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ABSTRACTS *for the*

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SCIENTIFIC KNOWLEDGE SESSION

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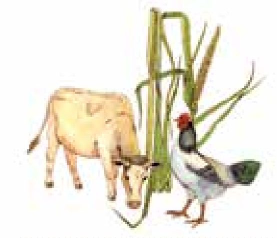

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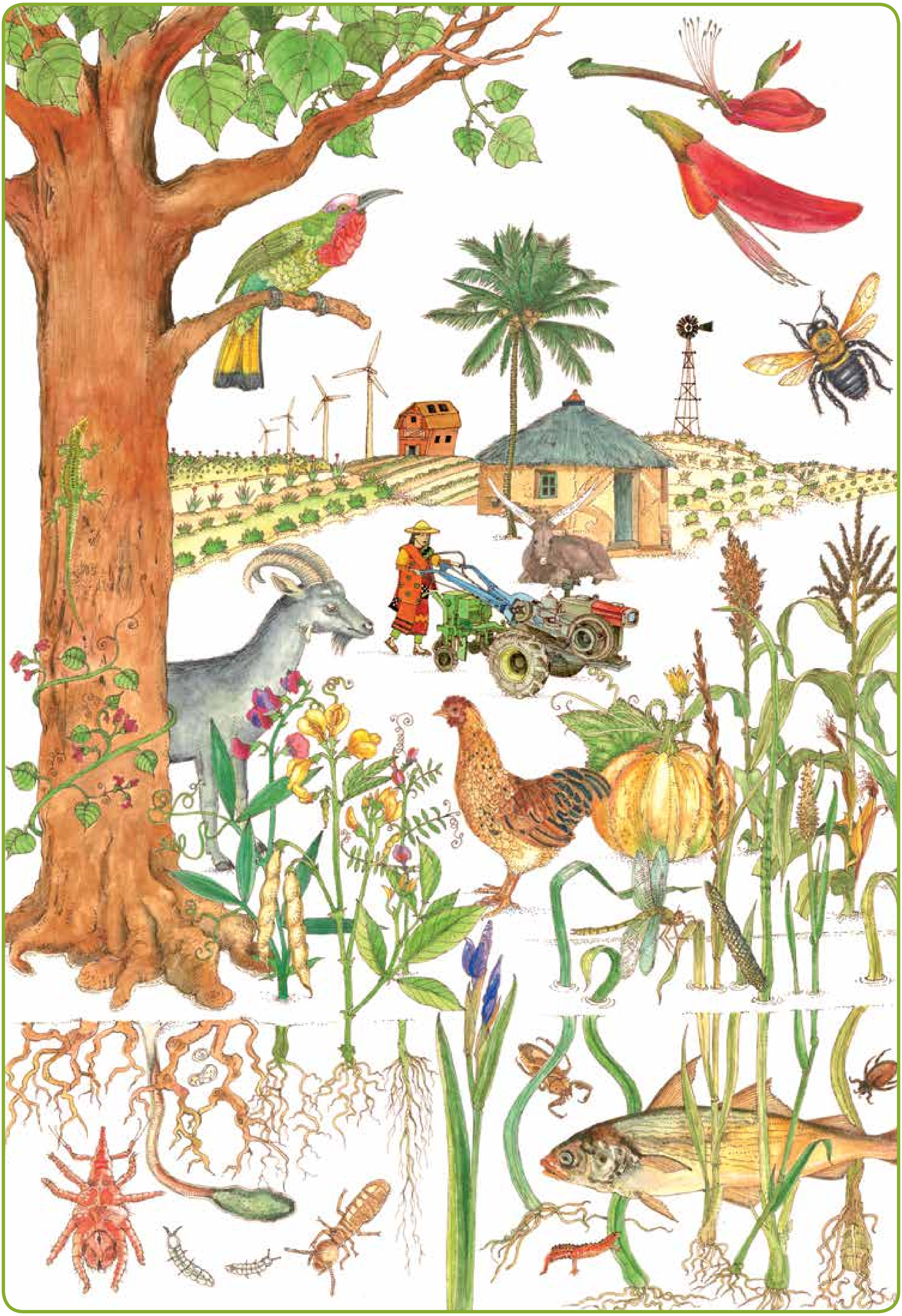

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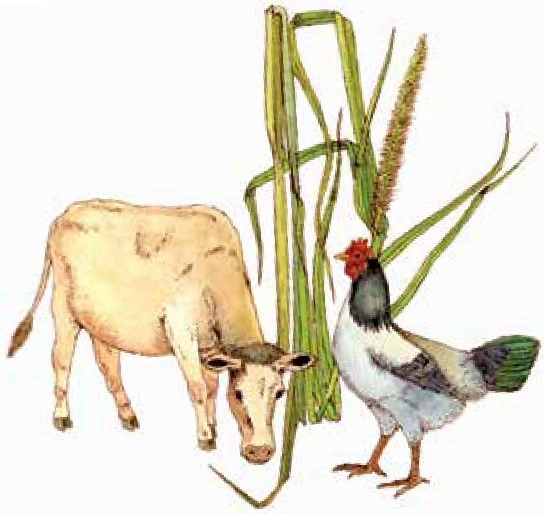

Agroecology and the Transformation of Global Food Systems

Stephen R. Gliessman
University of California, Santa Cruz, emeritus

Agroecology is the participatory action and change that brings sustainability, security, equity, and resilience to all parts of the food system - from ecological, to economic, to social components. To do this, agroecology must simultaneously function as a science, as productive practice, and as social change. With a foundation in ecosystem science, the agroecosystem becomes a purposeful system where humans design and manage food systems with sustainability as the ultimate goal. A process for guiding and evaluating the changes needed to transform food systems using agroecology is described.

