEVELS AND TIERS OF SUSTAINABLE AGRICULTURE

There are two broad levels when looking at factors influencing sustainable agriculture. There are also two broad tiers (Figure 2). Problems may either be "macro" or "micro." Macro issues of sustainability have more to do with national policies, legislation, country economics and the "bigger picture" issues which affect the environment of sustainability or non-sustainability for the Philippines as a whole. The micro issues of sustainability deal with local communities and individuals who have, within their circle of influence, the option to adopt sustainable agriculture practices or not.

The "external" tiered constraints are those things outside a nation, country, village, or group affecting the quality of sustainable agriculture. These problems are usually outside of the insiders' influence. While they have tremendous impact on the sustainability of the system, many times, there is very little the group can do to change these constraints. The "internal" tiered constraints are "local" problems within the circle of influence of a nation or community. They can be addressed by the local people within their own capabilities and resources given the right conditions.

Both levels and tiers are critical in assessing overall sustainability of agriculture for any community. This paper, however, will be confined mostly to micro level issues of an internal nature. This paper looks at the experiences of a small NGO with the majority found at the village and farmer level.

	EXTERNAL	INTERNAL
MACRO	Large-scale constraints from the outside usually not seen by the community but sensed and felt in decisions	Large-scale constraints within the village; community usually seen but does not have skills and resources to solve
MICRO	Small-scale constraints from the outside not usually seen but felt by the community	Small-scale constraints within the village; easily seen and identified and community has resources and ability to solve

FIGURE 2
Relationship of levels and tiers of sustainable agriculture

DETERMINANTS OF SUSTAINABILITY

The main determinants of sustainability for any agriculture system revolve around three major areas.

◗ Biophysical determinants

These are usually the easiest to see, measure and deal with when confronting non-sustainability in a system. These include erosion in an upland farming system, depletion of nutrients in a crop production system, and lack of adequate management/feeds in an animal system. Physical and biotic factors can usually be solved through better technologies.

◗ Economic determinants

These are the barriers to sustainability due to lack of financial resources. This could be manifested in the re-sale by the farmer of dispersal materials such as seeds or animals. In times of economic need (such as food for the family, schooling needs for the children, etc.), items which can be converted to cash usually are used for immediate needs. Economic factors can usually be solved through empowering-type credit schemes, diversity, and long-range planning skills imparted to the farm family and communities.

◗ Socio-cultural determinants

These are the strongest of the three types of determinants. They are centered around the adopters and their culture. They are decisions made based upon the farmers' values, beliefs and, more importantly, worldview. These determinants say that sustainability is dependent on what the people themselves in a given culture and situation define as sustainability. When barriers of the socio-cultural nature confront a development system, the best way to respond is with education, both formal and non-formal.

THE MBRLC EXPERIENCE IN SUSTAINABLE AGRICULTURE

MBRLC Technologies and Biophysical Sustainability

To date, the MBRLC has developed a number of sustainable agriculture systems for the uplands of the Philippines. They are collectively known as the Sloping Agricultural Land Technologies (SALT) and have been proven to be sustainable from a biophysical perspective not only in the Philippines but a number of other Asian countries (Watson and Laquihon, 1985).

A brief description of the MBRLC SALT technologies is as follows (MBRLC Editorial Staff):

◗ SLOPING AGRICULTURE LAND TECHNOLOGY (SALT 1)

Since the mid-1970s, the SALT 1 technology has utilized a number of fast growing nitrogen-fixing trees and shrubs (NFT/S) for soil conservation and a biological fertilizer source in the uplands. These NFT/S are planted in double hedgerows along the contour of sloping area every four to five meters apart. These rich nitrogen-fixing hedges act as a physical barrier to soil erosion, as well as giving a rich NFT/S mulch which enhances the soil erosion control potential for the system. It also provides a good source of organic nutrients for the system and is a soil covering conditioner. The original SALT 1 model is situated on a one-hectare plot. To date, almost 100 species of NFT/S have been tested and screened by the MBRLC for use as erosion control, biological fertilizer and soil conditioner within the SALT 1 system. The major NFT/S hedgerow species utilized are *Desmodium rensonii, Flemingia macrophylla, Gliricidia sepium, Indigofera tyesmani, Leucaena sp.* and *Calliandra sp.*

◗ SIMPLE AGRO-LIVESTOCK TECHNOLOGY (SALT 2)

This technology is a variation of the SALT 1 technology with a heavy emphasis on an animal component. In the SALT 2 model at MBRLC, the main demonstration makes use of an integrated goat dairy on a half-hectare. Half of the land area is dedicated to agroforestry trees (mainly NFT/S) dedicated solely as forage/fodder for the goats while the other half is dedicated to food and income for the farm family. Again, the main agroforestry species mentioned for SALT 1 are used in this system.

◗ SUSTAINABLE AGROFOREST LAND TECHNOLOGY (SALT 3)

Another variation of the SALT 1 technology is SALT 3 where a heavier emphasis is placed on small-scale reforestation for the farm family. This is a two-hectare model where one hectare is utilized as a regular SALT 1 project while the remaining land is planted to a small, farmer-managed forest. The majority of the agroforestry species utilized in the reforestation aspect are NFT/S species *Albizia saman, Pterocarpus indicus, Acacia auriculiformis, A. mangium,* and *Leucaena diversifolia*. However, a number of non-NFT/S are also used in this agroforestry model; these include *Swietenia macrophylla, Gmelina arborea* and *Eucalyptus spp.*

◗ SMALL AGROFRUIT LIVELIHOOD TECHNOLOGY (SALT 4)

A classification of trees which often escapes the attention of agroforesters are fruit trees; these are the building blocks of the SALT 4 technology. Working from the idea that some farmers would prefer fruit production over other commodities, SALT 4 integrates durian (*Durio zibethinus*), lanzones (*Lansium domesticum*), rambutan (*Nephelium lappaceum*), mango (*Mangifera indica*), jackfruit (*Artocarpus heterophyllus*), coffee (*Coffea spp.*) and calamansi (*Citrus madurensis*) in a half-hectare demonstration with high returns on investment. The majority of agroforestry fruit trees used are non-NFT/S but are supported by the presence of N-fixing hedgerows for erosion control and soil fertility management.

The main thrusts of all SALT technologies are: 1) minimization of soil erosion, 2) improvement and maintenance of soil fertility, and 3) provision of food and income for the farm family. In short, the SALT idea has sought to provide sustainable balanced farming systems where the undesirable farm outputs (erosion, leaching, burning, etc.) are minimized and desired outputs (production) are maximized. All of this is done in a NF framework where the inputs to the system are maintained largely by the use of NF plants as a surface-applied biological fertilizer and soil conditioner (Palmer 1996).

To date, numerous on-farm and on-station tests have been conducted to show the biophysical sustainability of the SALT farming systems. The following section describes a few along with the results.

1. NITROGEN-FIXING (NF) LEAF BIOMASS FERTILITY TEST

A "Nitrogen Test" was conducted at the MBRLC from 1982 to 1993. The test consisted of 23 croppings of corn (*Zea mays*) and was established on a 30% slope in a SALT double contour hedgerow system. One plot received all of the hedgerow prunings of *Leucaena* and *Flemingia* while the other plot received none. Both treatments were grown within the framework of NF contour hedgerows but the cuttings of the NF species were only applied to the crops in the first treatment (Table 1).

The data clearly shows that one treatment benefits from the addition of the N-rich leaf biomass. Both treatments have the erosion control benefit of the vegetative contour hedgerows. However, when the N-rich hedgerow biomass is added back to the system there is more than a two-fold increase in yield (Table 1).

TABLE 1

Comparison of corn yields grown in a SALT-NF contour hedgerow system with hedgerow prunings added versus hedgerow prunings removed. Twenty-three croppings from 1982-1993.

Hedges Removed	Yield	Hedges Added
0.87 a	(mt/ha)	**2.02** b

* Significant difference is determined using the one tailed Z-test, alpha = 0.05

2. EROSION CONTROL TESTS OF NF CONTOUR HEDGEROWS AT MBRLC

In one test known as "Test SALT" conducted for six years (1985 to 1991) at the MBRLC, erosion data was gathered from a side-by-side comparison of a traditional farmer's cropping system (Non-SALT) and a SALT project. The individual plots were 0.08 ha in size and duplicated for minimization of error. The slope of each plot averaged 18 %. Both treatments were cropped by no-till methods. Standing cornstalks were slashed three times and left on the soil surface. Corn was planted fairly close to the contour in both systems. Cropping consisted of a rotation that averaged two crops of corn and one crop of mongo beans (*Vigna radiata*) per year in keeping with local farmers' practices.

The SALT plots were planted to NFT/S double contour hedgerows spaced about four meters apart. Every third cropping strip or "alley" was used for permanent crops: banana (*Musa sp.*), coffee *(Coffea robusta* and *C. arabica),* and calamansi *(Citrus microcarpa*). Soil erosion was measured by the staking method with a check system of sample collection basins below each treatment to verify results. Erosion rates in the non-SALT treatment averaged 194 mt/ha/yr over the six-year period while the erosion rates in the SALT treatment averaged only 3 mt/ha/yr.

A second erosion test was designed and implemented in 1993 and is currently running. The layout of the plots is similar to the first test (side-by-side SALT vs. non-SALT) with the second test having each treatment triplicated. Along with measurements for soil erosion being made by the stake method, each treatment (12 x 33 m) has a cemented canal at its base which measures total sediment load from each plot. The canals have been constructed in a way to trap the total sediment load while allowing for escape of the surface water. Initial results (1993 to 1997) show a ratio of almost 400:1 in terms of soil loss for the Non-SALT when compared to the SALT system.

3. HEDGEROW SPACING TEST

A contour hedgerow spacing test has been conducted since 1993 to test the effects of varying widths of cropping alleys (2 m, 3 m, 4 m, 5 m, and 6 m) with respect to corn yields per hectare in the corresponding alley. This was set up to see what, if any, competition the NF contour hedges gave to the primary food crop in the southern Philippines (corn) under the given conditions. Measurements of productivity were made in actual metric tons per hectare (mt/ha). The productivity measurement gives a per meter actual production measurement per unit cropped and is the better measurement for evaluating hedgerow/crop competition (Table 2).

The numbers show that on a per unit basis, the best corn is produced in the two-meter treatment (Table 2). This is due to the high inputs of nitrogen-rich biomass from the closely spaced hedges. Thus the closer the spacing, the higher the amount of biomass produced. Consequently, the greater the biomass available per hill (up to a certain point) the greater the production of the individual plant.

TABLE 2

Corn yields (actual and production unit) in varying contour hedgerow spacings, 1994 to 1997

Treatment Spacing	Actual Yield Tons/ha	Productivity Tons/ha
2m	2.69 a	5.41
3m	3.23 b	4.85
4m	3.22 b	4.31
5m	3.66 c	4.57
6m	3.17 b	3.81

* Significant difference is determined using the one tailed Z-test, alpha = 0.05. Means in column 2 are not significantly different if followed by the same letter.

4. VEGETATIVE BARRIER TEST

A vegetative barrier test has been run for three years now testing the effects of different types of contour hedgerows on crop production (primarily corn) in the alleyways. A barrier of nitrogen-fixing trees/shrubs, rensonii and indigofera, non-nitrogen fixing tree cassia (*Cassia spectabilis*), nitrogen fixer plus grass (rensonii and vetiver) and grass (vetiver) were tested against each other. The results are shown in Table 3.

