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Agroecology and application in agriculture

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ABSTRACT: Agroecology combines scientific inquiry with indigenous and community-based experimentation, emphasizing technology and innovations that are knowledge-intensive, low cost and readily adaptable by small and medium-scale producers. These methods are considered likely to advance social equity, sustainability and agricultural productivity over the long term. Collaborative structures that emphasize co-learning, social networks of innovation, and building capacity in flexible place-based decision-making have proven more effective than conventional top-down transfers of technology in the developing world. Partnerships that focus on inclusion and meaningful participation, particularly by historically marginalized groups, contribute to the design and implementation of solutions that are robust precisely because they are appropriate. Research has shown that peasant sys-tems, which mostly rely on local resources and complex cropping patterns, are reasonably productive despite their land endowments and low use of external inputs. Moreover analysis of ngo-led agro ecological initia-tives show that traditional crop and animal systems can be adapted to increase productivity by biological lyre-structuring peasant farms which in turn leads to optimization of key agro ecosystem processes (nutrient cycling, organic matter accumulation, biological pest regulation, etc.) andefficient use of labor and local resources. Examples of such grassroots projects are herein described to show that agro ecological approaches can offer opportunities to substantially increase food production while preserving the natural resource baseband empowering rural communities.

Keywords**:** agroecology, sustainable agriculture

INTRODUCTION

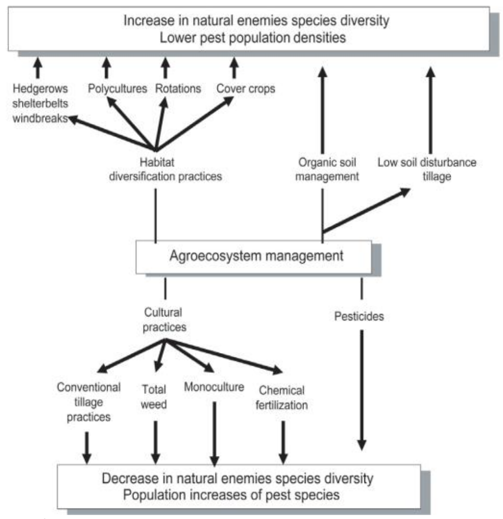
Although most traditional agricultural systems and practices encompass mechanisms tostabilize production in risk-prone environments without external subsidies, most agroecol-ogists recognize that traditional systems and indigenous knowledge will not yield panaceasfor agricultural problems (Altieri, 1995; Gliessman, 1998). Nevertheless, traditional waysof farming refined over many generations by intelligent land users, provide insights intosustainably managing soils, water, crops, animals and pests (Thrupp, 1998). Perhaps themost rewarding aspect of agroecological research has been that by understanding the fea-tures of traditional agriculture, such as the ability to bear risk, biological folk taxonomies,the production efficiency of symbiotic crop mixtures, etc., important information on howto develop agricultural technologies best suited to the needs and circumstances of spe-cific peasant groups has been obtained. This information has been a critical input for theapplication of agroecology in rural development programs.

An agroecological approach recognizes the multifunctional dimensions of agriculture and facilitates progress toward a broad range of equitable and sustainable development goals:

• Increased ecological resilience and reduced risk in weathering changing environmental conditions;

• Improved health and nutrition (more diverse, nutritious and fresh diets; reduced incidence of pesticide poisoning among workers, communities and consumers);

• Conservation of natural resources (biodiversity, soil organic matter, water quality and quantity, ecosystem services, e.g. pollination, erosion control);
• Economic stability (more diverse sources of income; spread of labor requirements and production benefits over time; reduced vulnerability to single commodity price swings, etc);
• Climate change mitigation through increased energy-efficiency, reduced reliance on fossil fuel and fossil fuel-based agricultural inputs, increased carbon sequestration and water capture in soil; and
• Increased social resilience and institutional capacity (increased ecological literacy and social support networks).



Ecologically-based management of agro ecosystems supports resource conservation and sustainable pest management

An agro ecological approach is particularly well suited for rural communities and developing economies. It recognizes the value of high quality scientific research and of advanced technological exploration and innovation. It also emphasizes the societal and knowledge gains from dialogue between researchers, farmers and indigenous communities. Indigenous knowledge systems and traditional farming practices often yield site-specific insights that would otherwise be outside the purview of formal science. Pro-poor sustainable development in the 21st century requires a redirection of institutional and policy support towards ecologically-sound decision-making by farmers; stronger and enforceable regulatory frameworks to reverse the damaging effects of resource-extractive agriculture; and significant new investments by public sector, donor, and commercial agencies in agroecological research, extension, education, product innovation, and marketing.

