Agroecology versus Ecoagriculture: balancing food production and biodiversity conservation in the midst of social inequity

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At first glance, everybody would agree that the concept of **Ecoagriculture** (ECOAG) is a good one. Who could oppose the idea of transforming agricultural systems so that they support healthy populations of wild species while simultaneously improving productivity and reducing poverty? There is an urgent need to conserve biodiversity and if this can be achieved through agricultural intensification, which many argue is needed to meet growing food demands in the developing world, there is no question that this is a win-win situation. Ecoagriculture advocates argue that their approach is particularly important in the biodiversity hotspots of the developing world where most of the poor concentrate and have little choice but to exploit wild habitats for survival.

Ecoagriculture promoters affirm that the best way to reduce the impact of agricultural modernization on ecosystem integrity is to intensify production in order to increase yields per hectare, and in this way spare natural forests from further agricultural expansion. They argue that feeding a growing world population without further endangering the natural environment and its biodiversity requires the need to evaluate the role that emerging technologies may play in helping meet food needs at a reasonable environmental and social cost. Although they embrace alternative, low input agricultural systems, ECOAG practitioners do not discount chemically-based, high-yielding, intensive agricultural systems, as part of their strategy for protecting wildlife while feeding the world's population. By doing so, ECOAG supporters adhere to two pervasive assumptions: (a) that alternatives to a chemically-based crop production system necessarily requires more land to produce the same amount of output and (b) that the adverse ecological and health consequences of industrial farming are minor in comparison to those that would be wrought by expansion of land extensive production systems. It is well known that widespread adoption of chemically-based, land intensive crop production systems have major environmental effects which are negative to biodiversity, but less known is the fact that such production model actually hinders attempts to provide adequate food for a growing world population.

In his global analysis of the impacts of agricultural intensification on biodiversity, Donald (2004) found that massive increases in production of five major commodities (soybean, rice, cacao, coffee and oil palm) were achieved by increases in both the area planted and in the yield achieved per unit area. Both strategies led to environmental degradation and negative impacts on biodiversity via massive loss of natural habitats but more importantly through pollution linked to heavy use of agrochemicals. Due to increased vulnerability, more than of 500 million kg of active ingredient of pesticides are applied annually on the world's genetically homogeneous agroecosystems (91% of the 1,5 billion hectares of arable lands are under monocultures of grain) to suppress insect pests, diseases and weeds. The environmental (impacts on wildlife, pollinators, natural enemies, fisheries, etc) and social costs (human poisonings and illnesses) of pesticide use reach about $8 billion each year in the USA alone. Such costs are much higher in the developing world where banned pesticides imported from the North are still being used at large.

Transgenic crops and large scale plantations: can they advance the goals of ecoagriculture?

Large scale plantations and transgenic crops are among the tools of the Ecoagriculture arsenal to reach the twin goals of meeting future global food needs and conserving biodiversity. In their Ecoagriculture book, McNeely and Scherr (2003) provide many examples of interventions that according to them can simultaneously reach the objectives of conservation and food production. Among the examples, they cite a large (3,300 has) corporate Costa Rican orange plantation that belongs to Del Oro Company, in which large patches of dry tropical forest are left within or adjacent to the farm, benefiting biodiversity while bringing substantial economic gains to Del Oro. It is difficult to visualize how a conservation strategy for large mammals and birds that require extended territories for effective reproduction can be compatible with an agricultural development agenda focused on small farmers that barely have small plots of land to grow their crops? Given that in most parts of the developing world the issue for poor farmers is access to productive land, it may be argued that it is precisely those very large biodiversity friendly farms such as Del Oro that need to undergo a process of land reform to reduce social inequities; an important pre-requisite to launch any meaningful conservation project. In fact breaking up large plantations into a patchwork of thousands of small farms which make up highly heterogeneous landscapes are a key to enhance a rich biodiversity. In Mexico, half of the humid tropics is utilized by indigenous communities and “ejidos” featuring integrated agriculture-forestry systems aimed at subsistence and local-regional markets. Recent research confirms that such systems like cacao and coffee based agroforestry managed with low inputs by smallholders harbor significant biodiversity, including a substantial number of plant, insect, bird , bat and various mammal species. Biodiversity is highest in the more rustic tree diverse and multistrata systems interspersed in a matrix of tropical forests (Perfecto et al 1996).