The greatest positive effect on corn yield by the vegetative contour hedgerow is found in the good nitrogen fixers rensonii and indigofera (2.63 mt/ha). In contrast, the greatest negative effect on corn yields from the contour hedgerows was found in the non-nitrogen fixing legume hedge of *Cassia spectabilis* (2.12 mt/ha). The above data clearly shows that selection of hedgerow species is a determining factor for good crop production and that NF species should be considered as first priority for vegetative barriers in terms of production.

If sustainability in a biophysical sense (i.e., resource conservation) is considered important along with production, then NF hedgerow type farming systems should be potentially sustainable. Production numbers are relatively high and obvious soil and nutrient conservation is occurring.

MBRLC TECHNOLOGIES AND ECONOMIC SUSTAINABILITY

As much as the MBRLC SALT technologies (as well as others) have been documented to be

TABLE 3

Effects of different vegetative barriers utilized as contour hedgerows on corn production		
Vegetative Barrier	Dry Shell Weight/plot	mt/ha
Nitrogen fixing trees *(Desmodium renzonii/ Indigofera tyesmani)*	6.6 kg	2.63 a
Nitrogen fixer + grass *(D. renzonii/Vetiveria zizanoides)*	5.8 kg	2.35 b
Grass strips *(V. zizanoides)*	5.6 kg	2.23 b,c
Non-nitrogen fixing trees *(Cassia spectabilis)*	5.0 kg	2.12 c

* Means in column 3 are not significantly different if followed by the same letter.

TABLE 4

Productive and economic indicators of each mature SALT system		
Farming System	Average Corn yield T/ha	Average Annual Income P/ha
Traditional systems	0.5-1.0	6,000
SALT 1 (NF hedgerow system)	2.0-2.5	24,800
SALT 2 (Animal system + NF species/hedges)	3.0-4.0	72,000
SALT 3 (Small scale reforestation scheme with NF species)	2.0-2.5	56,000
SALT 4 (Fruit production with NF hedges)	2.0-2.5	48,000

potentially biophysically sustainable, they have been even more so documented to be economically sustainable. However, for the sake of space, an ROI and economic analysis of each system will not be discussed here (Table 4).

It is sufficient to say that detailed records of costs and returns have been kept and made and the systems are more than sufficient in economic sustainability. As a tangible indicator of this, the MBRLC Base Project in Kinuskusan produces on the average about 80 percent of its annual budget which includes salaries for about 60 people, maintenance of a 19-ha farm and supplies and materials for hosting and training over 20,000 visitors annually. For a brief comparison in terms of yield and income of the different SALT systems refer to Table 4. For details on each system, please contact MBRLC.

MBRLC TECHNOLOGIES AND SOCIO-CULTURAL SUSTAINABILITY

These determinants are the hardest to measure and give examples of. These are best expressed in the change that has taken place in the hearts and lives of the people who are adopting and adapting the technologies. Even though they are probably the most important factors in determining sustainability, they do not lend themselves to easy discussion.

However, recently, the MBRLC staff conducted a survey in one of our IMPACT villages and was able to measure to a small degree the socio-cultural changes in a group of farmers (Palmer et al., 1999). In the survey, farmer adopters of the SALT 2 system were interviewed after five years of utilizing the SALT 2 system. The fact that they were continuing the SALT 2 system (albeit with slight modifications) was even more substantial in that they had all passed through

TABLE 5

Farmer's description of the process they passed through in implementing SALT 2 (as described by original adopters)
◗ We started with establishing a farming system that would prevent soil erosion in our farmland. ◗ In one of our meetings, we discussed what were the possible livestock projects that would help us in times of economic crisis. We discussed choices. ◗ The MBRLC extensionist asked us if we would be interested in goat raising. We discussed projected income. ◗ We chose goats because forage for goats is easier to get. Also, because the expected income is higher compared to the other livestock project we have discussed. ◗ We organized ourselves to make each one accountable to the agreement set in relation to the project.

the hard 1997 to 1998 El Niño phenomena and were still applying SALT 2. All of the original adopters were still utilizing the system. During their interviews as to why they were still following the SALT 2 system, the group of original adopters were able to clearly state the process they went through to decide and begin applying SALT 2 on their farms (Table 5).

To be able to relate this process five years after the fact is a good indicator that the group went through a very good process. In interviews with the extension worker responsible for the group, it was found out that the above described process took almost a year of meetings with the group.

When second generation adopters who abandoned the SALT 2 system after a year or so were interviewed as to why they abandoned, they gave a different answer. It was found that none of them could give a clear answer as to the process they went through in making a decision to adopt the technology in the first place. When asked to describe their process as to why and how they adopted SALT 2, they replied, "I went to a one-day meeting" and "I was asked to try it." This response is a far cry from process-oriented community development techniques and possibly contributed to their rapid abandonment: they didn't pass through the process!

Education, long term presence and emphasis on processing was seen as major factors in the success of the adopters. The original adopters being able to recall a process after five years and more importantly being able to continue the technologies indicates sustainability.

CONCLUSION

Sustainability in agriculture systems revolves around three main determinants: biophysical, economic and socio-cultural. Generally, it is easy to measure and quantify the first two, but difficult and elusive to accurately determine the third. Measuring nutrient inputs and outputs in a system (biophysical) is fairly easy and understandable. Coming up with ROI and net incomes has been done for years. However, it is not so easy to measure the socio-cultural changes necessary for sustainable systems such as the change in the hearts of the people adopting or the hopes and dreams of the adopters.

Dr. Wal Laquihon (personal communication), former Associate Director of the MBRLC, has said that sustainable agriculture systems are dependent upon how well they fulfill the dreams and hopes of the farmer participant. Thus, a new way of measuring sustainability would be to find a way to measure these things, hopes and dreams, and how they are fulfilled in the farm families lives.

Ironically, the most important determinants of sustainability are of the socio-cultural nature. It's ironic in that this is probably the least comfortable and least knowledgeable area for government and non-government development workers.

If the socio-cultural determinants are the most critical in seeing sustainable agriculture systems applied, then we should concentrate our efforts more and more in this area. We would emphasize less and less technology as well as doleouts and economic assistance. We would endeavor to help expand the people's horizons through education primarily utilizing good community development techniques and tools.

People and communities needing development come to us with a thimble in their hands asking for a cup of cold water. We take them to the well of knowledge and our experience and pump and pump into their thimble until it overflows a million-fold. We go away thinking we have given good development while they still only have a thimble full of water.

If we are true developers and are looking for adoption and application of sustainable agriculture systems, we need to be in the business of helping people to have bigger cups. We should concentrate on expanding their capabilities. We should not solve problems for them but rather give them better tools so they can solve their problems themselves.

Finally, more research is needed in helping all of us to come up with better measuring tools in determining whether certain agriculture systems are sustainable or not.

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Development and Efficacy of Improved Bio-organic Fertilizer (IBF) for Rice

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The continuing search for an alternative fertilizer input that is easy to handle, inexpensive and environment-friendly led to the development of Improved Bio-organic Fertilizers (IBF). This research was spearheaded by the Research and Development Unit (R & D) of the Pilipinas Shell Foundation, Inc.

Research and development of bio-organic fertilizers was started by the National Institute for Biotechnology and Molecular Biology (BIOTECH) of the University of the Philippines Los Banos (UPLB). Microorganisms were used to hasten the decomposition of agricultural waste materials thus enriching the resulting compost. The original enrichment method was through the introduction of a free-living biological nitrogen-fixing bacteria under the genus *Azotobacter sp*. Results have been very encouraging but field applications produced mixed results. Further research was needed to increase the potency of the enrichment method.

Initial tests showed that improvement in the quality of bio-organic fertilizers can be achieved through the development of several types of microorganisms. Besides applying biological nitrogen-fixing bacteria, the addition of a phosphate-solubilizing microorganism increases the quality of the bio-organic fertilizer (BOF).

This paper is the result of the study on the development of an improved bio-organic fertilizer (IBF) conducted from May 1996 to December 1997. A field trial was also conducted to compare the improved bio-organic fertilizers (IBF) technology to the farmer's practice (Department of Agriculture Balance Fertilization Program) and that of University of the Philippines at Los Baños technology of seed inoculation and bio-organic fertilizers.

DEVELOPMENT OF ENRICHMENT INOCULA

Different strains of microorganisms were isolated from different soil samples. Standard microbiological methods were used to isolate, cultivate and characterize the different strains.

Isolates were maintained in selective media. The *Azotobacter sp*. and the biological nitrogen fixing bacteria, were grown, maintained and stored in Burk's Medium while the phophate-solubilizing fungi, *Aspergillus sp.* was grown, maintained and stored in potato dextrose agar (PDA).

In the preparation of the inocula, an enriched coconut water medium was used. Enriched-coconut water medium was composed of 980 ml coconut water, and 20 grams sugar. The medium was sterilized for 15 psi. Each culture was inoculated in one liter of the sterilized medium and was shake-incubated in one liter of the sterilized medium for 48 hours at room temperature. Before application on composted materials, the microbial populations were determined using the standard plating method.

1. Production of Fertilizers

The improved bio-organic fertilizer (IBF) was produced from a mixture of 60% chicken manure and 40% sawdust. Two tons of the mixture were prepared. The mixture was heaped and inoculated with composting inocula (*Trichomedia sp*) and was incubated for 14 days. The set-ups were harvested after 14 days and samples were taken for nutrient analysis. About fifty percent (50 %) recovery was achieved (approximately 1 ton). The compost materials were divided into two parts at 500-kg weight each. One 500-kg part was inoculated with the enrichment inocula *Azotobacter*, while the second 500-kg was incoculated with *Azotobacter* and the phosphate-solubizing fungi, *Aspergillus*. The inoculated compost was incubated for three more days before being packed in plastic sacks. Samples were later taken for nutrient analysis. Organic fertilizer was produced from 6-month old composted chicken manure. Samples were also taken for analysis.

2. Crop Testing

Pot experiments were conducted with pepper. Seeds of sweet pepper (California wonder variety) were grown on growing beds (composed of cotton moistened with tap water) for three weeks before being transplanted in a soil mixture of 50% sand and 50% soil. Black plastic bags were used for the experiments. The fertilizers were applied immediately before transplanting. The rate for all organic fertilizers is the same, equivalent to six bags per hectare. The fertilizer rate were as follows: for chemical fertilizer treatment, 12 bags per hectare or 13.77 grams of 14-14-14 NPK-fertilizer per plant; for organic fertilizer, 30 bags per hectare or 33.76 grams per plant; for bio-organic fertilizers, 15 bags per hectare or 16.88 grams per plants; and for improved bio-organic fertilizers, 15 bags per hectare or 16.88 grams per plant. The basis for the computation of the fertilizers rate is the recommended nutrient requirements of the plant taken from the Department of Agriculture information sheets. Plants and fruits were harvested after 45 days. Shoot dry weight, shoot length, root dry weight, root length and fruit dry weights were determined using standard methods. Fresh samples were weighed and then dried at 60^0 C for three days before being weighed.

A field experiment was conducted at the Center for Rural TechnologyDevelopment-Philippine Business for Social Progress (CRTD-PBSP) in Calauan, Laguna. The formulated IBF was used for two consecutive seasons of wet and dry condition for the cultivation of rice. It was then compared with the previous yield using chemical and commercial organic fertilizers (which are commonly the farmer's practice in the area).

3. Results and Discussion

Nutrient analyses of the organic fertilizers are shown in Table 1.

The base material for all types of fertilizers used, which is composted chicken manure is the same for all treatments. BOF and IBF are not the same. This is necessary to prevent major difference in fertilization.

