BIODIVERSE FARMING PRODUCES MORE

GRAIN | 20 octubre 1997 | Seedling - October 1997

October 1997

BIODIVERSE FARMING PRODUCES MORE

GRAIN

Biodiversity-based farming systems have always proven their worth to the communities that developed them. But proponents of these systems have had difficulty convincing the formal agricultural research network and industrial agriculturists that such farming practices are more effective than industrial agriculture especially for local food security. In recent years, however, a wealth of documented evidence has been accumulated making the case for biodiverse farming. Such studies demonstrate that it can compete with industrial agriculture in terms of productivity and that biodiverse farming offers the important additional advantages of sustainability and risk reduction. GRAIN examines the evidence that the formal sector can no longer ignore.

Even in the face of widespread criticism of the ecological havoc and health threats it poses, industrial agriculture is being thrust ever more forcefully upon a sceptical global public. Industry and government officials alike are using scaremongering tactics about the population explosion to manufacture acceptance of further intensified, chemical-dependent farming. This vision of agriculture depicts industrial production of a few farm products produced largely by the world's biggest agricultural exporters, such as the US and the EU. Many countries would depend on international markets for their food supplies, which would undermine local food security and cause social disintegration.

Meanwhile, advocates of sustainable, biodiverse farming systems argue that such systems are far more productive than is generally recognised and that they offer an alternative strategy for intensification with far greater long-term sustainability. They also argue that locally-based production and distribution systems are better suited to protect the natural biodiversity, health and well-being of their communities. This article examines the arguments for local traditional farming systems[1] in the South[2] offering a realistic alternative to the industrial model.

Industrial agriculture assesses productivity in terms of the comparative yields of a few specific farm products. However, when productivity is defined as the capacity to provide stable supplies of sufficient, quality foods and other products in harmony with social and cultural realities, a very different picture emerges of sustainable, productive agriculture. Using this definition, three elements are essential for optimising the sustainable productivity of a farming system:

* Agroecosystem biodiversity

* Integrated resource management

* Traditional local knowledge

Industrial agriculture shunned the integrated model that had served farmers well since agriculture began. Instead it opted for a simplified, mechanistic approach which has wreaked havoc on the environment and peoples' lives. At the centre of such Northern-led strategies to *modernise* agriculture lies a mechanical conception of nature which has dominated scientific thinking since the mid-17th century, with its emphasis on linear thinking and scientific objectivity. According to this *reductionist* paradigm, phenomena are understood by breaking them down into their component parts, and are perceived as little more than the sum of those parts.

Reductionist thinking lies at the root of the Green Revolution style of industrial agriculture. It has fostered hierarchical and arrogant thinking among contemporary formal research structures: scientists know better than farmers, lab-produced high yielding varieties (HYV's)[3] are better that local ones, and *modern* single commodity farming beats integrated approaches. Green Revolution mastermind Norman Borlaug stated as recently as 1992 that *"Development specialists... must stop `romanticising' the virtues of traditional agriculture in the Third World".*

Industrial agricultural productivity is measured in terms of net yields of selected crops and certain plant parts. Diverse and highly productive ecosystems are substituted with single commodity crops, such as wheat in India or Eucalyptus trees all over the South. Plants and animal are engineered so that the net volume of selected commodities — such as grains in wheat or milk in cows — increases. *Magic bullet* solutions to problems usually merely displace the problem, which then manifests in a different form.

During the second half of this century growing numbers of scientists began to question the scientific method. Modern physicists now see the material web not as a simple mechanical system, but rather as a complex web of relationships. The system is seen as much more than the sum of its parts. In agriculture, this means seeing production as the sum of agroecosystem components and the complementary relationships between them, which must include humans and their social reality. When the subject of agroecosystem productivity is approached from a systems perspective, productivity requires a broader definition, embracing the following elements:

* The total production of livelihood resources for the farming family, including crops, animals and wild foods, fuel, medicinal elements, clothing, construction materials and total biomass.

* Food security, which means sufficient and nutritional supplies year round and in the future, including supplementation through exchanges, salaries or market access.

