INTEGRATING BIODIVERSITY IN MODERN AGRICULTURAL PRACTICE

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ABSTRACT: Cultural landscapes-areas that have been modified to varying degrees by human activity, now dominate most of the earth`s land surface, and surprisinglyy high levels of biodiversity are often found in areas devoted to crop production and livestock raising, particularly in »traditional« farming areas. Some of that biodiversity is directly useful to improving agricultural productivity, such as traditional varieties of crops with disease resistance genes and wild or weedy populations of crops that are tapped by breeders for other useful traits. In order to improve agricultural productivity and raise rural incomes, biodiversity must therefore be better managed in transformed habitats. This paper not only outlines measures that can be adopted to reduce off-site impacts of agriculture on biodiversity but also pinpoints policy options to help conserve and better utilize agrobiodiversity-plant and animals, including beneficial insects and other organisms, that are essential for agriculture. In this study will be highlight how best practices are being applied in many different situations and how such practices can alter the agrobiodiversity picture at farm and lanscape level.

Keywords: agrobiodiversity, agricultural productivity, modern practice, traditional varieties.

INTRODUCTION

Biodiversity is the sum total of the variability and biological processes of all organisms. Its level of organization includes genes, populations, species, habitats and ecosystems and the processes that support them. In contrast, biological resources are individual elements of biodivesity, like genes or species. Agrobiodiversity is any component of biodiversity that has potential impact on environmental sustainability of agricultural systems. Components of agrobiodiversity include plant and animal species, varieties, breeds, wild ancestors of crops, forage and trees. Soil fllora and fauna are also integral parts of agrobiodiversity (Oljača et al 2002).

Agricultural intensification, a world-wide imperative, can be accomplished only if biodiversity is better protected and managed. Conversely, biodiversity will be safeguarded only if it contributes in a tangible way to human welfare and if essential needs are being met from areas already in production (Oljača 2001). The purpose of this paper is to highlight technological issues to improve agricultural projects designed to boost

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crop yield while incorporating greater biodiversity and reducing pressure on wildlife habitats.

LOSS OF GENETIC DIVERSITY

In the last several decades, the overall genetic diversity of domesticated plants has declined. Many varieties have become extinct and a great many others are heading in that direction. In the meantime, the genetic base of most major crops has become increasingly uniform. Only six varieties of maize, for example, account for more than 70% of the world`s maize crop (Gliessman 2000). The loss of genetic diversity has occured mainly because of conventional agriculture`s emphasis on short-term productivity gains. When highly productive varieties are developed, they tend to be adopted in favor of other varieties, even when the varieties they displace have many desirable and potentialy desirable traits. Genetic homogenity among crops is also consistent with the maximization of productive efficiency because it allows standardization of management practice.

The problem is that the increasing genetic uniformity of domesticated crops leaves the crop as a whole more vulnerable to attack by pests and pathogens that acquire resistance to pesticides and to the plant`s own defensive compounds. It also makes crops more vulnerable to changes in climate and other environmental factors. This problem is made worse by the accompanying shrinkage in the size of each crop`s genetic reservoir: there are fewer and fewer varieties from which to draw resistant or adaptive genes. The importance of having a large genetic reservoir is great because of genes carried resistance to some pests or diseases. As varieties are lost, the valuable genetic reservoir of traits is reduced in size, and certain traits potentially invaluable for future breeding are lost forever.

HARNESSING AND MANAGING BIODIVERSITY

Biodiversity needs to be better harnessed and protected to foster the worlwide process of agricultural intensification and to avoid potentially serious setbacks in productivity gains. Future gains in the productivity of existing crops and livestock, as well as the domestication of new crops and animals, will be difficult and ephemeral if biodiversity losses continue. The management of biodiversity for agricultural intensification implies a more rationale use of this resource and improved conservation efforts. Because it is difficult to predict what parts of the broader biodiversity pool might provide a yield breakthrough in the future or a new biocontrol agent for reducing pest damage, a wise course is to safeguard as much biodiversity as possible in natural and cultural habitats. With the adoption od appropriate farming practices, crop and range land can be used in such a way that they minimize damage to wildlife, water supplies and nearby habitats. Agricultural intensification could help alleviate destructive pressure on habitats by meeting agricultural production needs on existing farmland.