Total nitrogen increased for both IBF and BOF. This was due to the biological nitrogen fixation activity of the enrichment inocula, *Azotobacter sp*. However, there is a higher increase in total nitrogen level in IBF than BOF, 51.42% for IBF as compared to only 20.0% for BOF.

Total phosphorous and potassium did not vary as neither element can be fixed but only liberated. However, available phosphorous was observed to increase drastically with the addition of the phosphate-solubilizing fungi. Generally, the action of microorganisms in the decomposing organic matter liberates the

TABLE 1

COMPARATIVE NUTRIENT ANALYSIS OF THE DIFFERENT ORGANIC FERTILIZERS USED

	BIO-ORGANIC		IMPROVED BIO-ORGANIC		ORGANIC
FERTILIZER	Before Enrichment	After Enrichment	Before Enrichment	After Enrichment	
Total nitrogen, %	0.35	0.42	0.35	0.53	0.26
Total Phosphorous, %	0.58	0.58	0.58	0.58	0.30
Available Phosphorous,%	0.08	0.13	0.08	0.38	
Total Potassium, %	0.17	0.17	0.17	0.17	0.11

TABLE 2

COMPARATIVE VEGETATIVE GROWTH OF BELL PEPPER PLANT USING DIFFERENT FERTILIZERS

PARAMETERS	PLANT HEIGHT (cm)	NO. OF LEAVES	ROOT LENGTH (cm)	TOTAL DRY WT. (g)	SHOOT DRY WT. (g)	ROOT DRY WT (g)
Control (no fertilization)	23.73 B	11.87 C	19.67 A	6.98 B	5.74 B	1.29 B
Chemical fertilizer (CF)	26.10 B	15.60 C	19.70 A	10.74 B	9.26 B	1.48 B
Organic Fertilizer (OF)	25.57 B	22.37 B	17.47 A	12.49 B	11.06B	1.51 B
Bio-Organic Fertilizer (BOF)	26.80 B	22.20 B	21.00 A	13.17 B	11.42 B	1.75 B
Improved Bio-Organic Fertilizer (IBF)	36.13 A	40.87 A	22.47 A	28.64 A	22.30 A	2.88 A

Means in a column followed by the same letter are not significantly different at 5% level using DMRT. Measurements were on a per plant basis.

phosphorous ions and can make it available for plants and other microorganisms. The presence of sufficient amount of nitrogen could greatly affect the rate of phosphorous liberation, as microorganisms are stimulated to multiply. In BOF, the rate of increase in available phosphorous is 62.5%, which is quite efficient, but the action of phosphate-solubilizing microorganisms increases the rate to 325%. The higher increase in available phosphorous could indicate a more potent organic fertilizer.

Growth parameters were monitored for sweet pepper for all types of fertilizer. The results are shown in Table 2.

In all parameters, the vegetative growth of sweet pepper fertilized with IBF has the highest value. With plant height, total, shoot and root dry weight, all fertilizer treatments, except IBF showed non-significant difference. This means that the effect of all fertilizer treatments, except IBF, on the growth of the plant is undetectable. Sweet pepper fertilized with IBF

TABLE 3

COMPARISON OF THE YIELDS OF SWEET PEPPER FERTILIZED WITH IMPROVED BIO-ORGANIC FERTILIZERS (IBF), BIO-ORGANIC FERTILIZERS (BOF), ORGANIC FERTILIZERS AND CHEMICAL FERTILIZERS.

TREATMENT	YIELD (grams per 3 plants)
Control	2.90 D
Chemical fertilizer (12 bags/ha)	15.25 B
Organic Fertilizer (30 bags/ha)	7.00 C
Bio-Organic Fertilizer (15 bags/ha)	13.50 B
Improved Bio-organic Fertilizer (15 bags/ha)	22.25 A

Yield of different treatments with the same letter are not significantly different at 5% level using DMRT. Measurements were on a per plant basis.

had an average of 71% increase in dry weight (total, shoot and root dry weights) as compared to the next highest treated plants (BOF fertilized) which had an average of 134% increase in dry weight relative to chemically fertilized sweet pepper. This is considerable given that the rates of fertilization for IBF and BOF were equal while the difference between IBF and chemical fertilizers was only three bags.

The yield results (Table 3) shows that the IBF-fertilized sweet pepper has an increase in yield of 64.8% as compared with BOF fertilized plants and 45.9% as compared with chemically fertilized plants.

In the field experiment/demonstration, significant increases in yield were noted while significant decreases in volume of input were done. Before, CRTD used chemical fertilizers as nutrient amendment for their rice. Based on their documentation a total of 16 bags of chemical fertilizers were used, just like other nearby farms. The chemical inputs were of two types, a nitrogenous fertilizer (urea) and a complete NPK fertilizer (Table 4). In the dry season of 1995, they shifted to organic fertilization of rice. Unfortunately, in order to get the same yield using an alternative means an increase of nutrient amendment and the substitution of chemical fertilizers means an increase in volume by as much as 3 times. They based the rate of organic input on the relative nutrient content of the commercial organic fertilizer used. Costwise, the fertilizer input is more expensive but an increase in yield can be noted. However, the rate of changes between cost and net income is compared, there is not much difference.

In 1996, PSFI introduced the use of IBF for both dry and wet planting season. At the rate of 6 bags per hectare (the same as the usual number of bags of chemical fertilizers previously used), the yield increased by as much as 13% and 20%, if compared to commercial organic fertilizer and chemical fertilizer, respectively.

Substitution of chemical fertilizer with IBF at the rate of one-to-one can be done. Yield increases occur while fertilizer cost decreases. The impact of at least 20% increase in yield and 55% decrease in fertilizer cost will greatly affect the productivity of the farmers by increasing the

TABLE 4

COMPARATIVE COST OF FERTILIZER INPUT
BASED ON THE FIELD DEMONSTRATION AT CRTD

FERTILIZER	TOTAL COST
Chemical Fertilizer 3 bags urea (46-0-0) X P320/bag = P 960.00 3 bags complete (14-14-14) X P350/bag = P1,050.00	P 2,010.00
Commercial Organic Fertilizer 20 bags X P 120.00	P 2,400.00
Improved Bio-Organic Fertilizer 6 bags X P 150.00	P 900.00

TABLE 5

COMPARATIVE COST AND INCOME FOR DIFFERENT TYPES OF FERTILIZERS
BASED ON THE FIELD DEMONSTRATION AT CRTD

FERTILIZER	FERTILIZER COST (P)	YIELD (kilos)	GROSS INCOME[1] (P)	NET INCOME[2] (P)
Chemical Fertilizer	2,010.00	4,000	26,000.00	23,990.00
Commercial Organic Fertilizer	2,400.00	4,250	27,625.00	25,225.00
Improved Bio-organic Fertilizer	900.00	4,800	31,200.00	30,300.00

[1] based on P6.50/kg palay
[2] gross income minus fertilizer only

profit that will be derived from using an improved bio-organic fertilizer (Table 5).

EFFICACY OF THE IMPROVED BIO-ORGANIC FERTILIZER (IBF) IN RICE: FIELD TRIAL IN LUNA, ISABELA

Three one-hectare demonstration plots were identified at Brgy. Mambabanga, Luna, Isabela to compare the efficacy of the improved bio-organic fertilizers scheme with the farmer's practice (pure chemical fertilizers) and the combination of the farmer's practice and seed inoculants (UPLB technology).

Three vegetative parameters were determined (plant height, tiller number and panicle length) as well as the yield. Eight one square meter samples were taken for each treatment. Samples were measured and statistical procedures were done to determine variability and significance.

The farmer's practice was determined as using six 50-kg bag of urea and four 50-kg bags of complete chemical fertilizers. The seed inoculants used were bought from UPLB and used at the rate of six 250-gram packets per-one hectare.

The IBF procedure was done as follows: the straw yield for one hectare was decomposed using formulated composting inoculant. After two weeks the composted rice straw were enriched with IBF enrichment inoculant at the rate of one liter per ton. A total of 1.5 tons of IBF enriched composts were used.

Results of the field trial are shown below (Table 6).Three vegetative parameters (plant height, panicle length and tiller number) were determined to compare the effect of each fertilization scheme. Among the three-fertilization schemes, the IBF was shown to have the highest numerical value for all three vegetative parameters.

The IBF-fertilized plants were significantly higher in tiller number as against the other two fertilizer schemes but were not significantly higher than the chemically fertilized plants (from farmer's practice) in terms of plant height. This could indicate that IBF can provide higher amounts of nitrogen (and other nutrients) than the combination of chemical fertilizers and seed inoculants. Longer panicles of the IBF treated plants over the farmer's practice (Table 6) can also be the result of the enhanced nutrition using IBF.

The IBF inoculants are a mixture of microorganisms that require high levels of easily digestible compounds which are provided through the decomposition of the rice straw. These compounds provide energy for the growth and activity of the microorganism, fuelling different biological processes such as biological nitrogen fixation and phosphate solubilization. Processes involved are then responsible for the availability of high amounts of the needed nutrients for plant growth and are significantly shown through its yield. Unlike other composts, the presence of the IBF inoculants could have spelled the difference in terms of yield.

Good yield results coupled with easy production procedures and competitive pricing makes the IBF technology a good alternative solution for the high performance but expensive chemical fertilization scheme.

TABLE 6

COMPARATIVE VEGETATIVE GROWTH OF RICE FERTILIZER WITH IMPROVED BIO-ORGANIC FERTILIZERS (IBF) COMPARED TO THE FARMER'S PRACTICE

TREATMENT	PLANT HEIGHT (cm)	PANICLE LENGTH (cm)	TILLER NUMBER
Farmer's practice	87.63 a	20.88 b	16.75 b
Farmer's practice plus seed inoculant	82.75 b	21.06 ab	14.75 b
Farmer- produced IBF	89.63 a	22.12 a	22.50 a

In a column, treatment means followed by the same letter are not significantly different at 5% by DMRT.

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Rice Hull and Market Waste Treatment into Improved Bio-organic Fertilizer

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SA
Views and Experiences from the Ground

THE WASTE SITUATION IN CALAPAN CITY, ORIENTAL MINDORO

RICE MILL WASTE

Rice milling is a year-round activity. Millers are experiencing an ever-increasing volume of rice hull and rice bran. A solution for most millers is dumping and burning of the “waste” products in areas leased or bought by the millers themselves. Rice bran is disposed of by selling it as feed mixture to pigs and livestock. Because of the present relatively high efficiency level of rice mills, only limited quantities of bran is produced, rendering bran disposal easy. Unfortunately, the rice hull or husk is a totally different problem.

Rice hull or husk is made up of strong, complex carbon compounds called cellulose, lignin and chitin, compounds that render them very hard to decompose. Decomposition usually takes months or years. The best disposal method is dumping, landfill and burning.

At Calapan City, Oriental Mindoro, there are approximately 20 rice mills generating an average of 3 tons of hull per day. Given the average hull generation and the current number of millers, approximately 60 tons of hull is generated and disposed of daily. This rationalizes millers’ preference to dump and/or burn it.

Research in the disposal, decomposition, treatment and conversion of rice hull has been made by local and foreign researchers. The hull itself can be used as soil conditioner and fertilizer. But as conditioner, it has many limitations, namely:

- Silica and complex carbon compounds in the hull render the soil less porous and vulnerable to hardening, especially if there is no continuous and proper watering.
- Rice hull decomposing in the soil could further deplete the soil nutrients and thus, limiting what’s available to the crop.
- Rice hull requires longer decomposition time and contains less nutrients. Therefore, farmers

TABLE 1

RICE HULL GENERATION OF 20 RICE MILLS IN CALAPAN CITY, ORIENTAL MINDORO

	PER RICE MILL	20 RICE MILLS
DAILY	3 tons	60 tons
MONTHLY	90 tons	1800 tons
YEARLY	1080 tons	21600 tons

who wish to use it as fertilizer would need tons of it to meet the crop's nutrient requirement.