* Agroecosystem resiliency as the result of natural resource conservation and sustainable use, and the efficient internal management of nutrients, water, soil and genetic resources.

* Social, economic and cultural community integrity as an integral component of agroecosystem management and stability.

Biodiversity increases productivity

Instead of reducing biodiversity, traditionally-managed systems sustain it in order to ensure year-round access to all sorts of products essential for local livelihoods. Net commodity yields occupy second place to assuring food security and long-term productivity. People of the Henwal Valley in India have access to as many as 142 types of food-yielding species, and a single village cultivates up to 126 varieties of rice. Malawian women farmers, when asked why they grow a wide variety of beans, gave a whole array of reasons that includes many aspects of daily needs and expectations: food security through diversity, insuring against crop failure from biotic and abiotic stress, dietary variety, and different household needs such as market acceptability, faster cooking, earlier maturity, and leaf quality. **Table 1** show that there are many biodiversity-based strategies to increase agroecosystem productivity, both in terms of product availability and increased food security.

Forest gardens, such as the long-standing and productive shaded coffee farms in Latin America, play a key role in farmer-based conservation and utilisation strategies. *Dambo* management in Zimbabwe's drylands involves complex intercropping and relay cropping systems. This strategy increases food security by ensuring that one plot will thrive even if another fails and opens up opportunities for cash cropping.

Coffee: Biodiversity's Pick-me-up

Traditional coffee farms are highly structured forests managed by people. Four different layers are usually involved. At the highest level, a canopy of shade trees provides organic material for recycling, micro-climate temperature control, and water flow enhancement. This layer usually includes leguminous species for nitrogen fixation. A second layer of fruit trees may be included — banana, citrus, avocado — for secondary cash income. The coffee plants themselves occupy the third layer, and the available floor space may be used to intercrop root vegetables, such as tanier, taro or yam. Built-in erosion control protects waterways and supply aquatic species important as protein sources. Besides the seasonal coffee cash income, this elaborate system provides year-round supplies of food, fuel, construction materials, medicinal plants, cash and other elements to the farming family.

These types of coffee forests may last decades and require low levels of maintenance, need very little or no chemical fertiliser use, show high resiliency to water supply fluctuations, and suffer hardly any major pest or disease problems. They may harbour up to forty different tree species, have more insect fauna than surrounding forests areas, and serve important functions as wildlife and migratory bird refuges.

Nonetheless, between 1970 and 1990 half of the area in coffee production in Northern Latin America has been converted to industrialised, chemical, mostly monocropped, shadeless production. Why? To increase net coffee bean production. In these "modern" coffee farms 25% of costs are for chemicals, and non-harvest labour accounts for the greatest single production outlay. Differences in net coffee bean production may be as much as 4 to 1, but at the same time in one study production costs for a kilo of shadeless coffee was found to be US$1.24, compared to US$0.85 for a kilo traditionally-produced.

In Latin America, the US Agency for International development (USAID) has played a major role in that transition, spending $181 million since 1978 on getting small producers to use high-yielding varieties, increasing chemical applications and eliminating shade.

The industrialisation of coffee production has come under severe criticism in recent years, mostly because of massive soil erosion, waterway disturbance, chemical poisoning, biodiversity destruction, short coffee plant productive cycles, and decreased family security. Governments must come to grips with the high level of associated environmental and social costs which local economies are internalising in subsidising industrialised coffee production. As the USA National Research Council admits, *"Shaded coffee plants produce less annually, but shade adds many years to the useful life of the plants"*. Many small and medium coffee growers are moving back to diversified shaded coffee farming in order to reduce external inputs, risks, and natural resource erosion. In the process, some growers are reaping much higher returns from specialised organic markets.

SOURCE: Shade Coffee: A Disappearing Refuge for Biodiversity, BioScience 46(8), 1996.

The folly of the Green Revolution's bias in favour of monocropped HYV's has been well documented. The resulting genetic erosion has been responsible for the disappearance of many locally-adapted varieties, and the destruction of age-old productive and resilient farming systems. For example highly nutritious and locally-adapted staple foods, such as millet in Africa and amaranth in the Americas, have been neglected.