Table 1. Agricultural practices that reduce natural resource degradation, boosting yield and enhancing biodiversity

Tabela 1. Agrotehničke mere koje smanjuju degradaciju prirodnih resursa, povećavaju prinos i biodiverzitet

Practice - Agrotehnička mera	Control-Kontrola			Conserve water quality Očuvanje kvaliteta voda	Maintain soil fertility Održanje plodnosti zemljišta
	Weeds Korovi	Pests Štetočine	Disease Bolesti		
Reley cropping - Preklapanje useva	+	+	+		+a
Crop rotation - Plodored	+	+	+		+a
Mixed cropping – Združeni usevi	+	+	+	+b	+b
Varietal mixes – Mešavine varijeteta		+	+		
Maintenance of traditional and modern breeds Održanje tradicionalnih i modernih sorata		+	+		
Buffer zones of natural habitats Buferne zone prirodnih staništa		+c	+	+	+d
Release of biocontrol agents Oslobađanje agenasa za biokontrolu		+			
Fallow management - Uvođenje ugara	+	+	+	+	+
Conservation tillage – Konzervacijska obrada	+		-e	+	+
Crop-livestock integration Integrisanje ratarske i stočarske proizvodnje				-f	+
»Precision« irrigation »Precizno« navodnjavanje				+	
»Precision« fertilization – »Precizno« đubrenje					+
Terracing – Pravljenje terasa				+	+
Contour strips of grass or perennial crops Obodne trake trava ili višegodišnjih useva				+	+

a. – If one of the crops is a legume or provides sufficient mulch to maintain levels of organic soil matter.
b. – Especially if trees are involved that create a moist microclimate and help protect the soil against erosive forces
c. – Natural or relatively undisturbed habitats as integral parts of a farm can provide environments to support predators of crop pests. On the other hand, they may harbor crop pests and pathogens. Safeguarding of natural habitats is likely to be positive from the pest control perspective, among other benefits.
d. – By reducing soil erosion by wind and water.
e. – In some cases conservation tillage can increase disease preassure since crop debris left on the soil can harbor crop pathogens.
f. – Can fertilize ponds for aquaculture, particularly with ducks or pigs, but cattle can pollute streams with their dung, and farmers may clear vegetation along water courses to increas pasture

This paper outlines measures that can be taken to alleviate some of the collateral damage associated with agricultural development and pinpoints ways that biodiversity can be enhanced on landscapes managed for crop and livestock production. Given the variety of ecological environments and the cultures involved, only sound practices at the generic level are highlighted in table 1. There is little new about the sound practices, farmers have employed many of them for centuries or even millennia. But as agriculture was mechanized along more modern lines, many of these ancient practices were dropped or marginalized. The time is ripe to reintroduce them as part of the intensification process rather than discard them as symbol of obsolete, even backward agriculture.

A menu of recomended practices should not to be forced on farmers in order to bring their agricultural systems round to a single model of agricultural intensification. Rather, they should represent opportunities to intensify their crop and livestock systems while minimizing adverse impact on biodiversity. In other words, recommended practices will always have to be tailored to the specific climatic, soil, vegetation and socioeconomic conditions of areas targeted for intervention. Each of the sound practices outlined above is essentially a tree with many branches, offering a diverse array of distinct variations on the theme. For example, conservation tillage has a drop-down menu of numerous practices, from no-tillage, where seeds are inserted directly into unplowed ground, to plowing (Kovačević et al 1997). There is also a mounting interest in returning to more diversified agricultural production systems to obtain improved crop protection and benefit from the increased productivity offered by many intercropping systems (Oljača et al 2000b). Management of intercrops to maximize their complementarity and to minimize competition between them follows simple natural principles and its practice is limited only by imagination of agronomists. This may be due to some of the established and speculated advantages for intercropping systems such as higher grain yields, greater land use efficiency per unit land area and improvement of soil fertility through the addition of nitrogen by fixation and excretion from the component legume (Oljača 1998; Oljača et al 2000a; Momirović et al 1998).