MARKET AND MUNICIPAL WASTE

Market, municipal and household waste are a totally different problem. Calapan as a newly established (second or third rate) city is growing, both in economic and population terms. People migrating to the city creates waste problems, illustrated by the following:

- A survey of market waste shows that on a daily basis the organic, biodegradable waste generated by the city market amounts to 950 kg, or 28.5 tons a month.
- Approximately 800 grams of assorted waste are generated everyday by a single person. This amounts to 24 kg a month.
- A third to half of the household waste generated are organic and biodegradable. This translates to 250 grams a day, or 8 kg a month of waste.
- If Calapan City alone has a population of 100,000 then the biodegradable, organic waste generated would be 25 tons a day or 750 tons a month.

MICROBIO-ORGANIC WASTE TREATMENT: THE TECHNOLOGY AND THE PROJECT

THE TECHNOLOGY

The "Microbio-organic Waste Technology" utilizes specially formulated mixtures of microorganisms that can efficiently degrade a specific mixture of waste, in this case rice hull and market waste. A system of incentive-based segregation and collection has effectively provided the needed raw materials for the technology. This system has been standardized to determine costing, labor and other requirements. Schedules had been formulated and specific mixtures identified and used depending on the type and volume of waste available (especially for market waste). A formulated mixture of microorganisms used effectively degrades the waste into a shorter time span, i.e., approximately 16 days.

Other aspects on the technology are as follows:

- It is labor, time and cost efficient. The specially formulated microbial mixtures, if applied in a compost heap, do not need to be physically aerated (like turning the heap every 3-5 days). Labor is only needed for mixing, watering and covering the heap with plastic. The heap is produced in half a month. Daily bags of fertilizers can be harvested, used or stored, provided that a heap is mixed everyday.
- By combining the preceding two practices lower production and total cost is achieved. The project can then compete with existing fertilizers available in the market. With more waste produced, the over-all cost per bag of "fertilizer" produced also decreases.
- To compete with commercially available organic/bio-organic and chemical fertilizers the project utilizes another formulated mixture of microorganisms that can enrich the finished product. The comparative nutrient content of the finished product as compared to an available commercial organic and chemical fertilizers are shown in Table 2.

With an enriched finished product farmers no longer need to apply so many bags to get the same yield. A farmer can shift from chemical to organic fertilization totally and immediately. One bag of chemical fertilizer can be substituted with one bag of the improved bio-organic fertilizer (IBF). In a demonstration, 2,500 square meters of riceland used 2.5 bags fertilized by IBF from rice hull-market waste. Total yield obtained was 24 bags. The previous yield was a little less than 20 bags using chemical fertilizers.

THE PROJECT

The project started in March, 1998 with the cooperation of BBC Ricemill (Ms. Evelyn Cacha-owner), KAFCODE (an NGO under Ms. Doris Melgar), SAVE MINDORO (an NGO under Councilor Grace Infantado) and the Municipality of Calapan (under its mayor). The two NGOs and Ms. Cacha have been very active in environmental projects, having sponsored several "Clean and Green" activities. At that time disposing the rice mill waste and the market/municipal waste were a problem. After several negotations and demonstrations of technologies that can efficiently treat and convert the waste, Mss. Cacha and Melgar decided to test the system.

TABLE 2

COMPARATIVE NUTRIENT ANALYSIS OF DIFFERENT TYPES OF FERTILIZERS

FERTILIZER	NUTRIENT ANALYSIS N-P-K (%)
Complete Chemical	14-14-14
Commercial Organic	1-2-1
Improved Bio-organic Fertilizers (rice hull-market waste mixture)	1-0.7-0.6

After two months of testing and demonstration, the Microbio-organic Waste Technology formulated by the author was adapted. It was in July 18, 1998 when the first large-scale pilot treatment and conversion activity was held. Since then, the market wastes of Calapan City, together with the rice hull waste of BBC Ricemill, have been continuously treated. By the middle of October, the total number of combined waste (hull-market wastes) treated was 250 tons.

THE MANAGEMENT SYSTEM

1. The market waste was systematically segregated using an incentive wherein monetary equivalent was formulated for every unit of segragated waste

2. The biodegradable wastes were then disposed in a predesignated processing area where it is mixed with the rice hull and a proven microbial innoculant. The formulated microbial innoculant was selected out of the different tests conducted before, and were proven effective on the waste mixtures.

3. The average duration of total waste treatment/conversion is 16 days.

4. After the treatment, the composted mixture is then processed (sieved) to acquire uniform quality. The sieved compost can either be used or stored.

5. Microbial innoculants are used to provide the necessary nutrients for crops given that the resulting compost had a relatively low nutrient analysis.

6. The recovery rate ranged from 60 to 90% depending on the formulated waste mixture.

7. The total cost per 50-kg bag is P60 to P85. On the other hand, the current selling price for a commercial organic or bio-organic fertilizer in Oriental Mindoro ranges from P180 to P240 (Table 3).

The IBF from the treated rice hull-market waste had been tested on crops. In July-August, 1998, several crops (rice, vegetables, rootcrops and fruit trees) were tested. Results showed that yields did not suffer, but were equal to or higher than chemically fertilized crops.

DISSEMINATION OF THE TECHNOLOGY

The project has begun its active promotion of the developed fertilizers. A seminar on the technology and the product had recently been conducted. The mayor of Calapan City bought 10 bags each for testing by its 30 technicians.

Various municipal agencies like the DENR, DA, and DAR expressed their willingness to compare the fertilizer from other available fertilizers and test it to as many crops as possible.

The project is now a joint undertaking of NGOs, private individuals and the LGU. The type and nature of cooperation is currently being formalized. Meanwhile, the project is continuing to produce IBF and expects to generate enough volume of fertilizers for the need of at least 1000 hectares by the start of the next cropping season.

TABLE 3

COMPARATIVE COST ANALYSIS OF FERTILIZERS USED IN ONE HECTARE OF RICE

FERTILIZER	AVE. CONSUMPTION PER HECTARE (50 Kg BAG)	SELLING PRICE PER 50 Kg BAG (P)	COST OF FERTILIZER PER HECTARE (P)
Chemical (Average)	7	350	2450
Commercial Organic	10	200	2000
Improved Bio-organic from Waste Treatment of Hull-Market Waste	7	150	1050

Sustainable Agriculture:
The Don Bosco Perspective and Experience

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THE GLOBAL EXPERIENCE OF UNSUSTAINABLE AGRICULTURE

During the "Earth Summit " or the UN Conference on Environment and Development (UNCED) on June 14, 1992 in Rio de Janeiro, Brazil, over 140 countries around the world signed their approval of Agenda 21, the global agenda for the 21st century. Chapter 14 of Agenda 21 (Promoting Sustainable Agriculture and Rural Development) called for a more sustainable approach to agriculture and rural development particularly with regard to food security and sustainable development. International bodies, governments, national agencies and institutions, the academe, the scientific community, the NGO/CSO community, the activists and revolutionaries, the politicians and the farmers—all have adopted and owned the term sustainable agriculture. Unfortunately, however, different proponents understand and use the term differently such that in many cases, the agreement starts and stops at the spelling of the term. The differences are wide ranging, from one extreme to another.

The Consultative Group on International Agricultural Research (CGIAR) network of 17 International Agricultural Research Centers or IARCs who launched the "Green Revolution" Agriculture is now calling for more sustainable forms of agriculture. Without changing their policies and package of Green Revolution technologies, and more recently, the more dangerous Gene Revolution Agriculture—they feel comfortable joining the sustainable agriculture bandwagon. Even among the NGO/CSO community, the term evokes quite different understanding, different visions and different operational concepts and consequently, different technologies and approaches.

The basic framework of understanding what is sustainable agriculture (SA) begins from a more basic one—that of understanding what is unsustainable agriculture. The emergence of sustainable agriculture stems from the experience of the negative impacts of unsustainable agriculture on Nature (which others reduce to "natural resources") and on the human being and on society, in general. Sustainable agriculture emerged as the alternative to an unsustainable agriculture. Herein lies the more fundamental differences in understanding SA. The invitation I received from the National Program Coordinator of SARDIC states the expectation of identifying some common measures of sustainability that SARDIC can adopt and use. I will venture to say that the task will not be difficult despite the diversity of our backgrounds if we begin from a common understanding of what we are trying to change—the unsustainable agriculture.

Thus, I will begin with a thesis of what the "other" agriculture is which we are trying to counter with SA, and what the damages are which we are trying to heal. The Green Revolution Agriculture and, more recently, the more sinister Gene Revolution Agriculture (genetic engineering of agricultural biotechnology) are what we spell as THE unsustainable destructive agriculture. They are not just packages of technology springing from a certain science, they have ramified into the social fabric of society (economics, politics, and culture); into the physical environment or life support systems of the Planet Earth; and into the moral/ideological dimension of human life.

The Green Revolution agriculture and more recently, its sibling, Gene Revolution through genetic engineering/biotechnology, are both offspring of the marriage of a "bad science" and big business interests. The essence of unsustainable petro-chemical dependent agriculture is portrayed in Figure 1.

There is global recognition that intensification of agricultural production with the use of pesticides, chemical fertilizers and related technologies is a dead end approach. This recognition is

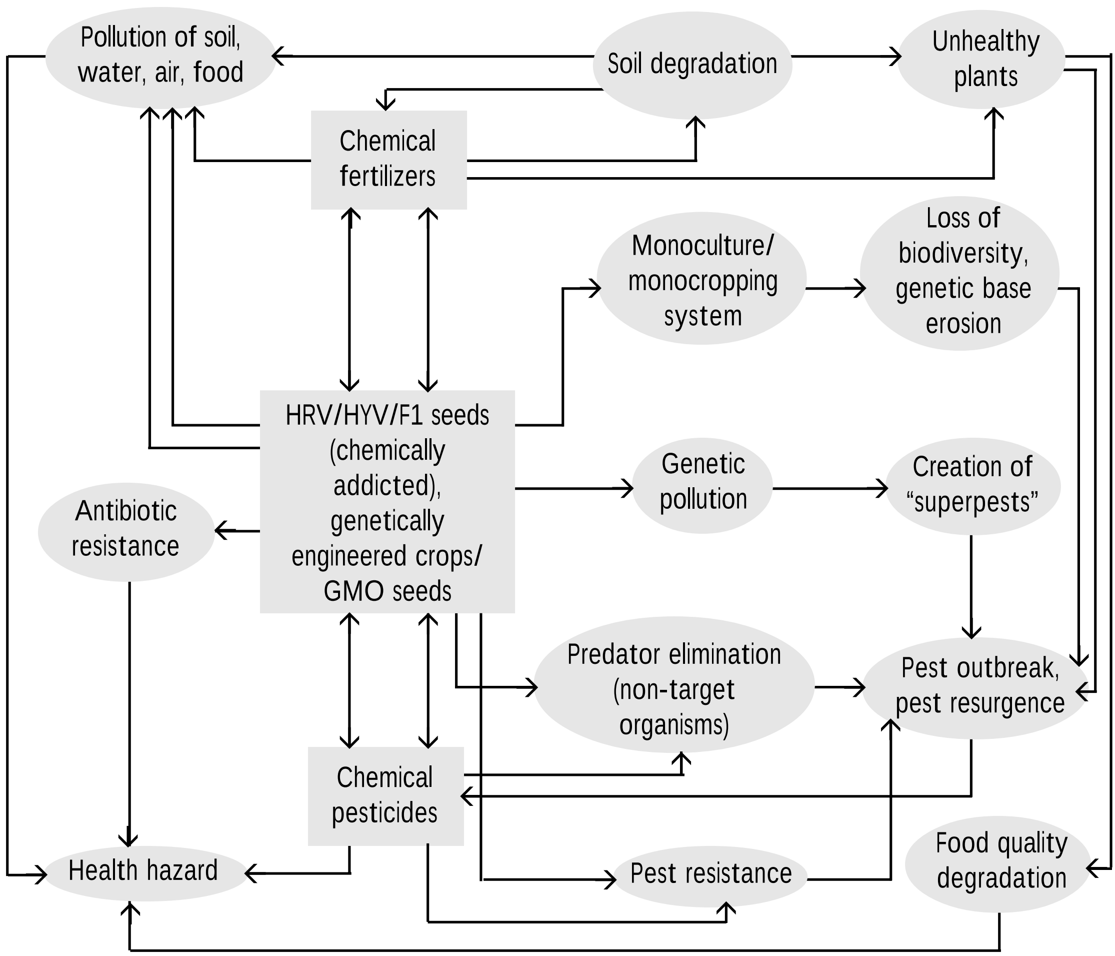

FIGURE 1

THE VICIOUS CYCLE OF GREEN REVOLUTION AND GENE REVOLUTION AGRICULTURE: A CIRCLE OF POISON

Modified from Murakami, S., 1991.