Food security and ecosystem services in a changing world: it is time for agroecology

Pablo Tittonell
Wageningen University and CIRAD

Most of the agricultural land in the world is currently producing below its capacity (e.g., van Ittersum *et al.*, 2013). At global scale, however, the average yield of most major crops has increased steadily over the last 50 years (FAO, 2012). Such growth has been unequal across the world and today's productivity tends to be the lowest in the poorest regions of the world, where food is most needed, and even lower for the least resource-endowed farmers at any given location (Tittonell and Giller, 2013). Although, globally speaking, the world produces enough food calories to feed everyone (2700 Kcal person-1 day-1 produced vs. 1800 to 2100 Kcal person-1 day-1 required – WHO, 2013), food production per capita remains at the same level as in the 1960s in the least favored regions of the world (WFP, 2012). In such regions, inadequate models of agricultural development coupled with increasing (settled) population densities in rural areas led to severe degradation of the natural resource base. Most farmers in these regions do not have access, cannot afford or are unwilling to adopt 'modern' agricultural technologies. Such technologies were not developed to fit their reality of their systems and their environment and hence they are ineffective at increasing crop and livestock productivity. In the most affluent regions of the world, by contrast, agricultural intensification through the use of inputs in excess of what their factor elasticity would dictate led to environmental pollution with often noxious consequences for human health and high costs for society as a whole (costs that are never internalised in the price paid for the agricultural produce). Climate change further threatens both food production and environmental risks in the South and in the North. The time has come to rethink our current agricultural model, one that has been conceived to address the world's problems in a completely different historical context. It is time for a new agricultural model that ensures that enough quality food is produced where it is most needed, that preserves nature and that delivers ecosystem services of local and global relevance. It is time for agroecology. I will explore this concept as put forward by different schools of thought around the world, and provide evidence from science, practice and policy on the potential of agroecology to propend to restorative, adaptable, inclusive and resource use efficient agriculture.

Enhancing the function and provisioning of ecosystem services in agriculture: agroecological principles

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Centre de coopération internationale en recherche agronomique pour le développement (CIRAD)

Agroecology is essentially based on the use of biodiversity and ecosystem services in agriculture production, and thus represents a true rupture with the way agriculture has been seen and analyzed by mainstream science for over a century. AE does not have a consensual definition, but it represents a new conceptual space in which to think about agriculture sustainability through strong interactions between science and society with a wealth of new concepts, questions and tools. Among the diverse "incarnations" of AE, the lowest common denominator is found at plot level. The basic and common principle is to enhance the services provided by living organisms, taking the optimal advantage of natural resources, especially those which are abundant and free (sun radiation, air carbon and nitrogen, rainfall). AE aims to increase production in a sustainable and resilient way that will maintain and improve the ecosystem capital in the long term. It will pilot functional biodiversity above and underground, over space and in time, by both intensifying biological cycles for nutrients, water and energy, and controlling aggressors of crops. Because ecosystem services are involved, AE has long been working on larger scales (farms, landscapes, watershed basins, value chains, food systems). It has been extremely interested in inter-disciplinary research questions, in particular about some of the drivers of agriculture evolution such as food industries and distribution, consumer health, public policies, etc. Furthermore, since AE strongly depends on locally available natural resources including agro-biodiversity, it does not prescribe ready-to-use technical packages to farmers. The models and solutions are built mingling scientific and traditional knowledge and strongly relying on local learning and innovation processes. With the many challenges ahead, AE represents a true alternative for agriculture transformation but it questions the role and practices of agriculture research and calls for a significant renewal.

People managing landscapes & watersheds: agroecology and social processes

Irene Cardoso
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The presentation will be based on the experience developed in Zona da Mata of Minas Gerais, Brazil. Since 1988, the Centre for Alternative Technologies of the Zona da Mata (CTA), an NGO (Non-Governmental Organization), and a group of professors and students of the Federal University of Viçosa have been working in partnership with family agriculture, following agro-ecological principles, in activities such as soil management and agro-forestry systems. During the 1980s, a strong movement of family farmers developed, which lead to the creation of unions and other organizations representing their interests. CTA emerged in this context, whose social basis consists of local family farmers unions within the region. The adoption of agro-ecological principles in Zona da Mata is connected with creative ways of dealing with land scarcity and land degradation. To deal with land degradation and to diversify production agroforestry coffee systems were experimented, using participatory methodologies. These systems were important for improving food for the family, for the domestic and wild animals and for increasing income. The trees also improve soil quality, increase carbon sequestration, increase water quantity and quality, attract pollinators and give shade to the workers. In agro-ecology as understood by the group in Zona da Mata, the scientific knowledge has to be constructed by all involved, including the farmer's knowledge. The farmers are not only a source of knowledge but also an autonomous and creative agent of transformation. Nowadays, a project called "knowledge exchange" involving family farmers, scientists, students and technicians is being developed. However, for the transition of conventional to agroecological agriculture, appropriate public policies are needed, prioritizing investments in sustainable production. Therefore, the Brazilian agroecological policy will also be discussed.