Green Revolution propaganda led to the almost mythical belief that higher farm yields could only be obtained through laboratory-bred varieties. Yet even before the first "*super rices*" came out of the labs of the Philippines-based International Rice Research Institute (IRRI), an internationally renowned Indian scientist had been documenting locally-selected and improved varieties. Those yield results continue to match and even beat the highly acclaimed HYV's. More recent research carried out in Brazil by the Alternative Technologies Project (PTA), a local NGO network, with support from the national agricultural research agency, EMBRAPA, on recuperating local maize varieties, showed that local cultivars could match or surpass HYV's, at lower production costs.

Despite the massive — and often forced — introduction of HYV's in the South, farmers have often resisted them. Where government and market pressures have overcome this resistance, many farmers have at least kept using their traditional varieties for family and community consumption. In Zimbabwe, despite the extensive introduction of hybrids, farmers still cultivate open-pollinated varieties which are better adapted to local conditions. Studies from the Centro Internacional de la Papa (CIP) and the Centro Internacional para Mejoramiento de Maiz y Trigo (CIMMYT) have documented that even the poorest and most isolated farmers will not adopt technical recommendations if they are not in accordance with the specific natural and socio-economic conditions under which they produce.

The Western scientific community has finally recognised this reality and *discovered* the multiple functions of, and synergetic relationships between, agroecosystem components. Many non-commercially targeted organisms serve as pollinators, seed dispersers, decomposers, pest predators and disease control agents. Within that ecosystem diversity, genetic diversity among and within crop varieties and breeds has been recognised as having a buffer effect, stabilising or enhancing productivity over time. What local farming communities have demonstrated now merits *official* recognition: that integrated systems have significant stability and resiliency as a result of structural diversity.

A neglected aspect of Green Revolution claims on net food increases has been the nutritional quality of the produce delivered. In South Asia net caloric intake has increased, but intakes of iron and other key nutrients have fallen. This has been directly linked to the fact that Green Revolution rice, wheat and maize crops and varieties are usually low in essential mineral and vitamin trace elements. Local communities no longer have access to the displaced fruits, vegetables, legumes and local cereal varieties which traditionally supplied essential micro-nutrients to their diets. Iron, zinc and vitamin A deficiencies in developing countries have been linked to poor health, slow mental and motor skills in children and reduced economic activity. Meanwhile, studies show that crops from a more diversified agriculture grown on organically manured soils have 20-30% more micro-nutrients than those from chemically-based agriculture.

Agroecosystem stability — with the associated risk reduction and food and community security — is practically impossible in the monocropped fields and low diversity ecosystems promoted by high-external-input research establishments and by corporate extension services. As Dr. Fetein Abay of Ethiopia's Mekelle University College, has stated, *"Food security should not be promoted solely with the objective to increase productivity: it has to be coupled with sustainable management and conservation of biodiversity".*