Arguments in favor of consolidating land holdings to take advantage of greater productivity and efficiency, as well as biodiversity conservation potential have no scientific basis. The actual data shows the opposite -- small farms produce far more per acre or hectare than large farms. The relationship between farm size and total production for fifteen countries in the developing world, shows in all cases that relatively smaller farm sizes are much more productive per unit area -- 200 to 1,000 percent more productive -- than are larger ones. In the United States the smallest farms, those of 27 acres or less, have more than ten times greater dollar output per acre than larger farms. While in the U.S. this is largely because smaller farms tend to specialize in high value crops like vegetables and flowers, it also reflects relatively more attention devoted to the farm, and more diverse farming systems (Rosset 2002). Recent evidence from agroecological surveys of small scale coffee producers in Chiapas, Mexico, reveals an important relationship between farm size, technology used and production. Conventional coffee producers had larger landholdings averaging 7 hectares, devoting most of their land to coffee production. Since their systems used shade trees, they conserve some biodiversity but their dependence on external markets for cash, food and inputs was very high, making such farmers very vulnerable to the vagaries of an economic system out of their control. Conversely small organic producers’ average farm size was 4 hectares exhibiting the highest average coffee yields, and they devoted about 30-50% of their land to maize and beans for food security, pasture for animals and forest reserve. Given the heterogeneous patchy nature of such farming systems, their contribution to biodiversity was significant but such services were achieved without sacrificing farmers autonomy and food security (Martinez-Torres 2003).

Reflecting the views of the Future Harvest Foundation , other donors and the CGIAR , Ecoagriculture advocates argue that biotechnology is biodiversity friendly because engineering crops for high yields will avoid advancing the agricultural frontier. This view is a legacy of the Green Revolution, which assumed that progress and the development of traditional agriculture as inevitably requiring the replacement of local crop varieties with improved ones, which led to disruption of biodiverse traditional agricultural patterns and the erosion of landraces and wild relatives along with indigenous knowledge. They also presume that the economic and technological integration of traditional farming systems into the global system is a positive step that enables increased production, income and community well being.

As a new form of industrial agriculture, the rapid spread of transgenic crops threatens crop diversity by promoting large monocultures on a rapidly expanding scale leading to further environmental simplification and genetic homogeneity. Worldwide, the areas planted to transgenic crops jumped more than thirty-fold in the past seven years, from 3 million hectares in 1996 to nearly 58.7 million hectares in 2002 (James 2002) an unprecedented move towards increased agricultural uniformity (Jordan, 2001). Such simplification and the associated environmental impacts of transgenic crops can lead to reductions in agroecosystem biodiversity. Direct benefits of biodiversity to agriculture lie in the range of environmental services provided by the different biodiversity components such as nutrient cycling, pest regulation and productivity. Disruptions in biodiversity levels prompted by transgenic crops is bound to affect such services and thus affect agroecosystem function. For example it is known that polyphagous natural enemies of insect pests that move between crop cultures frequently encounter Bt containing non-target herbivorous prey in more that one crop during the entire season. According to Groot and Dicke (2002) natural enemies may come in contact more often with Bt toxins via non-target herbivores, because the toxins do not bind to receptors on the midgut membrane in the non-target herbivores. These findings are problematic for small farmers in developing countries who rely for insect pest control, on the rich complex of predators and parasites associated with their mixed cropping systems (Altieri 1995). Research results showing that natural enemies can be affected directly through inter-trophic level effects of the toxin present in Bt crops raises serious concerns about the potential disruption of natural pest control, as polyphagous predators that move within and between crop cultivars will encounter Bt-containing, non-target prey throughout the crop season. Disrupted biocontrol mechanisms will likely result in increased crop losses due to pests or to increased use of pesticides by farmers with consequent health and environmental hazards.