Creating Virtuous Cycles through Agroecology

Paul Mapfumo
University of Zimbabwe

There are increasing global concerns about failures of current regimes of food systems and accelerated degradation of the natural resource base in the wake of rising pressures on agricultural production systems due to a growing human population and climate change. This raises questions about the appropriateness of the contemporary concept of 'agriculture' in fostering sustainable and resilient production and livelihood systems among the world's poor communities such as those in Africa. This paper draws on example cases of research and development interventions from sub-Saharan Africa to reveal how agro-ecological approaches at field and farm-scales can create virtuous nutrient cycles, triggering higher level socio-ecological dynamics that enhance food security and livelihoods for smallholders. Interventions that involved use of indigenous non-cultivated herbaceous legumes, planned sequences of integrated soil fertility management (ISFM) options and introduction of conservation agriculture (CA) showed potential for reversing soil carbon decline, nutrient depletion and falling crop yields, which are currently sustained under conventional agriculture. The study also highlights challenges in managing resource and nutrient use efficiencies due to intricate inter-dependences among agricultural production, natural resource pools, social safety net systems, and access patterns to knowledge, production resources and technologies, all in a non-linear fashion. Research and extension approaches that created platforms for co-learning and co-innovation of farmers with diverse actors, including those beyond agriculture, became critical for success. Such approaches opened opportunities for farmers to share and pursue their livelihood objectives within and outside agriculture, reinforcing the cycles and broadening horizons for further collaboration (and also conflict) as demands for new forms of resources, skills and technologies arose. Drawing on these experiences, the paper argues that inherent elements of resilience and visions of success among the predominantly smallholder farmers in Africa have largely been ignored in favor of current paradigms of agricultural development, often increasing vulnerabilities.

AFTERNOON SESSION
ECOLOGICAL APPROACHES

Conception and Engineering of Cropping Systems: how to integrate ecological approaches?

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The science of agroecology, which is defined as the application of ecological concepts and principles to the design and management of sustainable agroecosystems has known these last years a tremendous renewal of interest among the community of agricultural scientists but also amongst policy makers. This is mainly due to the important ecological disservices and often failure to ensure food security provided by intensive modern agriculture and associated techniques based on the combined use of agrochemicals and high-yielding varieties in monocropped systems. The main principle of agroecology consists in assembling and increasing functional biodiversity in agroecosystems to enhance synergisms in order to provide various categories of ecological services such as the activation of soil biology, the recycling of nutrients, and the enhancement of beneficial arthropods and antagonists. Functional diversity may be enhanced through different practices and strategies which include crop rotations, cover crops, intercropping, crop/livestock mixtures, agroforestry mixtures, etc. New strategies incorporating ecological knowledge gained from the observation of natural ecosystems and or traditional agroecosystems may be a credible alternative to design such innovative systems. Designing such novel agricultural systems calls for in-depth knowledge of biological regulations in ecosystems, but also for the integration of traditional agricultural knowledge held by local farmers. Integration of these two aspects is one of the challenges that agricultural science has to deal with today. In addition, although practices are applied at the plot and / or farm scale by farmers, their efficiency and associated services are expressed mainly at the landscape scale. This paper reviews the main initiatives that lie behind these trends, analyzes the basic concepts underlying the design of such systems, and suggests new frameworks for action that include Nature observation, experimental and model-based designs and participatory approaches.

Closing the Nitrogen Cycle

Mark Sutton
Centre for Hydrology and Ecology, UK

Substantial progress has been made in recent years through synthesis activities conducted by the International Nitrogen Initiative (INI), the Task Force on Reactive Nitrogen (TFRN) and the Global Programme on Nutrient Management (GPNM), including the recent report 'Our Nutrient World'. Nitrogen emerges as especially interesting because of the way it couples food security and bio-energy benefits with multiple environmental challenges. Based on analysis of the global nitrogen cycle, estimates of each of the major nitrogen flows have been made. These have allowed 10 key actions to be identified to improve economy-wide Nitrogen Use Efficiency (NUE). Using cost-benefit analysis, it is estimated that a 20% increase in NUE would deliver annual net benefits worth around US$ 170 billion globally, including benefits for ecosystems, health and climate, as well as direct savings in additional fertilizer costs. While major uncertainties remain for some terms of the global nitrogen cycle, especially for biological nitrogen fixation and denitrification, these uncertainties do not prevent a proactive approach where the multi-sector benefits of improved nitrogen management can be counted. The presentation will highlight how a strengthened focus on the nitrogen cycle can support many policy challenges through quantified contributions to meet existing goals (food, energy, climate, biodiversity, water quality etc.), while supporting development of the green economy. The emerging vision will be shared from a GEF/UNEP project currently being prepared on the global nitrogen cycle, which will investigate the basis to establish an International Nitrogen Management System (INMS). Such a coordinated approach, including evidence gathering, indicator refinement, integrated assessment and cost-benefit analysis across the nitrogen cycle, holds the prospect to strengthen multiple policy processes simultaneously.