Table 1. Local biodiversity based systems and higher productivity

WHERE	WHAT	SOURCE
Africa	Preliminary study has shown that leaf yields of indigenous green leafy vegetable plants can be as high as, or compare well with, exotic types. The same study has shown that indigenous vegetables are as nutritious, or more so, than exotic ones.	J. Chweya, in proceedings of CTA/IPGRI seminar, 1992, Nairobi
Africa, Asia and Latin America	A review of projects (1.93 million households farming 4.1 hectares) in 20 countries of the South following transition to low-external-input biodiversity-based agriculture in rainfed areas led to wheat, maize and sorghum-millet yields doubling those of high-external-income agriculture.	J. Pretty, Regenerating Agriculture, EARTHSCAN, London, 1995
Bangladesh	Experiments on small family rice farms with intensive and diversified use of rice paddy dikes for vegetable and tree growing led to increases in available crop residues and and manure for fertility management and increased family income.	K. Camp et al, ILEIA Newsletter12(2), 1996
India	The *baranaja* (twelve seeds) cropping method traditionally practiced in the Central Himalaya produces more food than soya monocultures promoted by agricultural agencies.	V. Shiva, ILEIA Newsletter12(3),1996
India	A three quarter *bigha* (0.3 acre) home garden with more than 40 species at any given time supplies 50% of annual farm income, even though the family has 5.5 *bigha* of bananas and 4.5 *bigha* of cash-cropping groundnut and wheat.	JN Sutariya, Honey Bee (India) 7(4), 1996
Mexico	The high degree of biological diversity and the cultural practices of *chinampa,* the Aztec-developed, high-raised platform farming system, partially account for its high productivity.	P. Torres Lima et al , Agriculture & Human Values, 11(1), 1994
Peru	In Cajamarca, after three years of a model research agroecological farm incorporating traditional technology, it was demonstrated that the farming system and associated bio-diversity lead to productivity increases.	M. Altieri, ILEIA Newsletter, 12(1), 1996
SE Asia	Intercropping leads to higher productivity because it profits from environmental differentials by matching them to corresponding differentials in crop characteristics (eg weed control). Among cereals, the greater the difference between crops in days to maturity, the greater is the gain that results from mixing them: yield advantages can be as great as 20-80%.	GG Marten, Traditional Agriculture in Southeast Asia, Westview Press, London, 1986

Integrated resource management

Agricultural industrialisation has been characterised by a piecemeal approach to agricultural production, mostly focused on isolated agronomic characteristics . If pest or disease problems arise, the solutions involve introducing the most powerful chemical agents available or breeding in some genes for vertical resistance. The same strategy permeates weed control, fertilisation, soil management and so on.

The *magic bullet* approach to isolated problems tends to reduce overall agroecosystem performance, while externalising economic, environmental and health costs. T.T. Chang, a former IRRI Principal Geneticist, has stated that *"The enormous crop losses in maize, wheat and rice since the early 1970s due to serious disease and insect damage resulting from varietal uniformity has been amply documented".* Pesticide use in the Philippines has been directly linked to reduced rice productivity when the associated health costs are counted as production costs. Even though farming will always be, by definition, human interference with nature, modern industrialised agriculture destroys ecosystem balance, sometimes irrevocably. Local farming communities are much more effective at managing nutrients, water, soil and pest and disease control.

In most community approaches to agriculture the goal is for stability leading to sustained production, and resource conservation through use. By optimising biodiversity through the nurturing of crops, perennials, soil life, livestock, and wild fauna, complex and synergetic relationships provide enhanced total resiliency. Many of the methods used, such as intercropping, cover crops, organic residue management and tillage practices serve multiple functions for soil and nutrient enhancement. When green manure cover crops are integrated into the farming system, increased field biodiversity becomes an integral aspect of soil, pest, weed, nutrient and water management.

Some locally-adapted systems have been proven over hundreds and thousands of years. Labour spent on most of the technology involved serves multiple purposes. In Bolivia, recently reintroduced water catchment ponds have lead to crop diversification, improved nutrition and a healthier economic situation for the community. In Southeast Asia, age-old rice terraces continue to provide a variety of food and other livelihood products for farming families. Rehabilitated *waru-waru* Incan farming fields in Peru increase soil quality and fertility, reduce pest problems, manage water flows, produce 40% increases in potato yields, and provide greater economic returns to farmers.

Local farming communities also use multiple biotic components to increase stability and productivity. In West Java the traditional *Kebun-talun* increases overall production and serves multiple functions by sequentially growing agricultural crops and tree crops. The efficiency of resource utilisation under integrated farming practices means that Sahelian traditional livestock production outperforms ranching in the United States and Australia under the same climatic conditions. **Table 2** contains other examples of how an integrated approach to resource handling favours increased productivity.