Recent studies conducted in UK, showed that in herbicide resistant crops there was a reduction of weed biomass, flowering and seeding of plants within and in margins of beet and spring oilseed rape, which involved changes on resource availability with knock-on effects on higher trophic levels reducing abundance of relatively sedentary herbivores including Heteroptera, butterflies and bees. Counts of birds and predaceous carabid beetles that feed on weed seeds where also smaller in transgenic fields (Hawes et al 2003).

Another key problem with introductions of transgenic crops into diversity regions is that the spread of characteristics of genetically altered grain to local varieties favored by small farmers could dilute the natural sustainability of these races. Thus, traits important to indigenous farmers (resistance to drought, food or fodder quality, competitive ability, performance on intercrops, storage quality, taste or cooking properties, compatibility with household labor conditions, etc) could be traded for transgenic qualities (i.e. herbicide resistance) which surely are not important to farmers (Altieri 2003). Under this scenario risk will increase and farmers will lose their ability to adapt to changing biophysical environments and be able to produce relatively stable yields with a minimum of external inputs while supporting their communities' food security. The social and environmental impacts of local crop shortfalls, resulting from such uniformity or changes in the genetic integrity of local varieties due to genetic pollution, can be considerable in the margins of the developing world. In the extreme periphery, crop losses often mean ongoing ecological degradation, poverty, hunger and even famine. It is under these conditions of marginality that traditional skills and resources associated with biological and cultural diversity should be available to rural populations to maintain or recover their production processes.

The agroecology and ecoagriculture divide

As proposed by many ECOAG advocates, "greening" the green revolution will not be enough because if the root causes of poverty and inequity are not confronted head-on, tensions between socially equitable development and ecologically sound conservation are bound to accentuate. Organic farming systems that do not challenge the monocultural nature of plantations and rely on foreign and expensive certification seals, IPM systems that only reduce insecticide use while leaving the rest of the agrochemical package untouched, or fair-trade coffee systems destined only for agroexport, may in some cases benefit biodiversity, but in general offer very little to small farmers. Fine-tuning of input use does little to move farmers towards the productive redesign of agroecosystems, keeping them dependent on an input substitution approach. Niche markets for the rich in the North, in addition to exhibiting the same problems of any agroexport scheme, create stratification within rural communities as only a few members can capture the benefits from markets that have limited demand of gourmet products for the northern elite.

Deep differences on the above issues define the divide between Agroecology (a truly pro-poor farmers science) and Ecoagriculture. For agroecologists, environmentalists should no longer ignore issues relating to land distribution , indigenous peoples and farmers rights, nor the impacts of globalization on food security, and of biotechnology on traditional agriculture. It is crucial to transcend the Malthusian view that blames the poor for environmental degradation. In fact their impact on nature is low compared to the damaging effects of the economic activities of large landowners, mining and timber companies. Social processes such as poverty and inequity in the distribution of land and other resources push the poor to become agents of environmental transformation, and as long as such processes are not dealt with prospects for an ecoagriculture approach are limited. It is also important for Ecoagriculturalists to understand and respect the fact that values of indigenous people may be different from the global conservation community, although species and habitats valued by local people have global significance. Much of the concern for the global community is the alarming loss of biodiversity and associated environmental services; while for local communities such issues may also be important, their real concerns, needs and perceptions usually remain hidden to outsiders who despite their good intentions can at time embrace a sort of eco-imperialist perception of conservation.

The agroecological approach to conservation

Aware of this reality, a key challenge for agroecologists is to translate general ecological principles and natural resource management concepts into practical advise directly relevant to the needs and circumstances of smallholders. The strategy must be applicable under the highly heterogeneous and diverse conditions in which smallholders live, it must be environmentally sustainable and based on the use of local resources and indigenous knowledge . The emphasis should be on improving whole farming systems at the field or watershed level rather than the yield of specific commodities.