Alternatives to External Inputs

André Leu
International Federation of Organic Agriculture Movements

Reducing the costs of external inputs while producing good yields is an important key to successful agriculture. Purchasing external inputs is costly and at times logistically difficult for most of the world's farmers: smallholders in developing countries. The ability to generate effective alternatives to external inputs on farm at no or low costs, reduces the reliance on and the costs of paying for external inputs. Organic agriculture is part of the agroecology paradigm. Modern ecological organic agriculture is not the same as the way people farmed in the past and it is not about going backwards. The new ecological organic agriculture combines tradition with innovation and science. Published scientific studies show that organic systems have higher yields under conditions of climate extremes such as drought and heavy rain events. Good ecological science based organic practices increase yields in traditional farming systems. A report by the United National Conference on Trade and Development and the United Nations Environment Programme that reviewed 114 projects in 24 African countries covering 2 million hectares and 1.9 million farmers found that organic practices increase yields on average by 116 per cent (range: +54% to +176%) for sub-Saharan African projects. The innovative and science-based methods provide the necessary practices and inputs that are needed for soil nutrition and pest, disease and weed control to obtain good yields. These science-based systems can provide all the necessary macro nutrients such as nitrogen, phosphorus and potassium as well as all the trace minerals needed for high yields through a combination of green manures, composts, natural minerals and many other sources at much lower costs than imported synthetic fertilizers. Eco-Functional Intensification, using functional biodiversity, natural minerals and agroecological methods can ensure that the inputs for soil nutrition and pest, disease and weed control can be generated on farm at no cost or sourced locally at very little cost. The use of organic matter to provide biogas not only provides partial energy self-sufficiency, the residues can give over 100% increases in crop yields. The combination of higher yields, resilient biodiverse production systems and lower production costs can achieve both food and income security for farmers.

Agroecological approaches to breeding: Crop design for improved agroecological fitness, sustainable intensification, ecosystem services, and food and nutrition security

Len Wade
Charles Sturt University, AU

Agroecological approaches are designed to attain sustainable food production systems, with enhanced ecosystem function and resource efficiency. Choice of appropriate crop and cultivar for those agroecological targets is essential, in addition to appropriate management. Crop and genotype selection must be focussed first upon agroecological fitness, which requires a close understanding of the crop and plant behaviour desired in order to achieve the productivity, sustainability and ecosystem goals. At issue is crop design, specifically the traits and trait combinations which confer resource efficiency and hence ecosystem function. The dynamics of crop response should also be considered, including patterns of adaptation to different soil constraints or management regimes, and how these patterns may vary with seasonal conditions and climate change. Crop design will differ depending upon these ecosystem and management considerations. These principles are then adapted to alternative systems, including intercropping, relay sowing and mixtures, based upon concepts of competition and commensualism. The products to be generated must be considered, whether grain, forage, livestock or all of these, and the associated system rather than individual efficiencies. Issues for selection in mixed systems are examined, with reference to concepts of co-evolution and joint selection, drawing from diverse examples, including underused and perennial crop forage and tree species. Derivation of successful systems will require improved agroecological understanding as a basis for improved crop, mixture and systems design.

Soil health and agricultural sustainability

Edmundo Barrios
ICRAF

Soil health is a measure of the state of natural capital that reflects the capacity of soil to respond to agricultural management by maintaining both the agricultural production and the provision of other ecosystem services. Human-environment interactions are dominated by agriculture, which consumes more natural resources than any other human activity. This has raised concerns about natural resource management trajectories as related to planetary boundaries and land degradation tipping points. The adaptation of ecological concepts and principles to the design and management of agroecosystems through agroecology is a key strategy contributing to address these sustainability concerns. The soil resource is central to agriculture and therefore sustainable agriculture is inherently dependent on soil health. The majority of ecosystem processes have the soil as the critical and dynamic regulatory center and soil biota play a key role in a wide range of ecosystem services that are essential to sustainable agroecosystems. Recognizing the great biological diversity in the soil and the complexity of ecological interactions we focus on management of soil biota strongly linked to functions which underpin soil-based ecosystem services. Desired features of agroecosystems that promote soil biological activity, that in turn promotes ecosystem functioning will be discussed and illustrated with case studies. Farmers represent the largest group of natural resource managers in the planet and have a critical role to play in the agroecological transition towards sustainable land management. Farmers and other land managers need to be active players in the conservation and enhancement of soil health and soil-based ecosystem services. The participatory development of soil health indicators and monitoring systems that integrate local and scientific knowledge is a key component of the strategy to predict and adapt to land use change, agricultural intensification and environmental changes while moving from a reactive to a more proactive approach towards sustainable land management.

Managing Pests and Pollinators with Agroecology

Muo Kasina, Lusike Wasilwa
Kenya Agricultural and Livestock Research Organization, KE

John H. Nderitu
Mt Kenya University, KE

Dino Martins
Nature Kenya, The East Africa Natural History Society & Turkana Basin Institute, KE

Barbara Gemmill-Herren
Food and Agriculture Organization of the United Nations

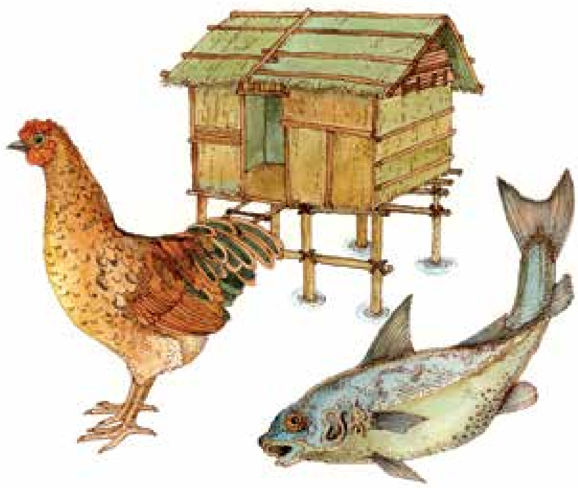
While pest organisms (including insect pests, diseases, weeds, etc.) have long been the focus of agronomic research, singular approaches to their control have often result in escalating costs and pest resurgences. Agroecological approaches, in contrast, seek to restructure and manage agricultural systems so that an array of biological interactions are in place and serve to prevent pest damage. These interactions go beyond simple biological control, to include such measures as (1) cultural practices- often based on traditional knowledge – including polycropping, and planting of diverse genetic mixtures (2) building healthy soils to grow plants that can fend off attacks and (3) enhancing or introducing natural enemies and (4) using insects' own chemical signals to alter their behavior. A further ecological synergy, only recently well understood, is that by increasing diversity on a farm and reducing pesticides, the abundance of pollinating insects can be increased, increasing the yields of pollinator-dependent crops. We highlight ways in which the complex management of these biological interactions has shown inherent strengths, in the context of Kenya and East Africa.