INTEGRATED PEST MANAGEMENT

Integrated pest management and the promotion of a balanced mix of modern and traditional crop varieties and livestock breeds are examples of practices that can be promoted at the farm level. IPM provides an especially useful catalyst to promote the concept of increasing biodiversity in agriculture at the farm level. IPM has already served as vanguard for much of the thinking on sustainable agriculture (Altieri 1995; Thrupp 1998). Farmers are generally amenable to IPM approaches because they can reduce their pest control costs and increase yields. IPM strategies include a basket of practices from crop rotation to the release of biocontrol agents and the judicious use of pesticides.

BALANCE OF MODERN AND TRADITIONAL VARIETIES

Many modern production systems promote the use of a single variety over large areas, often requiring heavy doses of pesticides. Farmers then find themselves on the pesticide treadmill as pests develop resistance. Modern varieties are understandably promoted in agricultural development project because they are generally higher yielding. While it is true that modern varieties have helped to increase food production and have improved the livelihoods of millions of farmers, they are not always the only choice. The widespread policy in both industrial and developing countries of promoting the use of modern varieties has incurred hidden costs in some cases, including the genetic narrowing of our crop production base if the obsolete varieties are not saved in genebanks. Certified varieties are generally those that have been tested by government agricultural research programs and have been deemed sufficiently robust to deliver on their promise. Traditional varieties are rarely included in such trials, even though they may perform better than improved varieties, particularly under the suboptimal application of inputs. As a matter of policy, it makes sense to analyze the relative advantage of modern and traditional varieties when promoting a crop. It would probably make sense to identify a basket of improved and older varieties for farmers to choose from, rather than pushing only an approved variety or a single traditional cultivator.

SAUND PRACTICES AT THE LANDSCAPE LEVEL

Certain practices can be adjusted at the farm level, but broader-scale processes are under ways that warrant attention. The aggregate actions of individual farmers translate into patterns of land use at the scale of the plain, valley or entire watershed. The landscape ecology of farming areas is an exciting new dimension to conservation work because at this level steps can be taken to ensure that wildlife has sufficient space and resources to survive. For example, wildlife corridors, an important way to promote gene flow and sustain larger predators at the top of food chains, can only be effective if habitat fragmentation is avoided. Particular attention will be paid to ensuring a balanced mix of land use systems, minimizing the off-site impact of farming and initiating rapid agrobiodiversity surveys at the project design stage. Particular attention should be paid to natural and near-natural habitats that contain significant plant resources that extracted for local use. Specific measures to accomplish this goal include: the removal of fiscal incentives for certain cash crops that tend to promote the homogenization of landscape;

setting aside natural habitats, with varying degrees of human intervention ranging from near total protection to multiple use; recognizing the importance of wild collected foods where appropriate for local inhabitants and safeguarding such habitats from destruction; identifying habitats that contain wild populations of crops or their near relatives, and encouraging locals to manage such environments without destroying them; establishing buffer zones or shelter belts to reduce soil erosion and providing habitats for wildlife, including biocontrol agents, especially in degraded landscapes; recognizing how farmers use different habitats in a landscape at different times of the year so that essential seasonal grazing lands, for example, are not cut off or eliminated by development activities (World Bank 2003).

CONCLUSIONS

Cultural landscapes-areas that have been modified to varying degrees by human activity, now dominate most of the earth`s land surface, and surprisingly high levels of biodiversity are often found in areas devoted to crop production and livestock raising, particularly in »traditional« farming areas. Some of that biodiversity is directly useful to improving agricultural productivity, such as traditional varieties of crops with disease resistance genes and wild or weedy populations of crops that are tapped by breeders for other useful traits. In order to improve agricultural productivity and raise rural incomes, biodiversity must therefore be better managed in transformed habitats.

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