The enhancement of biodiversity is key and at the heart of the agroecology strategy is the idea that agroecosystems should mimic the biodiversity levels and functioning of local ecosystems. Such agricultural mimics, like their natural models, can be productive, pest resistant and conservative of nutrients. This ecosystem-analog approach uses biodiversity to enhance agroecosystem function, allowing farms to sponsor their own soil fertility, plant health and sustained yields, therefore eliminating totally the need for external agrochemical inputs or transgenic technologies. As a result of the biodiverse designs and absence of toxics, non-functional biodiversity (wildlife species of interest to EACOAG) thrive in such systems.

In such biodiverse farms free of agrochemicals and transgenic crops, the opportunities for wildlife species to thrive are much greater than in "green" monocultures managed with input substitution. Thus in agroecological systems conservation is a product of the assemblage of productive agroecosystems rich in functional biodiversity (the collection of organisms that play key ecological roles) , and not as in ECOAG the result of deliberate attempts to improve wildlife habitat within agricultural areas. Wildlife rich, but functionally biodiverse poor systems do not necessarily meet the needs of small farmers for food diversity, productive self sufficiency, low inputs, etc.

Benefits of agroecologically designed integrated farming systems extend beyond conserving biodiversity as they produce far more per unit area than do monocultures. Though the yield per unit area of one crop -- corn, for example -- may be lower on a small farm than on a large monoculture farm, the total production per unit area, often composed of more than a dozen crops, trees and various animal products, can be far higher. In most multiple cropping systems developed by smallholders, productivity in terms of harvestable products per unit area is higher than under sole cropping with the same level of management . Yield advantages can range from 20 to 60% and accrue due to reduction of pest incidence and more efficient use of nutrients, water and solar radiation. And all this happens while conserving native crop genetic resources and overall biodiversity. It is not a matter of romanticizing traditional agriculture or to consider development per se as detrimental, but if the interest lies in "improving" local agriculture, researchers must first understand and build on that agriculture that is to be changed, rather than simply replace it. It is important to highlight the role of traditional agriculture as a source of agrobiodiversity and regenerative farming techniques which constitute the very foundation of any sustainable rural development strategy directed at resource-poor farmers. Moreover diverse agricultural systems that confer high levels of tolerance to changing socio-economic and environmental conditions are extremely valuable to poor farmers, as diverse systems buffer against natural or human-induced variations in production conditions.

A case study: harmonizing biodiversity conservation and cacao production

The main goal of this project was congruent with ECOAG goals: to improve the sustainable production of cacao while conserving biodiversity in small organic cacao farms managed by indigenous peoples in Talamanca, Costa Rica. The project's main strategy was to find ways of simultaneously enhancing cacao production in a sustainable manner while conserving biodiversity. The focus on cacao is justified by the fact that in addition to being culturally and economically important to local indigenous groups of the area, it is well known that highly diverse and multistrata cacao agroforestry systems (CAFS) support higher levels of biological diversity than most tropical crops (Rice and Greenberg 2000). A key problem is that the permanence of these systems is threatened by low yields and low prices of cacao. By improving the productivity of cacao, the project pretended to increase farmers' income and in this way avoid that farmers shift to other less biodiversity conserving crops such as banana (Somarriba et al 2003).

After training a number of local farmers to monitor CAFS, researchers confirmed that CAFS harbor significant biodiversity, including 55 families, 132 genera and 185 species of plants, as well as a substantial number of insect, bird (190), bat (36) and various mammal species, some of which seem to be declining. Biodiversity is highest in the more rustic tree diverse and multistrata systems (about 55-60% shade cover) and lowest in CAFS with simple strata (maximum two shade tree species with 35-40 % shade).

CATIE researchers proposed a number of interventions aimed at improving cacao production (pruning, introduction of clones, enrichment with fruit trees, shade management, etc) while at the same time preserving biodiversity. After three years of project interventions there was no evidence that newly designed CAFS conserved or enhanced biodiversity. Apparently, biodiversity declines as plant diversity and structural complexity of cacaotales decreases, although lower diversity in cacaotales may be more desirable from an agronomic point of view. Productivity in rustic systems is lower than in the less diverse CAFS, suggesting a negative relationship between conservation and production and presenting a major challenge to researchers and managers because as cacaotales are renewed or intervened to enhance production (especially through pruning, elimination of shade trees and genetic homogenization with clones), biodiversity levels apparently may be sacrificed. When replacing existing trees with new timber or fruit species or reducing shade through pruning or thinning, it is important to consider that such practices can reduce habitat complexity for wildlife. Likewise enrichment with forest or fruit trees must be done considering the potential competition pressures that these plants may exert on existing cacao trees, and the possibility that some trees may be sources of insect pests or diseases (i.e. viruses).