Above and belowground biodiversity and agroecosystem services

Fabrice DeClerck
Bioversity International

Biodiversity and ecosystem function research has highlighted the critical role that biodiversity plays in the provisioning of ecosystem services and improving human well-being. Nowhere is this more evident in agricultural landscapes which are unique in their simultaneous dependence on ecosystem services that support production functions, and their capacity to provide ecosystem services extending beyond primary production. Biodiversity plays a fundamental role in ecosystem service provision of agricultural landscapes providing the foundation to sustainability and supporting provision functions in the form of water, soils, pest control, and pollination. These can be classified as private services that are best managed by increasing on-farm agroecological management options. There is a critical needs however to recognize the services provided by agricultural landscapes, including hydrological flow regulation, water quality, habitat conservation and human nutrition and to reward farm management that secures these services. These serves often transcend individual property rights requiring the development of benefit/risk sharing mechanisms that secure service provision. There are three undervalued considerations in operationalizing biodiversity for ecosystem service provision in agricultural landscapes, notably: (1) how multiple processes interact to provide a single function; (2) the critical role of scale in (plot, field, landscape) in managing biodiversity for service provision and its interaction with farm management; and (3) the values accorded to biodiversity for the services it provides agricultural landscapes. Emphasizing singular production goals grossly under-estimates biodiversity's contribution and value; global development, agricultural, and conservation efforts will need to better demonstrate these contributions and values to landscape multifunctionality and to human well-being.

AFTERNOON SESSION
BUILDING SYNERGIES



Resilience and Agroecology and the design of climate change resilient farming systems

Clara I. Nicholls and Miguel A Altier
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Diverse, severe and location-specific impacts on agricultural production are anticipated with climate change. Adaptation is considered a key factor that will shape the future severity of climate change impacts on food production. Changes that will not radically modify the monoculture nature of dominant agroecosystems such as shifting planting dates, switching or introducing new crop varieties, expanding and improving irrigation, may moderate negative impacts temporarily. The biggest and most durable benefits will likely result from more radical agroecological measures including the diversification of agroecosytems in the form of polycultures, agroforestry systems and crop-livestock mixed systems accompanied by organic soil management, water conservation and harvesting and general enhancement of agrobiodiversity. In this paper we contend that what is needed is an agroecological transformation of monocultures by favoring field diversity and landscape heterogeneity, as research shows that enhancing a diversity of species acts as a buffer against failure due to environmental fluctuations. Agroecological diversification represents a robust path to increasing the productivity, sustainability and resilience of agricultural production while reducing undesirable socio-economic and environmental impacts due to climate change. Contrary to the monocultures of industrial agriculture, many traditional farming systems, which have stood the test of time, offer an array of management options and designs that enhance functional biodiversity in crop fields, and consequently support the resilience of agroecosystems. These diversified traditional systems have allowed small farming families to meet their subsistence needs in the midst of environmental variability without depending on modern agricultural technologies. Understanding the agroecological features that underlie the resilience of traditional agroecosystems can provide the foundation for the design of adapted agricultural systems.

How to achieve food security: China case from individual to millions of farms

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Despite remarkable growth in food production during past half-century, the challenges facing agriculture today are greater because of the need for increased global food production while protecting environment and conserving natural resources over the next 30 years. During the past 50 years, the 3.4-fold increase in Chinese agricultural food production can be partly attributed to a 37-fold increase in N fertilization and a 91-fold increase in P fertilization, but the environment costs have been very high. To achieve food security and environmental sustainability, agricultural development in China must be transformed to address both challenges, from solely high yield to both high yield and high resource use efficiency. We have developed an integrated technology system focusing on achieving both high crop-productivity and high resource-use-efficiency termed as "double high-DH" technology system. The DH agriculture depends on effective technology innovation and transfer at large scale from individual to millions of farms. In China, various agricultural economies with different scales coexist. The arable land area on each farm varied from around 0.5 ha in more than 90% of farms in China, to around 2 ha in Jilin, and to around 25 ha with large-scale agricultural service in Heilongjiang province. We established a model of how to achieve food security for millions of farms in China, with the key components: 1) establishing an integrated platform for efficient interactions among scientist, expert, technician, enterprise sector and farmer; 2) developing innovative and integrated agricultural technologies; 3) establishing high efficiency technology application channels directly to farmers; and (4) strengthening communication among public extension-systems, scientists, enterprises, and farmers. In China, this system has been successfully tested and demonstrated. The new "double high" concept has the potential to become an effective agricultural development path to ensure food security and improve environmental quality, especially in China and other rapidly developing economies.