Asalientfeatureoftraditionalfarmingsystemsistheirdegreeofplantdiversityintheformof polycultures and/or agro forestry patterns (Chang, 1977; Clawson, 1985; Thrupp, 1998).This peasant strategy of minimizing risk by planting several species and varieties of crops, stabilizes yields over the long term, promotes diet diversity, and maximizes returns underlow levels of technology and limited resources (Harwood, 1979). Much of the production of staple crops in the Latin American tropics occurs in polycultures. More than 40% of the cassava, 60% of the maize, and 80% of the beans in that region are grown in mixtures with each other or other crops (Francis, 1986; Table III). 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 canrange from 20% to 60%. These differences can be explained by a combination of factorswhichincludethereductionoflossesduetoweeds, insectsanddiseasesandamoreefficientuse of the available resources of water, light and nutrients (Beets, 1982).

Support small-scale farmers and their organizations

• Strengthen women's, farmers', indigenous and community- based organizations; invest in rural areas.
• Ensure farmers have secure access to productive resources, information, credit, certification and marketing infrastructure.
• Provide technical assistance in agroecological production and agro-processing, and in adjusting to and mitigating climate change and other system stresses.

Suitability to measure competitive ability by an index of competition in various crop

Detecting more competitive crops (e.g., due to variety, fertilisation, crop density, etc.) represents an important tool to implement integrated weed control.

However, the use of competitive indexes (e.g., the competitive balance index *Cb*) is time and work consuming (as the growing of weed pure stands and their sampling is also required) and, at least in some cases, likely statistically inefficient, as ratios of ratios concurr to the means that have to be compared, with problems of high error MS and difficulties to evidence statistically significant differences. Ranking competitive ability seems to be definitely more simple by ranking crop biomass or grain yield decrease (if the harvest index is not affected) in the weed presence. However, this does seem reliable only in some cases, particularly when crops compared for their competitive ability do not complement with weeds or complement to the same extent [i.e., when the RBT (relative biomass total) of the various crop/weed mixtures is 1 or, even if higher, does not significanlty change for the various mixtures]. When crops to be compared complement with weeds to a different extent, ranking competitive ability by an index of competition is correct, while ranking competitive ability by crop biomass decrease is not, and similar biomass decreases can even result in very different competitive ability. Examples concerning different crop/weed associations are given of these different conditions of reliability in measuring competitive ability in the two above mentioned alternative ways.

Sustainable weed management systems aim to increase farm biodiversity by conserving residual weed populations in arable fields while maintaining yield. These systems need to address three questions: 1) Which species should be conserved; 2) How many individuals can be tolerated and 3) What is the appropriate agronomy to achieve these objectives. This presentation mainly addresses the first of these questions. Weed species need to be categorized on the basis of their potential benefit to higher trophic groups and their impact on crop yield. A 'good' weed can be defined as a species which combines tangible benefits for farm wildlife with low competitive ability. It is likely that weed species which meet this criteria will share similar plant strategies for growth and reproduction in the crop canopy. The aim of the current project is to categorise weeds in functional groups on the basis of the ecophysiological traits which determine these strategies.

Crops grown simultaneously enhance the abundance of predators and parasites, which intern prevent the build-up of pests, thus minimizing the need to use expensive and dangerouschemicalinsecticides.Forexample,inthetropicallowlands,cornbeansquashpolyculturessufferlessattackbycaterpillars,leafhoppers,thrips,etc.,thancorresondingmonocultures,because such systems harbor greater numbers of parasitic wasps. The plant diversity also provides alternative habitat and food sources such as pollen, nectar, and alternative hosts to predators and parasites. In Tabasco, Mexico, it was found that eggs and larvae of thelepidopteranpestDiaphaniahyalinatexhibiteda69%parasitizationrateinthepolyculturesas opposed to only 29% rate in monocultures. Similarly, in the Cauca valley of Colombia, larvae of Spodoptera frugiperda suffered greater parasitization and predation in the corn–bean mixtures by a series of Hymenopteran wasps and predacious beetles than in corn monocultures (Altieri, 1994).

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