Growing evidence shows that in the process of increasing yields industrial agriculture aggravates population problems. Displacement of rural communities results from reduced employment, increasing the numbers of rural and newly urbanised poor. Recent studies show that sustainable intensification can be achieved under increased population pressures. Increases in population are balanced by greater labour availability, which in turn promotes better resource utilisation at the local level. Centuries ago the Mayan culture in Yucatan, Mexico, reached population densities much higher than those that the same area supports today, partly through the development of biodiverse intensive home gardens and forest management, which included sophisticated genetic selection and breeding[4]. A five-fold population increase since the 1930's in Kenya's Machakos District has been associated both with increased productivity, more tree cover, and improved conservation of land and water resources. In Kano, Nigeria, increased population has led to productive and sustainable intensification.

Integrated farming increases production

There has been much debate on whether agriculture will be able to support a growing population in semi-arid West Africa without damaging the environment and transitioning to high-external-input agriculture. Of special concern is the competition for scarce resources between farmers and herders. However, the intensively cultivated area of the Kano closed-settled zone in northern Nigeria has supported intensive cultivation for many years without suffering land degradation.

The local farming system is based on the production of crops, livestock and tree products. But as increased land has come under cultivation the fallow periods have decreased, soil fertility has declined and grazing lands have contracted. In Kano, the transition from isolated pastoral or arable crop enterprises to crop-livestock integration has come about as increased population has provided more labour. Soil fertility decline has been overcome by increased labour input used to reduce nutrient losses by nutrient recycling. Leguminous crop residues are collected for animal fodder and manure is transported to the fields as fertiliser. In this way, production has intensified and increased despite increased population pressure.

Source: Frances Harris (1996), IIED Gatekeepers Series No. 59, London.

This integrated multi-dimensional approach to agriculture is gaining currency amongst agricultural "experts" in the formal sector. Integrated pest, weed, water, and nutrient management strategies have been incorporated by institutions such as the World Bank and CGIAR.

Knowledge systems and biodiversity

The almost total disregard for traditional farming system knowledge has been one of the glaring mistakes of modern agricultural research. Local knowledge has been looked down on and largely ignored. Women farmers — who in many places are in the majority — are usually the most knowledgeable about local crops and agroecosystem micro-adaptation, and often control the links between agricultural production and household economy. Yet women farmers are often ignored by male-dominated agricultural science and development programmes, and their knowledge is often not perceived as scientific knowledge, but as *primitive* or *intuitive*.

Only recently has reductionist applied research come to recognise that traditional farming practices are highly sophisticated and appropriate. Formal sector scientists, faced with overwhelming evidence, are finally coming out and saying that traditional ways of making a living, the result of many generations of intelligent resource handling by local communities, provide necessary insight into managing complex agroecosystems.

What western science has not yet grasped — and may not be able to, due to inherent conceptual limitations — is that many traditional local communities have developed cosmovisions whereby nature and humans are viewed as part of one whole. For Northern Amazon indigenous rainforest people there is no such thing as living in harmony with nature: nature is seen as an extension of humanness, and any damage done to it will result in damage to a person's own life. This is expressed by many Andean local communities of Incan descent through the concept of *crianza recíproca* ("crianza" meaning "rearing" or "breeding"). Humans care for all aspects of the environment, which in turn takes care of them. *Culture* and *nature* are indivisible and nurture each other.

Traditional local agricultural development rests on agroecosystem micro-adaptation. Crop, trees, wild species and animal husbandry follow complex patterns according to soil, water, climate, topography, and socio-cultural condi
tions. This has direct implications for technology development, which will usually be patterned according to local realities. Many attempts at extension have failed because farming families do not tend to *adopt* isolated technologies or techniques. Farmers always have shown great curiosity for technological innovation and new seeds — be they traditional, improved or HYV's — but *integration* is done carefully so as not to disrupt system resiliency. Farmers feel comfortable when they are in control of innovation, and have a sense of ownership over it. Rejection of new technology may have nothing to do with its intrinsic characteristics, but rather with socio-economic caution in the face of external pressures — such as governmental policies, corporate extension and market integration — which are perceived as disruptive.