widespread in academic, scientific and policy circles. The World Commission on Environment and Development (Box 1) of the United Nations, in its 1987 report to the UN General Assembly, Our Common Future states, thus:

" Using chemicals to control insects, pests, weeds and fungi enhances productivity, but threatens the health of humans and the lives of other species. Continuing long term exposure to pesticides and chemical residues in food, water and even in the air is hazardous, particularly to children. A 1983 study estimated that approximately 10,000 died each year in developing countries from pesticide poisoning and about 400,000 suffered acutely. The effects are not limited to the area where pesticides are used but travel through the food chain.

Commercial fisheries have been depleted, bird species endangered and insects that prey on pests wiped out. The number of pesticide resistant pest species worldwide has increased and many resist even the newest chemicals. The variety and severity of pest infestations multiply, threatening the productivity of agriculture in the areas concerned."

The Living Environment (Tyler, 1985), the bible of environmental science, summarizes the impact of chemical pesticides in agricultural production as follows:

"Harmful Effects of Widespread Use of Insecticides and Herbicides

1. Killing of natural enemies: Broad spectrum insecticides kill both the target pest species and a host of other organisms, often including the pest's natural predators. Without natural enemies, rapidly reproducing insect pests can make a strong comeback within a few days or weeks, forcing farmers to use heavier doses and more frequent applications of insecticides to keep them under control.

2. Creation of new pests: Parasites and insects, especially mites, can become new major pests when broad-spectrum pesticides kill off their natural predators.

3. Development of genetic resistance: When heavy doses of pesticides are used over and over, the short generation time of most insects, disease organisms, and weeds allow them to adapt and mutate so later generations can become highly resistant to being killed by the chemicals within about 5 years and even sooner in the hot and wet tropics, where insects and diseases adapt and mutate even faster. Worldwide, by 1982 at least 432 species of insects, mites and ticks, 50 species of fungi, and several species of weeds that affect crops had strains resistant to one or more chemical pesticides – more than a fourfold increase since 1960. When genetic resistance or new pests develop, pesticide company representatives recommended more frequent spraying, stronger doses or switching to a different chemical—putting the farmer on a pesticide treadmill.

4. Biological magnification of persistent pesticides: Because DDT and some other persistent pesticides are more soluble in fats than in water,

BOX 1

THE WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT

The World Commission of Environment and Development (WCED), headed by Gro Harlem Brundtland, Prime Minister of Norway, was set-up as an independent body in 1983 by the United Nations. Its brief was to re-examine the enviromental and development problems on the planet and to formulate realistic proposals to solve them, and to ensure that human progress will be sustained through development without bankrupting the resources of future generations.

their concentrations can be biologically magnified in food chains and webs to levels thousands to millions of times higher than those in soil or water threatening the health and survival of species that eat at the higher trophic levels.

5. Global mobility of persistent pesticides: Only about 1 % of all pesticides applied hit the target pest. The other 99 % enter local ecosystems and persistent pesticides are transported by wind, rain, snow, and moving water throughout most of the world and are then magnified to higher levels in food chains and food webs, just about everywhere in the world including your body and those of Arctic seals and Antartic penguins located far from agricultural areas.

6. Reduction of ecosystem diversity and resilience: Species and food web diversity can be reduced, which in turn can disrupt the efficiency of energy flow.

7. Threats to wildlife: Marine organisms, especially shellfish, can be killed by minute concentrations of chlorinated hydrocarbons. Some bees, necessary for pollination of many vital crops, are extremely susceptible to pesticide poisoning. A breakdown of DDT/DDE, reduced the populations of peregrine falcon, brown pelican, osprey, bald eagle, and several other predatory birds that help control populations of rabbits, ground squirrel and other crop-damaging small mammals...

8. Threats to human health: By conservative estimates, about 500,000 farm workers, pesticide plant employees, and children worldwide become seriously ill and about 5,000 die (10,000 according to one estimate) each year from exposure to toxic insecticides—especially organophosphates. In the United States insecticides caused an estimated 45,000 illnesses and 200 deaths each year. Insecticide-related illnesses and deaths are particularly high among farm workers in less developed countries (LDCs), where educational levels are low and control over pesticide use is often lax. Trace amounts of DDT and other persistent pesticides are found in the fatty tissues of almost every person on earth. In 1971, Americans carried an average of about 8 ppm of DDT in their bodies. After the 1972 ban on DDT use in the United States, the average level had dropped to about 2 ppm by 1980. A 1983 study, however, showed that 44 % of fruits and vegetables grown in California contained residues of 19 different pesticides including DDT and other supposedly banned pesticides. Recent National Academy of Sciences studies indicate that 66% of 1,400 different chemicals used in registered pesticides in the United States have not been adequately tested for possible human health hazards and up to 25% of these 1,400 chemicals may cause cancer in people. Possible long-term effects, if any, from the trace amounts of DDT and other pesticides in our bodies won't be known for several decades because the oldest people who have carried these chemicals in their bodies since conception only reached age 40 in 1985. Even then it will be almost impossible to determine that a specific chemical such as DDT caused a particular cancer or other harmful effect."

Cases against chemical pesticides are thoroughly studied and well documented in a book published by, ironically, IRRI itself through its Natural Resource Management and Policy. The book, "Impact of Pesticides on Farmer Health and the Rice Environment" published the multidisciplinary study participated in by some 31 scientists from IRRI, NRI (England), ORSTOM (France) and UPLB. Other studies have been conducted, all yielding the same conclusion — the Green Revolution technology package is a dead-end approach, that the only direction is negative economics, and it is definitely unsustainable. Despite these proofs, Green Revolution

BOX 2

LORDS OF LIFE: LEADING ENTERPRISES IN 5 MAJOR LIFE INDUSTRY SEGMENTS

WORLD'S TOP 10 AGROCHEMICAL CORPORATIONS

	Company	Headquarters	1995 Sales (in million $US)	Comment
1.	Novartis	Switzerland	4,410	Combined with Ciba Geigy & Sandoz
2	Monsanto	USA	2,472	
3.	Bayer	Germany	2,373	
4.	Zeneca	UK	2,363	
5.	AgrEvo	Germany	2,344	Formerly Hoechst & Schering
6.	Du Pont	USA	2,322	
7.	Rhone-Poulenc	France	2,068	
8.	DowElanco	USA	1,962	
9.	American Home Products/ American Cyanamid	USA	1,910	American Home Prod. Acquired Cyanamid
10.	BASF	Germany	1,450	

Source: RAFI, based on AGROW, No.253, March 1996

WORLD'S TOP 10 SEED CORPORATIONS

	Company	Headquarters	1995 Sales (in million $US)	Comment
1.	Pioneer Hi-Bred Int'l	USA	1,500	
2.	Novartis	Switzerland	900	Formerly Ciba Geigy & Sandoz
3.	Limagrain	France	525	French Cooperative
4.	Seminis	Mexico	500	Owned by Empresas La Moderna (Mexico) and George Ball (USA)
5.	Zeneca/Van dHave	Netherlands	460	Pending merger
6.	Takii	Japan	450	vegetable, flower, maize, turfgrass
7.	Dekalb PlantGenetics	USA	320	40% Monsanto Share
8.	KWS	German	315	
9.	Sakata	Japan	300	vegetable, flower, turfgrass
10.	Cargill	USA	250	privately held

Source: RAFI based on information provided by Kent group , Inc.

WORLD'S TOP 10 PHARMACEUTICAL CORPORATIONS

	Company	Headquarters	1995 Sales (in million $US)	Comment
1.	Glaxo Wellcome	UK	11.80	
2.	Merck	USA	10.96	
3.	Novartis	Switzerland	10.94	Ciba Geigy and Sandoz combined
4.	Hoechst	Germany	9.42	
5.	Roche	Switzerland	7.92	
6.	Bristol-Myers Squibb	USA	7.81	
7.	Pfizer	USA	7.07	
8.	SmithKline Beechman	UK	6.60	
9.	Johnson and Johnson	USA	6.30	
10.	Pharmacia	Sweden	6.26	

Source: Wall Street Journal, 7 March 1996.
Company sales exclude sales of non-drug products.

proponents continue unabated in its promotion. Some sectors are benefiting from the destruction and the havoc to human life, the social fabric and the precious physical environment. The leading 10 enterprises have major stakes in the different life industries, including pharmaceuticals, agrochemicals, seed, food and biotechnology companies/corporations (see Box 2).

Some of the major conclusions are:

a.The top 10 agrochemical corporations accounted for $23.6 billion , or 81 % of all Agrochemical sales in 1995.

b. The commercial seed industry is worth approximately (US) $ 15 billion per annum. The top 10 corporations account for $ 5,520 billion or 37% of the worldwide market.

c. RAFI estimates that the total world pharmaceutical market is approximately $197 billion per annum. The top 10 companies account for approximately 43% of the total.

Big business interest is raking in profits from the chemical–based technological fix. Seed companies producing pesticides for the seeds also produce pharmaceuticals/drugs for the medication of the negative health impacts of these same pesticides. We can aptly say that the multinational companies take care of us *"mula duyan hanggang puntod"* (from cradle to grave). This is more obvious with the recent development of agricultural biotechnology revolution through genetic engineering. Monsanto, now the biggest seed company after it bought Cargill and Dekalb Plant Genetics, is producing genetically-engineered corn, soya and cotton seeds designed to boost sales of their glyphosate herbicide, Roundup. It is producing Roundup Ready or glyphosate-resistant corn, soya, among others. It is currently introducing Bt corn to the Philippines (recombinant DNA of toxin-producing soil bacteria *Bacillus thuringiensis* and corn).

The impact of these Green and Gene Revolution Technologies cannot be simplified to mere health hazards or environmental degradation. There are three dimensions of technology, namely, a) ideological/moral, b) resource/ environmental, and c) social-political economics and culture. The Green and Gene Revolution have impacted on all three dimensions. Its ramifications and damages have reached deep into the human culture and psyche. Sustainable agriculture is the exact opposite of conventional chemical agriculture. Any alternative that claims itself as sustainable must be the total opposite of conventional chemical agriculture. Sustainable agriculture must liberate the farmer from the fallacy of the science that spawned chemical agriculture; liberate the farmer from the destructive technology packages it promotes; and from the short-sighted, narrow and negative economics; from instant and cash culture; and disempowerment that resulted from it.