An Agroecological Approach to Water Scarcity

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Water scarcity is increasingly posing a challenge to development in the arid and semi-arid lands (ASAL) in developing countries. The challenge is made worse by climate change, increasing human population, land and water degradation and other drivers. Drought, flooding and other extreme events are expected to increase (FAO 2008; Rockström *et al.*, 2010) and this will lead to loss of ecosystem services of fragile environment in the ASAL. This paper explores the agricultural water management (AWM) practices that farmers have been using to simultaneously increase water use efficiency (WUE) and ecosystem services in the ASAL. Given that water supports all forms of life, its shortage causes large agroecological imbalance leading to loss of ecosystems services. Farmers in the ASAL have developed rich indigenous AWM knowledge for tackling water and soil moisture scarcity. Intercropping cereals and legumes help to spread production risks and enhance moisture conservation (Young 1987). Water harvesting technologies have also been used by farmers to increase water productivity. Agroforestry practices also enhance soil fertility, WUE, and provide fuelwood and other benefits. Recently, there has been a strong promotion of conservation agriculture (CA), which reduces soil erosion and improves WUE through improved infiltration and reduced evaporative water losses (Vogel 1993; Giller *et al*., 2009). Despite weaknesses of traditional AWM, a recent study in sub-Saharan Africa (SSA) showed most of them are more profitable, enhance soil moisture conservation and store more carbon than land degrading practices (Nkonya *et al*., 2014). Yet, their adoption rates are much lower than those of land degrading practices (Ibid). Among the leading of such inverse relationship of adoption rate and returns to land management practices is the weak extension services on organic inputs and AWM (Ibid). Livestock is a major production sector in ASAL in SSA and South Asia. It is dominated by pastoralists who have developed strong indigenous knowledge on sustainable land and water management practices (Nkonya and Anderson 2014; Fernandez-Gimenez 2000). Movement of livestock during the dry and rainy season is determined by availability of water and pasture and by pest and disease pressure. However, recent economic and institutional changes have made this sustainable transhumant livelihood less amenable. Land privatization has restricted livestock movement. Recent land grabbing trend has also led to loss of grazing land, such that their ability to achieve sustainable grazing management has been reduced (Banjade and Paudel 2008; Sulieman 2013). Additionally, public expenditure on livestock sector is less than 2% despite the increasing demand for livestock product. To achieve sustainable agroecological land and water management systems an integrated approach is required that will build ecological synergies of land, water and the environment, areas which remain highly compartmentalized in many countries. Efforts to promote and improve indigenous land and water management also need to be increased.

Agroecological management of energy flows to maintain healthy agroecosystems: some general principles and practical examples

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Making more efficient use of energy has always been a focal point of agroecological practices, and still is for any design of sustainable food systems. Indigenous and traditional farming offers a multitude of examples of how energy efficiency, attained by circulating energy through an integrated set of different technologies and land uses, can ensure the nutritional and energy requirements of societies while maintaining a healthy environment. A socio-ecological study of metabolic interactions with nature through tracking energy and material flows driven by farmers allows the identification of some basic principles of a healthy agroecological functioning and offers a historical bundle of examples to look for alternatives to the present unsustainable patterns of pollution, biodiversity loss and inefficient energy use in agriculture. Concerns for energy inefficiency in human activities as well as for its direct effects on climate change put pressure on science and policy. While biodiversity is globally at stake, many practical examples show how in agroecology the energy efficiency is tightly related with multiple strata silvopastoral systems and crop-livestock integrated managements which are able to host high species richness. Diverse, integrated and self-sufficient agroecological farm systems that employ low levels of external inputs, demonstrate efficiency in the use of water, nutrients and energy, while also being environmentally sound, economically and technically feasible, and socially desired. This presentation explores several facets of energy use within agroecological farming systems and ways in which agroecology science and practice contribute to enabling farmers to access one of the most valuable and scarce resource for the development of rural livelihoods. It offers a theoretical and methodological approach to account for the energy profiles and throughputs in agroecosystems which will be illustrated by studies developed in Argentina, Cuba and Spain.

Agroforestry

Ravi Prabhu
ICRAF

Agroforestry is a dynamic, ecologically based, natural resource management system that, through integration of trees on farms and in the agricultural landscape, diversifies and sustains production and builds social institutions. Drawing on the most recent science and case studies, especially from the work of the World Agroforestry Centre (ICRAF) and its partners, the presentation will explore the contributions of agroforestry to the management of landscapes and the improvement of livelihoods at nested scales, taking account of fine scale variation and heterogeneity that is a feature of these landscapes. There is growing evidence from across the developing world that the adoption of agroforestry – a broad suite of ecologically and socially adapted practices – is helping to restore productivity and resilience of landscapes as well as contributing to goals of food, nutrition and income security of small holders and, especially, other vulnerable groups of society. The presentation posits that this is because it is a systems approach that is based on a sound understanding of ecology and an improving understanding of the social and economic systems of the people who inhabit these landscapes. The case studies selected from Africa, Asia and Latin America will illustrate the depth, scientific basis and diversity of these promising approaches. The science underpinning the scaling up of agroforestry will be presented as well as evidence for its impacts on ecology, society and sustainable development. Investments, including from the private sector, are helping agroforestry based agriculture to go to scale and the presentation will touch on the evolving nature and scale of these investments as important contributors to the widespread adoption of agroforestry. The presentation will identify opportunities and challenges for agroforestry in the context of rising populations, shifting demographics and changing consumption patterns before closing with a perspective on the way forward.