By only focusing on production enhancement and wildlife diversity, researchers failed to consider in their surveys a key relationship in peasant agriculture: the relationship between farm size, diversity levels and productivity. Smaller cacaotales (<1 ha) where more biodiverse and also seemed more productive than larger ones, indicating that given labor and cash constraints there may be an optimal size for efficient production (in terms of labor allocation and returns per unit of labor).

In situations like this, what agroecologists would recommend to harmonize conservation and production in cacaotales over 1 ha in size, is to intensify management to enhance production (pruning, grafting, etc) in a small optimal area of each cacaotal (0.5-07 has), leaving the rest of the area of the cacaotal under low input management, with high levels of plant diversity and multistrata designs for conservation of existing biodiversity. In a well-managed 0.5 ha cacaotal, farmers may be able to obtain higher productivity per unit of labor than in a badly managed 1- 1, 5 has. In this way a mixed strategy featuring intensification of production and conservation enhancement may be reached.

As farmers become aware of biodiversity components it would be useful that they also are able to distinguish among the various types and functional groups of biodiversity and the roles they play in the CAFS:

1. ecologically functional groups that mediate important processes such as biological control, pollination or organic matter decomposition;
2. conservation functional groups that protect soil and water;
3. livelihood functional groups that produce timber, fruit, cash, etc and

4. destructive biota that reduces production and other processes.
5. Non fucntional biodiversity (wildlife species, etc)

In this way farmers may be able to target specific biodiversity groups according to the functions they want to emphasize to maintain healthy and productive CAFS. The question that remains what mechanisms are in place to compensate farmers for the environmental services of interest to ECOAG advocates (non functional biodiversity)? Many farmers maybe trained to monitor biodiversity, and although they would appreciate this new knowledge and skills which helps to raise conservation consciousness in the communities, most farmers would doubt whether non functional biodiversity conservation would bring them direct economic benefits

Finally, an approach directed at increasing cacao production while conserving biodiversity must transcend the cacaotal and embrace the total farming system. Most farms in the hillside areas have an average size of 42 hectares where cacao occupies about 1,6 ha, the rest devoted to forest, fallow, pasture and annual crops. In such areas, farm designs should be directed at maintaining or enriching the surrounding environment conducive to biodiversity conservation (forest patches, etc), enhance food security (re- introduction of practice of growing beans, rice, corn, cassava, etc), and promoting other productive activities to generate income (honey, fish, wood for crafts, medicinal plants, etc), including ecotourism but under local control. Farm designs should promote integration among sub systems so that outputs from one subsystem become inputs into the other, creating efficient bio-resource flows, as well as synergisms that may aid in sponsoring the soil fertility, plant protection and productivity of cacao and the other crops of the total farm.

Spreading the agroecological approach

In order for agroecological approaches that lead to food security and biodivesrity conservation to spread, major changes must be made in policies, institutions, and research - development to make sure that agroecological interventions truly benefit small farmers by providing them with access to land and other resources, equitable markets, alternative technologies, but more importantly empowering them to become actors of their own development . It is clear that macro economic reform and sectoral policies promoted by trade liberalization have not generated a supportive environment for small and poor farmers. In most cases agricultural growth was concentrated in the commercial sector and did not trickle down. Trade liberalization reduced protection at a time when commodity prices were at historic lows, leaving small farmers incapable of competing in domestic markets. The drop in price of many crops and the lack of credit as well as long distance from markets are all factors that have led to increased pauperization of the small farm sector. Moreover, government programs and subsidies have concentrated on medium and large commercial farmers and small farmers have remained limited in their access to services, infrastructure and markets. Such negative trends must be halted so that they do not continue drastically affecting the viability of peasant and family agriculture