THE DON BOSCO PERSPECTIVE ON SUSTAINABLE AGRICULTURE

The first part of this paper attempted to define a global experience of unsustainable agriculture. The second part elucidates what to us in Don Bosco is sustainable agriculture. To be truly sustainable, agricultural systems must have the following attributes:

1. INTEGRATIVE AND HOLISTIC SCIENCE

Is science neutral? Is there such a thing as "pure science"? Apparently a difficult and controversial frontier to tackle, this questions the very nature of science itself. Nonetheless, I will attempt to clarify the issue. We propose for a Holistic and Integrative Science because there is a science opposite to this science – reductionist science that breaks down and divides instead of integrates. Complex reality is fragmented, broken apart conceptually. A fragment of that reality is hoisted up as THE explanatory nature of that reality (Perlas, 1992). Worse, this science explains the whole, reduces the whole through a part, through a piece. The complexity of causative factors in the real world is reduced to one or at most a few factors to be "the" cause or the "dominant" cause. For example, to produce Bt corn, the genetic engineer recombined the gene producing the toxin of the bacterium *Bacillus thuringiensis* (used against the corn borer which belongs to the Lepidoptera family) with the gene of corn. The scientist believes that with Bt toxin expressed in all parts of the Bt corn and in high dosage level, all the Asian/European corn borers would be wiped out and thus, the corn borer problem will be solved.

This is a typical example of reductionist science believing and reducing a whole reality to just a tiny part or piece which is much, much more complex than a chemical retort of a gene. This too is an example of methodological reductionism, which is overt and is an expression of an overt, metaphysical reductionism. A far more virulent, potent and destructive reductionism – the assumption that all natural, social and psychological reality can be fully explained by material and physical causes and processes lurk behind methodological reductionism. This is in short, materialist reductionism or materialism. Whoever said that science is neutral? Science has its inner logic and paradigm, referred to as what we call the ideology of science. It has metaphysical assumptions regarding reality. The agenda and inner logic of conventional science is to fragment complex natural and social reality, make a caricature of it, and ultimately bind it to a mere illusory material and physical existence (Perlas, 1992).

Holistic science on the other hand integrates rather than fragments. It views all horizontal and vertical factors of reality. Holistic science examines horizontal factors (e.g., occurrence of pest, plant vitality, seed/variety, water management, fertilization practice, climatic factors, other cultural practices) rather than zeroing in on one factor and attacking the identified dominant factor (e.g., get the "appropriate " pesticide and blast the pest). Holistic science accepts reality as the seen and the unseen, the named and the unnamed, as matter and non-matter. To see is to believe is the paradigm of the old or reductionist science. Reality is matter and matter is anything that occupies space and has weight. Anything that does not occupy space and possesses no physical weight is condemned as unreal. Causality or causation can only be local – governed by space and time. However, the reductionist scientist has forgotten that the very first tools of science – consciousness experienced in thoughts is non-local, non-physical. Reductionist science is a victim of its logic. Holistic science rests on the totality of reality, matter and non-matter, as a complex whole. Biodynamic science is one such science.

2. ECONOMIC VIABILITY

"To be economical, agriculture must be ecological" (Perlas, 1992). The current measure of economic viability, based on the mainstream market economy and permeating agricultural economics, looks at short-term productivity and profitability. Agriculture has been reduced to agribusiness. Rice farmers, for example, measure a system's economic viability through grain yield. The number of bags of *palay* produced is the measure of profitability; net income after the production cost is deducted is not used. This is a very shortsighted view of reality. A better way of measuring economic viability, the holistic way, is through systems yields.

Green Revolution proponents believed that economic development had no relationship with ecology. However, after paying so high a price in environmental destruction, economists are beginning to understand that the global agricultural system is only a subsystem of the larger global ecological system. Economic development is within an "ecological and social space." Thus, any agricultural system that purports to be sustainable must change its method of accounting, and be one that integrates development and ecology. Most agricultural technicians teach the farmers a very narrow cost accounting and cost-benefit analysis for a cropping season. Listed as production costs are labor and inputs. To come up with a profitable figure, production costs are deducted from the cash income. What is forgotten is that nature in economic jargon is "natural capital" (Perlas, 1992). In their rush to intensify agriculture, purportedly to feed the world, farmers and scientists have been depleting their "natural capital" instead of living off the stream of income and interest that the wise management of the "natural capital " can confer. Agriculture (the culture of tending the land) has been lost and replaced by agribusiness, unfortunately a losing business because it considers only the short-term productivity without foresight of long-term sustainability.

Our accounting method must reflect the harm or good, both on the micro and macro level done by our agricultural system to the "natural capital "—the ecology of the farm. To quote Charles Cassia, " How long can we go on and safely pretend that the environment is not the economy, is not health, is not a prerequisite to development, is not recreation?... (We have) a misplaced belief that we have a choice between economy and the environment. That choice, in the long term, turns out to be an illusion with awesome consequences for humanity." Only ecological soundness leads to real, sustainable economic viability. This demands a type of economic technology development that integrates production with resource conservation and enhancement.

In Don Bosco, we use an alternative method of cost accounting and cost-benefit analysis, albeit crudely, to try to reflect both the "hidden costs"—basically "systems costs" and "systems yield –hidden/silent benefits" of any particular system of agricultural production. This needs a shift in perspective from production to total productivity. It is simply not enough to say that production/yield has increased, but it is useful and more holistic to ask: But at what cost?

3. ECOLOGICAL SOUNDNESS

Although one of the more universally accepted dimensions of sustainable agriculture, the actual implementation of the idea is fraught with left and right turns, pitfalls and problems. NGOs may think they are on the other side of the fence but essentially some are just as guilty of the "technological fix" approach of the pesticide industry. As a reaction to conventional chemical pesticides and the mestizo IPM, many NGOs have substituted chemical pesticides with botanical pesticides or Alternative Pest Management (APM). However, botanical pesticides can suffer a number of drawbacks similar to the impacts of toxic pesticides.

The real alternative to chemical pesticides is ecological pest management, or community ecology. This approach relies heavily on encouraging and developing niches for different insect populations to proliferate to form a community within an agroecosystem, and microbiological population within the soil ecosystem. This should approximate the check-and-balance of a perfect ecosystem - a forest.

But this should not be enough. Another requirement for ecological soundness is for human beings to stop equating Nature with simply natural resources to be used, exploited and dominated for the satisfaction of human wants; ecological soundness otherwise would be a dream. Until the human being/farmer recognizes Nature as source of Life and not merely a source of livelihood, even organic farming movements will be environmental activism without a soul. Until the human being participates in deep ecology, until the human being encounters the Divine in Nature, he or she will always dominate Nature. Until the human being learns back reverence, this devastating relationship of dominance will prevail. Ultimately, for ecology to be healed, the human being must be healed from her/his alienation from Nature and the Divine.

In Don Bosco, ecology is not geocentric or it is not limited to the Earth biosphere. We have a concept of expanded ecology that takes into account the whole of the cosmos and the whole of creation in farming. The cosmic rhythms, energies, processes and forces in nature and their interrelationships and influences on human's agricultural activities upon the Earth are established. This, however, cannot be achieved within the realms of organic farming because organic farming is within the realm of conventional science which reduces reality into material existence. If conventional agricultural science has been explaining reality from the micro-level (laboratory microscope), organic

BOX 3

LEVELS OF ORGANIZATION OF MATTER

The Very Large Cosmic or SUPERMACRO	Universe	Life?
	Galaxies	
	Solar System	
	Planets	
	Earth	LIFE
The Ordinary MACRO	Ecosphere/Biosphere	
	Ecosystems	
	Communities	
	Populations	
	Organisms	
	Systems	
	Organs	
	Tissues	
The Very Small MICRO	Cells	
	Protoplasm	Borderline
	Molecules	Non-life
	Atoms	
	Sub-atomic Particles	

Source: Miller, G. T., 1985. The Living Environment

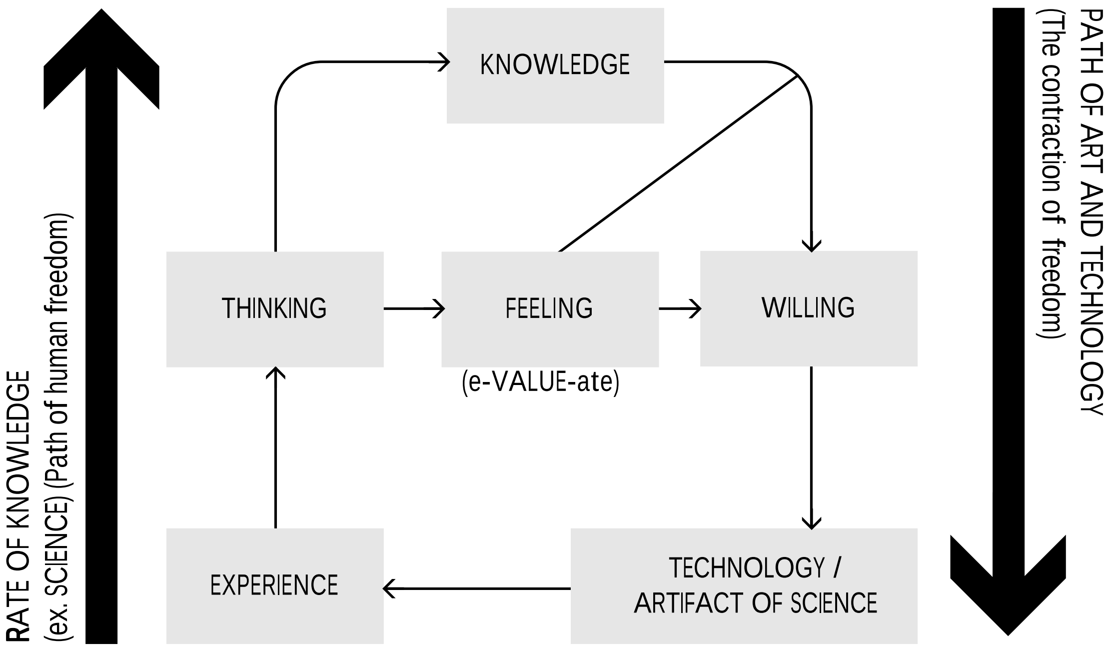

FIGURE 2

THE PROCESS OF TECHNOLOGY DEVELOPMENT

farming has been looking at it from the macro-level. This is where the interrelationships of communities and population within ecosystems are observable ordinarily through the naked eye. Biodynamic agriculture on the other hand, has been able to reach the supermacro level of dealing with agricultural reality (Box 3).

It would not be possible to deal with the finer details of the Biodynamic concept. However, one thing is for sure – our Planet Earth is a part of our solar system which is a part of our galaxy, the Milky Way, which is also a part of a local cluster of about 33 galaxies which is again a part of a super cluster of galaxies in one corner of the vast and endless universe. It takes about 100,000 years at the speed of light (380,000 miles/sec) to cross from one end of our galaxy to the other. The Earth is but a tiny speck in this vastness and grandeur. How can earthlings like us deny our relationship with the other beings of the cosmos? (For questions on this matter, one can explore the website of the Josephine Porter Institute of Applied Biodynamics based in the USA).

4. FOUNDED ON THE USE OF APPROPRIATE TECHNOLOGY

The birth or emergence of technology goes through a process and the appropriateness of technology depends heavily on the process and who are involved in it. Figure 2 tries to encapsulate the process.