Integration with livestock

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Livestock systems have seldom been covered by the scientific literature on agroecology. Extensive grazing systems are based on the management of plant biodiversity by means of the grazing behaviour and mobility of herds adapted to harsh environments. Such systems usually have a higher net primary productivity, soil N cycling and C sequestration compared to unmanaged grasslands. These low-productive systems recycle nutrients efficiently and use mostly biotic processes (e.g. biological N fixation, tannin-rich plants for gastro-enteric parasite control) rather than chemicals. However, they are vulnerable to climatic variability and land degradation especially in drylands. Improved grazing management can lead to pasture restoration, while the use of species rich grass-legume mixtures, organic fertilizers and mixed grazing allows for sustainable pasture intensification. Nevertheless, further intensification may generate large losses to the environment of nutrients and greenhouse gases, since intensive grazing uncouples the C, N and P cycles that are tightly coupled in extensive pastures. Above a threshold animal density, sustainable intensification can only take place through increased livestock integration with cropping systems. Integration with crop production (i.e. providing grains and crop residues as feed and returning organic N and other nutrients to arable land as manures) can raise the overall efficiency and productivity of agricultural land while enhancing landscape diversity and connectivity, thereby enhancing synergies across food production, biodiversity and other ecosystem services. Further recycling benefits may occur through optimization of the manure chain using technological options, such as anaerobic digestion and composting. Industrial ecology can also be adapted to rethink indoors livestock systems (e.g. recycling crop residues and by-products, using natural microbial phytases to increase feed-P digestibility by pigs) and to develop integrated systems (e.g. combining livestock, crops and fish ponds as in South Asia) that are based on the niche complementarity of animal species. Through these examples, we discuss how theories in ecology can be applied to the design and management of livestock based agroecosystems.

The Influence of Food Systems and Market Forces on Farmer's Adoption of Agroecological methods: Why Food Chains are Significant in Hindering or Facilitating Change

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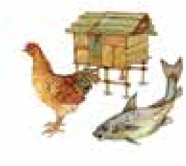
Farmers' decisions about the practices they use are inevitably affected by social and political-economic conditions which surround them, as well as the biophysical or environmental context. Accelerating the adoption of agroecological practices to produce nutritious food requires efforts to address critical socio-economic and market factors in food systems which influence farmers' decisions and actions. This paper will identify several key factors in food systems that hinder or limit the use of agroecological approaches and meeting food security needs, as well as contrasting elements that can support and expand the adoption of agroecology. The paper will



draw on empirical experience (i.e., case study material) and research findings. The influential food system factors that are considered here include food market demands and market conditions (such as the roles of food retailers, buyers, brokers), farm input suppliers, related food policies, demonstration effects of peers, and social movements. The degree of penetration and influence of mainstream mass food markets – or the availability of market alternatives – appear to have a significant influence on the ability of farmers to adopt alternative agroecological practices that meet food security/nutrition needs. The paper will conclude with brief comments on policy and political-economic implications, such as addressing marketpower in food systems, supporting social movements that are helping to scale up agroecological practices, as well as policy support to accelerate changes to more sustainable, healthy and just food systems.

AFTERNOON SESSION

PEOPLE AND ECONOMICS

Building Natural Capital through Agroecology

Salman Hussain
United Nations Environment Programme

The Economics of Ecosystems and Biodiversity is a UNEP-hosted project that seeks to demonstrate and capture the values of ecosystems and biodiversity. *TEEB for Agriculture and Food* is a recently-launched project that will categorize, characterize and estimate the extent of positive and negative externalities and impacts of the agri-food complex. Central to this is agro-ecology: production systems that maintain genetic diversity provide both public good benefits and potentially private benefits in terms of ecosystem service provision that often remain invisible. Further, the conventional lens used to assess agri-food system performance also needs to be reappraised. The scope, structure and intended outcomes of the *TEEBAgFood* study and its links to agro-ecology are to be presented in this session, along with a critical appraisal of some of the ecological economic methods that may be applied.

Building markets to support Agroecology

Luigi Troiani
Autogrill, IT

Without marketing techniques, no product may acquire an "economic" value. This implies that to "sell" Agroecology, we need to appropriately approach the market. What can be considered to be the markets of Agroecology? The first market is the "cultural" market. The culture of agroecology has to be spread around and has to circulate through governments, opinion makers, producers, consumers, students and researchers. It is not easy because our economic system is based on profit. Agroecology is instinctively considered not convenient for the majority of the present day agricultural systems. The second market is the "true" place where supply and demand meets. Agroecology appears irrelevant in macroeconomic terms. Organic food, the most visible part of the agroecology, does account for only €Bn50 in terms of global sold value, even though it expects to register more than 100% growth in the next decade. To jump from an élite microphenomenon to the macrophenomenon dimension is the challenge which agroecology

may choose for the next decade. In increasing the added value of the products coming from Agroecological systems, we will convince more and more market operators to adhere to the movement which is trying to put agriculture and food at the service of a better planet and make it free from the mere needs of profit. As an effect, it appears evident that the third market to be built to support Agroecology is political. A system of alliance with the decision makers has to be set up. New rules have to be fixed. Taking into the account the positive consequences on social and health factors that Agroecology is able to provoke, public financial measures to support conditions for Agroecology expansion have to be set up. The positive effects on employment have to be underlined. Restaurants and distribution should be targeted with specific campaigns: the consumers are the true masters of any future direction agriculture and food should take.