Despite such anti-peasant biased scenarios, the evidence shows that sustainable agricultural systems can be both economically, environmentally and socially viable, and contribute positively to local livelihoods as well as biodiversity conservation goals (Uphoff 2002). But without appropriate policy support, they are likely to remain localized in extent. Therefore, a major challenge for the future entails promoting institutional and policy changes to realize the potential of agroecological approaches. Necessary changes include land reform, protection of prices for food crops, appropriate and equitable market opportunities, and equitable partnerships between local governments, NGOs and farmers replacing top-down transfer of technology models with participatory technology development and farmer to farmer research and extension.

There is no question that small farmers located in biodiversity hotspots throughout the developing world can produce much of their needed food in ways that are compatible with conservation goals. The evidence is conclusive: new approaches and technologies spearheaded by farmers, NGOs and some local governments around the world are already making a sufficient contribution to food security at the household, national, and regional levels. A variety of agroecological and participatory approaches in many countries show production increases through diversification, improving diets and income, contributing to national food security and even to exports and also to conservation of the natural resource base including biodiversity (Uphoff and Altieri 1999). last fifty years has been devoted to increasing the productivity of sustainable and/or organic production systems and current funding is being threatened by Alternatives to both chemical- from scientific endeavors dedicated to their discovery and development. Only a fraction of the billions of research dollars spent over the intensive, high-yield agriculture and to land extensive sustainable agriculture exist can be expected to result proposed federal budget cuts

For some analysts, there is plenty of room for linkages and synergies to solve the dilemma of conserving while producing. To them , exclusive attention to meeting food needs can exert a very high toll on the environment undermining possibilities to meet food needs in the future. A sole focus on preserving the natural resource base can condemn millions to hunger and poverty. Feeding a growing world population without further endangering the natural environment depends upon public support of high-yield, sustainable agriculture research, education and extension. Alternatives to both chemical-intensive, high-yield agriculture and to land extensive sustainable agriculture can be expected to result from scientific endeavors dedicated to their discovery and development. Only a fraction of the billions of research dollars spent over the last fifty years has been devoted to increasing the productivity of sustainable and/or organic production systems and current funding is being threatened by proposed federal budget cut (Hewitt and Smith 1995).

The demands to dramatically increase food production in the next century may also require a re-evaluation by proponents on both sides of the debate. Farmers, consumers, researchers and others in support of sustainable agriculture will need to evaluate the role that emerging technologies (precision farming and biotechnology) may play in helping meet food needs at a reasonable environmental and social cost. Likewise, proponents of high-yield agriculture will need to recognize that scientifically valid alternatives to chemically-based agriculture exist and can and should play a vital role in developing the production systems of the twenty-first century.

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Ecoagriculture Partners: Progress towards linking conservation, production and rural livelihoods. Mobilizing PES at Landscape. S.Â Vision: Farmers around the world produce enough food while protecting the biological diversity of plant and animal life. Mission: To mobilize scaling up of successful ecoagriculture approaches, by catalyzing strategic connections, dialogue and joint action among key actors, at local, national and international levels. Three legs of the stool.Â Managing production systems for ecoagriculture landscapes. â€¢ Increase input efficiency, minimize pollution â€¢ Improve spatial organization of land use â€¢ Manage wild species to benefit farming â€¢ Economies of scale through collective action â€¢ Design agricultural systems to mimic natural. ones. Agroecology is the science of sustainable agriculture; the methods of agroecology have as their goal achieving sustainability of agricultural systems balanced in all spheres. This includes the socio-economic and the ecological or environmental.Â May 14, 2019 â€" In nature conservation and agriculture, there are two opposing views of how to combine high biodiversity and sustainable food production: nature conservation should either be integrated into read more. Palm Oil: Less Fertilizer and No Herbicide but Same Yield? Nov. 5, 2019 â€" Environmentally friendlier palm oil production could be achieved with less fertilizer and no herbicide, while maintaining profits.Â View all the latest top news in the social sciences & education, or browse the topics below: Science & Society.