The process of technology development begins from experience that gets processed by an active "I" or thinking. This is the path of scientific knowledge, it is the path of freedom. Here, the human being is fully free. The arrival at knowledge comes after the processing of experience. The will to apply the knowledge produced by the thinking process is bridged by feelings. The strength of the will to implement knowledge can only come from values or after evaluation of the knowledge. The will takes concrete, limited, contracted form in art or technology, in a limited space and material form. The application of the technology developed becomes a new experience that gets processed and evaluated again through the process of thinking by an active "I." With this process, technology development is a spiral process, two steps forward and one step backward, or praxis.

At Don Bosco, we are careful about the process. Since the Green Revolution, the process of thinking has been robbed off the farmer. The so-called "experts" with PhDs took over the whole process. Implicitly, the farmers' indigenous knowledge systems was declared as "superstitious," "unscientific," and therefore of no value. The farmers were assumed to be "illiterate" and that they must learn to use the dazzling products of PhDs based on some central experiment station. In this manner, knowledge became centralized and homogenized; this centralized power became a form of domination over the farmers. The whole Green Revolution has been telling the farmers that their indigenous knowledge systems are not enough to manage pests, soil fertility, etc. This was the very beginning of disempowerment of the farmers. The Green Revolution was not born out of purely altruistic motives; it was designed to modernize Asian societies to become a market for goods from industrialized countries especially US farm tools, fertilizers, pesticides, irrigation and other agricultural equipment (Perlas, 1992). "Arthur Moses, President of Agricultural Development Council founded by John Rockefeller III, argued early in the Green Revolution that the cooperative social structure evident in many agrarian communities needed to be dismantled in order to encourage aggressive interest in the market" (Perrelman and Michael, 1977).

Without delving into the big business interests behind the technology, the Green Revolution has a *de facto* legislative effect without the benefit of a democratic process of public hearing and discussion. It has become a national policy for agriculture, agricultural credit, and even the agricultural crop insurance system (these programs are PCIC, *Masagana* 99, *Masaganang Maisan*, GPEP, *Gintong Ani,* and lately, *Agrikulturang Makamasa*).

Undoubtedly, this debunked system has wrecked havoc on the ecological space of society and the planet as a whole. But for us in Don Bosco, the greatest devastation has been to the farmers. The Green Revolution made the farmers stop thinking and become dependent on external "experts." Many farmers who have experienced the bankruptcy of the Green Revolution for more than 20 years have so much difficulty processing the experience that they feel trapped in the system and that they cannot escape unless some "external force" leads the way. This sense of helplessness and dependence has gone through a historical process.

For us in Don Bosco, appropriate technologies can come only from the farmers who have taken back from the experts the process of thinking and deciding. Agricultural technology is site specific; there are universal truths but the applications must vary according to the bioregions' unique endowments. What we practice in Don Bosco is participatory technology development, a dynamic process of dialogue with the farmers. Extension work is not about teaching the farmers new technologies, or teaching them the answers. This will be merely substituting the "experts" of chemical-agriculture with the "experts" of alternative agriculture. For extension work to produce appropriate technologies, the most difficult task is teaching the farmers to ask questions and giving them back their faith in themselves. Only when the farmers participate in the process of technology development through active thinking can agriculture be truly sustainable. The sustainability of the program will be assured even if the NGO has long pulled out of the community.

5. CULTURAL SENSITIVITY AND GENDER BALANCE

Many of us who have been brought up and trained in the Western science and culture have little respect for indigenous peoples and their indigenous systems. Even if we have altruistic intentions in "teaching" farmers modern agricultural systems, we end up destroying not only their lands but also their spiritual center, or their culture. Germplasm, one of the pillars of Green Revolution in the form of the hybrid certified seeds, has encouraged and intensified the monocropping system. This type of seed resulted in displacement of existing indigenous systems of agriculture, food consumption and nutrition patterns. Indigenous communities have a specific kind of rice for specific occasions, rituals and community events, the meaning of which escapes Westerners. Before the advent of the Green Revolution, agricultural communities practiced *bayanihan/hunlos*, *lusong* or *alayon*, a kind of communal work among community members. After almost 30 years of the Green Revolution, this communal system is now very rare to find. This very positive Filipino value and tradition is gone and is replaced by a cash culture or "If you have cash, we will plant in your rice field."

The invasion of the spiritual/cultural center of farming communities will be greater with the coming of terminator and traitor technology in genetically-engineered seeds. When seeds are designed to be sterile with terminator genes, when keeping your own seeds becomes a crime under IPR laws, the rat race, the dog-eat-dog culture will have succeeded in ingraining in us the culture of competition.

The shame and indignity that the farmer feels every time he utters the word *lang* after introducing himself as *magsasaka lang* (just a farmer) is a stark reminder of the cultural and spiritual devastation that chemical-dependent agriculture has wrought on the agricultural community. There are two differing consciousness and cultures that produced differing agricultural technologies. The Green Revolution comes from the Western, literal consciousness while indigenous knowledge systems (IKS) are products of oral consciousness. Tribal communities who have an "oral mentality" (knowledge is not through the written word) are the cultural bearers of IKS which are the concrete forms of the indigenous peoples'communities' holistic knowledge and tacit science. The following example illustrates how knowledgeable are the "illiterates" (who have "oral consciousness") compared to the Western experts.

The International Rice Research Institute (IRRI) is hard pressed to create a cropping system where five economic species are growing at the same time. The *Hanunuos* of Mindoro, however, are acquainted with 430 crops and think nothing of multicropping as many as 40 species at the same time throughout the year. Their multistoried

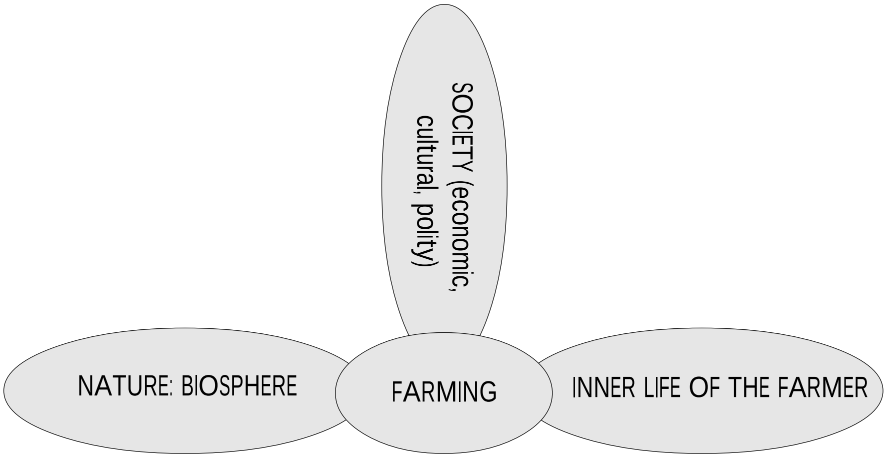

FIGURE 3

RELATIONSHIP OF FARMING WITH NATURE AND HUMAN BEINGS

cropping system is so finely attuned to ecological factors that some consider these complex farming systems as one of the modern wonders of the world. These indigenous multistoried cropping systems can achieve, at minimal costs, yields that are far ahead of intensive rice farming, yielding over 49 tons of edible mass compared to the 18-20 tons of irrigated rice yields assuming three crops a year at top yields (Perlas, 1992).

Cultural sensitivity is a factor to sustainability because it helps preserve the integrity and spiritual core of a people. An alien and invasive technology is likely to cause disintegration of the core values of a community. Introducing three crops of rice without a fallow period in a year for the simple reason of getting more money from the land has eroded core human values. The concept of fallow or rest has lost its meaning. The attraction of "more money" (at the expense of the "natural capital "and resource base degradation) hold sway with the prospect of being able to buy more consumer goods like convenience appliances, bigger houses, etc. Competition, domination, materialistic consumerism and other attending ills of cash culture have seeped through agrarian communities as pesticides and chemical fertilizers seeped through the earth and waters of our croplands. Any initiative that claims to be sustainable cannot ignore culture as a basic factor of sustainability. Moreover, sustainable development cannot exclude women who comprise half of the world's population. Our male-dominated culture or patriarchy in many forms cannot heal itself without the participation of women. The male-dominated culture will always be a culture of domination. True healing of a fragmented culture can only happen when women and men become partners, when women's role in development is recognized and enhanced.

6. SOCIAL JUSTICE AND EQUITY

Thus far, the expositions on the five different attributes or dimensions of agriculture to be sustainable are interrelated. All five are related too to the question of social justice and equity.

By shifting to ecologically sound farming system, we are working against the injustices of very few people, few global corporations raking profits at the "tragedy of the commons," at the expense of the farmers, the consumers, and the poisoning of the whole Planet Earth. It will ensure the food security capability of the life support systems of the Earth not only for today's population but generations to come. Participatory technology development empowers the "non-PhDs" in society; ensures getting people to participate in technology development, a more democratic way of doing things as opposed to the domination of the worldview, "ideology" or paradigm of a few. Cultural sensitivity means according basic respect for farmers' knowledge, dismantling the domination of one form of knowledge over billions of human inhabitants of the Earth. Holistic science makes justice for all of creation possible. The question of justice and equity is not to be limited among human beings. True democracy can take care of that. Social justice involves justice for ALL forms of life, as ALL are interrelated to ALL. Holistic science affords us not only democracy but biocracy or the consideration for all forms of life. Economic viability ensures the justness of food security for all.

The interconnectedness of the six dimensions/ attributes thus far have inherent implications to social justice and equity. However, social justice and equity issues are within the domain of political life. Laws, national policies, programs designed by the state must ensure social justice and equity in agricultural life. Thus, advocacy is among Don Bosco's activities. Through the advocacy efforts of the civil society /NGO community promoting Sustainable Agriculture in the Province of Cotabato, our Provincial Board and the Provincial Food Security Council declared the province as "GMO-free Province" by passing a resolution banning the entry of genetically engineered crops, genetically altered foods and genetically modified organisms in general.

7. DEVELOPMENT OF THE HUMAN POTENTIAL

Though the seventh, the development of human potential is the most fundamental dimension in Sustainable Agriculture. Farming is one of the relationships between the human being and Nature. It is an interface among three dimensions, namely: the human being, nature and society (Fig. 3).

Through human activities in the biosphere of the earth, changes for better or for worse occur in the atmosphere, hydrosphere and the lithosphere. Whatever endowments, whatever resources are present in the three spheres in a certain way shape the culture of the humans in a particular bioregion. However, the human being is resilient; she/he can occupy all habitats and adjust accordingly. Whatever changes we want to achieve in the biosphere of the earth has to begin not in watersphere, in the airsphere or landsphere but in the non-physical sphere – the "noosphere" or the mindsphere of the human being.

Thus, the Don Bosco program and perspective of Sustainable Agriculture begins in the human being and rests on the human being. All changes must begin from the inner life of the farmer. The development of active thinking, a holistic and nurturing relationship with Nature and the cosmos, are prerequisite to true sustainable agriculture. The worldview of the farmer – what he perceives as his/her relationship to nature, to the cosmos, to the evolution of the Earth community, and very basic questions of the meaning of life – will define his/her farming system. After all, the farm will only be a reflection of the wholeness or the brokenness/ alienation of the farmer. It is an illusion to think that if we produce a model farm (eg., diversified organic farming system), we produce a model farmer. It is an illusion to think that an economically viable and ecologically friendly farm will mean sustainable agriculture. After all, the surplus income can afford the farmer new consumption patterns and he can spend his income on liquor, or women or cheap thrills. We may have successful organic farmers who are chain smokers, who are wife beaters, despotic fathers, etc. The ironies can go on. In the end, sustainability cannot be achieved by piecemeal and fragmentary pieces of change. It has to be TOTAL and it has to begin in the inner life of the farmer. This can only begin in the active "I" experienced as "active thinking" of the farmer because the human potential lies in this level. This domain of reflective consciousness, just like freedom, is exclusive to the human being.