Table 2. Increased productivity through integrated resource management

WHERE	WHAT	SOURCE
Bangladesh	Increased diversification in rice farms, eg utilising dikes as raised beds or for tree growing, leads to better fuel accessibility, increased productivity and income.	K. Kamp et al., ILEIA Newsletter12(2) 1996
Burkina Faso	Mulching used to protect soil, increase fertility and provide humidity. In a study carried out among 49 households in Samatenga province, mulched fields increased crop production by 36%.	M. Slingerland, IKDM, 4(2), 1996
China	Terraces and dam-fields are traditional-low-external input sustainable technology for erosion control and water harvesting. Terrace fields yielded 30-50% more than slopes; dam-fields 3-5 times more than slopes.	Xia Quan et al., IKDM 4(2), 1996
Honduras	Velvet-bean maize intercropping system on steep slopes produced maize at approximately 30% less cost than nearby 'modern' high external input farms using tractors, hybrids and agrochemicals.	F. Shaxson and others, ODI/NRP 19, 1997
India	Pigs are used to control Cyperus (nut sedge) a perennial weed which is difficult to control, even with herbicides. The use of pigs to dig and eat the reproducing tubers in fallow rice fields has been successful, leading to increases in weight and milk	ILEIA Newsletter 12(2), 1996

	production. 25-30 animals can remove the tubers from one acre in one day.	
Sub-Saharan Africa	Increased residues and soil cover resulting from higher yields can generate an upward spiral of improvement in soil productivity.	F. Shaxson et al., ODI/NRP 19, 1997

Learning to listen

The evidence gained from this review of a small part of the available literature, both from the formal and informal sectors, clearly demonstrates that biodiversity-based agroecosystem management is the most appropriate practice for maximising overall agricultural productivity and assuring food security. The proven success of integrated, biodiversity-based approaches is now a significant force to counter the continued push by some formal sector specialists and transnational corporations for new *magic bullets* for agricultural development. More scientists and agricultural technicians must now join farmers in building participatory bridges that have their age-proven knowledge and technology as the starting point.

There are many examples that show that households which grow the greater crop variety and have integrated farming systems are more food secure than those which have increased the area under external input and modern varieties. As Sakia van Oosterhout, from the Agricultural Research Centre in Zimbabwe puts it, *"Crop diversity significantly and positively affects household food security"*. Food security must continue to be based on decentralised production and distribution, not on international unstable and unregulated markets.

Four areas that must receive high priority in future policy development are:

* Biodiversity conservation and sustainable use are inherent in traditional community farming systems, and must form the basis of agricultural and food security policy.

* Agricultural research must evolve through farmer first participatory strategies whereby scientists and technicians become learning partners.

* Means must be made available to enable local farming communities and their organisations to conserve, document, and enhance their resources and knowledge.

* Effective legal mechanisms must be developed at the international and local level which protect local farming systems and associated knowledge, by giving communities control and rights over their resources.

The evidence for the technical, biological, economic, social and cultural viability of feeding people sustainably through biodiversity-based farming systems sits squarely on the table. All that is lacking is the political will to follow through.

Footnotes:

1. The words local and traditional create some confusion, and are used here jointly or separately to refer to those farming systems that are mainly based on locally developed technology and knowledge. The use of the word `traditional' does not necessarily refer to very old systems, but is used to differentiate between community-based farming systems and the top-down agricultural technology fostered by contemporary mainstream research institutions.

2. Most of the arguments discussed in this article are also applicable to agriculture in Europe and North America, but their particular contexts are beyond the scope of this article.

3. The commonly used term High-Yielding Varieties (HYV's) is a misleading definition because they are only high yielding when packaged with expensive and environmentally-damaging chemical inputs, such as fertilisers and pesticides. An alternative being used by some is High Input Varieties (HIV's).

4. Even though Mayan farming systems were very successful, there is an ongoing debate as to the eventual decline of their civilisation, which some archaeologists blame on centralised policies which lead to extensive deforestation in the later period.

A fully-sourced and longer version of this article is available upon request. It is based on on-going research by GRAIN staffer Nelson Alvarez, who welcomes comments and/or other examples demonstrating how farm biodiversity enhances productivity.