Let me end by giving the biodynamic definition of agriculture, which is vastly different from the university definition of agriculture. For practitioners of biodynamic farming, **Agriculture is the path to self-development in the context of an agricultural partnership with Nature.**

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Sustainable Agriculture as Preached and Practiced in Antique and Iloilo

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In 1991, Sustainable Agriculture (SA), as preached and practiced in Iloilo and Antique, was defined as a continuing process of participatory research and development of indigenous, location-specific, safe-to-health, environment-friendly, and low external input technologies, that will lead to low cost, maintained or increased yields, increased profits, and intergenerational equity. Pesticides are eased out of the farming system and replaced with alternate pest management practices. Synthetic fertilizers are gradually reduced over time until totally replaced with organic farming, utilizing readily available fertilizer substitutes in the farm and in the community. On the other hand, natural seed selection is promoted to ease out made-to-order seeds.

An immediate (after training) impact of SA on two trained farmers compared to non-SA farmers showed reduced costs, increased yields, and increased net income and return on investment both during the first and second rice croppings.

HISTORY OF SA PROGRAM

My presentation is based only on my personal experience. At work, I have difficulty finding someone with the same SA perspective.

My interest in SA first started in 1977 when I was in college. An agricultural professor doubted the agricultural technologies that he was teaching. He once said, "Our fore-farmers did not use pesticides but there were no pest epidemics." I agreed because that was also our experience. He also said that farmers were not accustomed to using chemical or synthetic fertilizers back then. Today, however, if we stop using synthetic fertilizers, the land would experience nitrogen hunger; this means the land is asking for more.

I worked with KABSAKA in 1981 to 1984. AWorld Bank-funded project, we planted dry-seeded rice earlier than most rice farmers. No pest problems were experienced during that time. In 1997, I then worked at IRRI and got to know the so-called modern rice production technologies. Then I transferred to Atihan in 1991 where a semblance of SA started, starting with our experimentation with the so-called IPM.

During those days we conducted three-day and season-long training on IPM. One time a participant suggested that we try something else. In a season-long training of IPM in 1991, Antique took up a newest approach in SA, that is, zero or non-use of pesticides and reduced use of chemical fertilizers (i.e. less than 6 bags which was based on the then recommended rate of 60-30-30). We started recycling our rice straw. Despite some saying that rice straw would take a long time to decompose or that its effect on rice would be insignificant, our experience in Antique proved otherwise. We got as high as 6-7 tons/ha by recycling our rice straw and applying fertilizer only when necessary.

In 1993, the Antique experience was used by a colleague to develop a national IPM program, now called KASAKALIKASAN. The program diverted from the Antique experience by recommending two things: one, to spray when necessary (but when could that necessary time be?) and, two, the recommended amout of fertilizer was 6-10 bags/ha inorganic, or 400 kg or so of compost. Many NGOs did not follow the recommendation and just did their own thing.

I transferred to Iloilo in 1996 and there encountered some problems in implementing SA. In 1997, despite the approval of an SA project proposal, we were only able to start implementing in 1999. Meanwhile, our SA rice production program under DAR-UNDP SARDIC was to be approved. The program on SA in the provincial agricultural office, however, started in 1990.

RATIONALE OF THE SA PROGRAM

Our farmers used to produce an average of 70-80 tons/ha using old rice varieties. With the introduction of new varieties under MASAGANA 99 in 1972, we were able to more than double that production. Over time, however, our yields plateaued at pre-MASAGANA 99 levels despite the use of new technologies.

In 1970 when I graduated, Iloilo was producing between 19-20 M cavans of rice annually. Now, we are only producing 14-16 M cavans annually. Land conversion cannot account for the decreased yield. The real culprit is the decreased organic matter content in the soil. Realizing the problem, the provincial agriculture office defined SA in 1991 as "a continuing process of participatory research and development of indigenous, location-specific, safe to health, environment friendly and low external input technologies that may lead to low cost, maintain or increase yields, increase profits and inter-generational equity."

SA is based on participatory research and technology development because its technologies are developed with farmers and by farmers and spread through them. Although it was first called participatory action research, we changed it to participatory research and technology development or PRTD with farmers. This is a bottom-up approach to technology development, the exact opposite of the top-down extension, supply-driven, technology.

INDIGENOUS MANAGEMENT

We have a whole array of indigenous knowledge in managing major pests in rice so there is really no need for pesticides. We have eight major pests in the irrigated rice ecosystem but do not have the black-rot rice pathogen found in Iloilo. We quarantine our province from rice coming from Palawan and Mindanao. In the uplands, especially in rainfed upland conditions, we have nine pests because of mole crickets or *maramara*. We have indigenous alternatives for managing rodents and weeds. Under KABSAKA, we used to manage weeds through early and thorough land preparation. Now, we not only apply alternative management but also use fertilizer substitutes.

Rice straw is one fertilizer substitute. A hectare of rice straw in compost form is worth about P 1,500.00 in fertilizer form. This is equivalent to about 22 kg of N, 5 kg of P, and 96 kg of K. A rule of thumb in conversion is 1:1. For example, if you produce 4 tons of grain, you produce 4 tons of compost from rice straw alone. We do not use trichoderma because there is no need for the compost at that time anyway. Instead we recommend to farmers to try and make money while the compost is decomposing. Farmers usually plant squash, *ampalaya* (bittergourd), bush sitao on the rice straw pile, making about P1,500 – 3,000.00/rice straw pile in six months. We also encourage farmers to do "natural seed selection" in rice, to avoid genetic regression. After 30 years *maridu* would still be *maridu*, *mansaraya* still *mansaraya*, and *kamurus* still *kamurus*. Varieties are maintained while off-types will become other varieties.

LOCATION SPECIFIC TECHNOLOGIES

We encourage our farmers to become doctors of their own farms. Our belief is that farmers should conduct their own experimentation without outside intervention and that our role is to guide them and suggest technologies instead of dictating what they should do. This can be done by asking them what their problems are, how they believe they can solve them, and we then offer them an option. We encourage them to test our option along with their own and if they find it works, then others may wish to adopt it. Universal recommendations do not work. Location specific technologies not only work but are safe to handle, environment-friendly, and within the farmer's experience.

Meanwhile pesticides are being eased out from the system. In 1991 we tried biopesticides as well, but ultimately Antique farmers rejected them. We no longer use biopesticides but rely on *tanglad*, *madre de cacao*, bamboo leaves, and *kalakay* leaves.

We have reduced the use of synthetic fertilizers. The usual question is until when or for how many croppings would one still use these? My *ninong sa kasal* (godfather in marriage) started using chicken manure in his rice farm way back in 1993. By 1995, his soil was back to its normal state. There was no more need to apply compost or natural fertilizers.

LOW EXTERNAL INPUT TECHNOLOGIES

We do not ask our farmers to buy outside their farms in order to minimize costs. We start with input reduction. Our fertilizer management has become integrated with pest management. Luscious green crops are attractive to pests just like *magagandang dalaga na pinag-aawayan ng mga magagaling o matitipunong lalaki, o matitipunong lalaki na pinag-aagawan ng mga babae*. This is why the so-called new varieties, which are certified to be pest resistant, are attacked by pests after two to three times of usage. This actually points at one's fertilizer management, and the variety's genetic resistance to pest.

With our low cost system, we experience a 25% cost reduction. For example, if one had been spending P 10,000.00/ha, then he will he spending only P7,500.00 using our practice. Table 1 provides some hard data.

MAINTAIN OR INCREASE YIELDS

There are questions on whether there are any yield reduction when using SA. This is not true. An Antique farm experienced a dramatic 100 percent increase in yields. Usually only getting 75 cavans/ha, the farm yielded 150 cavans/ha after using the technology. Others experience 10% increase in yield. Increased yields coupled with a cost reduction of 25% show that the benefits can really go a long way.

INCREASE PROFITS

Before our program, a profit level of 50% was common. With the program, profit levels reached a dramatic 250%. In the past, farmers used to say that instead of being *magsasaka* (farmer), they were mere *magsasako* (bag filler). This meant that when they went back to their homes, they only had the *sako* (sack) but no paddy rice. Things have changed in Antique. This is a step towards ensuring inter-generational equity - what the farmer now produces, his

TABLE 1

Comparative analyses of an SA vs. non-SA rainfed rice production performance and cost and returns

1st crop

PERFORMANCE INDICATOR	NON-SA	SA	DIFFERENCE (%)
Expenditures			
- Seeds	1,419	1,061	25
- Fertilizers	1,395	1,130	19
- Pesticides	2,052	838	59
- Hired Labor	1,271	957	25
- Family Labor	1,798	192	89
TOTAL Expenditure	8,060	4,180	48
Net Production (ton)	53	60	13
Gross Income (P)	16,908	18,000	12
Net Income (P)	8,106	13,820	70
Return on Investment (%)	**101**	**331**	**228**

2nd crop

PERFORMANCE INDICATOR	NON-SA	SA	DIFFERENCE (%)
Expenditures			
- Seeds	1,352	1,061	21
- Fertilizers	1,312	1,130	14
- Pesticides	2,018	838	58
- Hired Labor	1,273	957	25
- Family Labor	1,735	192	89
TOTAL Expenditure	7,810	4,180	46
Net Production (ton)	46	48	4
Gross Income (P)	13,885	14,450	5
Net Income (P)	6,178	10,370	68
Return on Investment (%)	**79**	**248**	**214**

children and the children of his grandchildren could also produce.

AFTER-TRAINING IMPACT

The two-day training impact on two farmer adoptors took place in one of the most pest-prone areas. The farmer was able to reduce costs by as much as 48 %, increase net production by 13 %, and an increase net income by 17 % during the first rice cropping. Results for the second rice cropping were similar, with total expenditures reduced by 46 % and net income increased by 68 %. Yields are quite low during the second cropping (about 4%). This farmer also still used some pesticides. This could be partly due to the short duration of the training, contrary to our IPM program in Antique which spans the whole cropping season. Under our program, one whole barangay adopts the technology for one cropping after the training.

THE TRAINING PROGRAM

Our training is geared towards involving the farmers. It entails establishment of background information, the conduct of a two- to three-day training, a field visit, the establishment of a demo farm with the farmers, continuous monitoring and evaluation, and lastly retraining. Retraining is recommended because of the need for critical mass; there could be hundreds of farmers in a barangay but only 30 farmers attend the training.

LESSONS FROM FAILURES AND CONCLUSION

There are generally four reasons why farmers experience setbacks in implementing SA. One is his calendar or schedule; second is when there are pest infestations; third is the presence of pest damage; and fourth is when neighboring farmers spray commercial pesticides. The experience of Mr. Jose Lorenzo of Pampanga, on the other hand, has shown that synchronized planting is unnecessary because he maintains a rice garden. The question of biopesticides, and genetic regression in rice were addressed earlier in this paper. With respect to soil analysis, we monitor the health of the rice plants and add chemical fertilizer only when necessary. We also got immediate results from using compost and we use alternate pest management to avoid using pesticides. First and foremost is the issue of farmer decision-making. A farmer should know alternative pest management otherwise he will spray. A farmer should be given all possible options in order to make sound decisions.