Agroecological socio-economics: agroecology's contribution to farm incomes, employment and other socio-economical dimensions of food systems

Gaetan Vanloqueren
Belgian Agroecology Interdisciplinary Research Group / University of Louvain, BE

Does agroecology have anything to do with economics, or better with 'socio-economics'? Does it yield positive socio-economic impacts such as jobs and increased incomes? This communication will tend to demonstrate that agroecology does have significant positive social and economic impacts, which deserve consideration when seeking to design policies and programs that improve food and nutrition security. The communication will also highlight the intrinsic social and economic dimensions of agroecology. A remarkable achievement of the increased attention for agroecology by various organizations in the past five years has been the production of a series of recent reports and scientific studies that have highlighted the significant positive impact of agroecological practices on agricultural yields. These reports have progressively demonstrated that agroecology had to be considered as a serious challenger to certain agronomical conceptions of the past. However, relatively few research projects have attempted to assess not only the agronomical impacts of agroecology, but also the impacts of the adoption of agroecological practices on socio-economic variables such as farm incomes, labour demand and employment generation. Furthermore, the adoption of a comprehensive 'public policy' outlook is only nascent: for instance, projects seeking to assess the 'return on investment' of agricultural spending in agroecology programs comparatively to non-agroecological programs, are scarce, despite the importance of investing in programs with high social, financial and ecological returns in times of scarce public resources. The communication will present highlights of the socio-economic impacts of agroecology, based upon examples of various agroecological practices, including farm diversification, participative agroforestry, or soil conservation and water harvesting measures. However, the 'momentum' that we are now witnessing for agroecology (growing interest from a broad range of actors; some supportive public policies; some research programs and donors commitments) requires considering a second type of connections between agroecology and the socio-economic aspects of food systems. Agroecology, far from a narrow 'agronomical' concept that would only be meaningful at the crop or farm level, invites to take a fresh look at many levels of food systems, how they are organized, and how they could be improved to enhance food and nutrition security. The Symposium, in its online introduction, acknowledges the evolution from an 'ecological' definition of agroecology towards the current 'food systems' definition, which encompasses ecological, economic and social dimensions. It follows significant efforts from credible actors and organizations to map the connections of agroecology with different concepts and norms, including sustainability, food security and the right to food. The communication will contribute to clarify the social, economic and political dimensions of agroecology –as observed from the academic literature as well as the observation of relevant actors, with a view to inform decision-makers and to ensure that 'agroecology' does not becomes a new trendy buzzword, but a real choice.

What protective health factors are lost when moving from an acroecological to an industrial model of agriculture? How can we regain these protective factors?

Daphne Miller
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It is well documented that populations experience a sharp increase in the prevalence of many chronic diseases– including cardiovascular disease, diabetes, obesity, autoimmune diseases, cancer and depression– when they abandon a traditional lifestyle based on diversified farms in favor of a more industrial one. Research shows that the nutrition transition is an independent and significant contributor to this health decline. To better understand this dietary transition, most investigations have focused on identifying the ingredients within the standard industrialized diet that are potential promoters of disease such as sugar sweetened beverages, processed oil and refined carbohydrates. By contrast, this report focuses on understanding the protective dietary factors that are left behind when individuals no longer are connected to a system of agriculture based on agroecological principles. The protective benefits of agroecology will be discussed in four domains: 1) ethnobotany, 2) nutrients and dietary diversity, 3) microbial diversity and 4) dietary customs. Specific attention will be paid to the health impacts of alternative food security programs which are designed to reintroduce traditional foods and agroecology to transitioned communities.

Organization and Social Process in Bringing Agroecology to Scale

Peter Rosset
El Colegio de la Frontera Sur (ECOSUR), MX, and La Via Campesina (LVC)

Numerous scientific studies and empirical experiences around the world have shown the peasant and family farm-based agroecological approach to be superior to industrial agriculture in terms of: production of healthy food for local populations, rural livelihoods and cultures, resilience to climate change and other shocks, fewer greenhouse gas emissions, lower production costs, stewardship of productive resources and rural biodiversity ('Mother Earth'), relative autonomy and lower external dependence for farm families, etc. Yet the challenge remains of how to bring agroecology to scale, such that it is practiced by ever more families, over ever larger territories. The experience of rural social movements, and farmer and peasant organizations, indicates that the degree of organization (called "organicity" by social movements), and the extent to which horizontal social methodologies based on peasant and farmer protagonism are employed to collectively construct social processes, are key factors in "massifying" and bringing agroecology to scale. Campesino-to-campesino ("farmer-to-farmer") processes and peasant agroecology schools run by peasant organizations themselves are useful examples of these principles. While most agroecology research to date has emphasized natural science, these results point to the need to prioritize social science approaches and self-study by rural movements, to draw systematic lessons from their successful experiences. This can produce the information and principles needed to design new collective processes. These points are illustrated with reference to emblematic cases selected from the experience of La Via Campesina, arguably the world's largest social movement, and a key venue for expanding agroecological experience through its global, regional and national agroecology and peasant seed processes.

Local knowledge and participatory learning processes: primordial elements of agroecology

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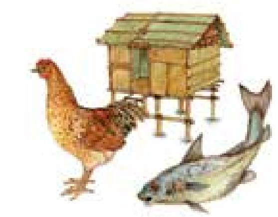
Most agroecologists contend that the starting point in the development of sustainable and resilient agricultural agroecosystems are the very systems that traditional farmers have developed throughout centuries. The majority of the farmers in the developing world are peasants who tend small plots using indigenous agricultural methods. These diversified agroecosystems have emerged over centuries of coevolution, and represent the experiences of farmers interacting with their environment without access to external inputs, capital, or scientific knowledge. Using self-reliance, these farmers have developed complex systems that offer promising models for other areas as they promote biodiversity, thrive without agrochemicals, and sustain year-round yields to realize a more autonomous food production. Part of this performance is linked to the high levels of agrobiodiversity, which in turn positively influence agroecosystem function. The development of these systems has been guided by a detailed folk knowledge about vegetation, animals, soils, etc., within a certain geographical and cultural radius. Rural knowledge is based on observation and on experimental learning. Successful adaptations are passed from generation to generation which historically farmers have shared successful innovations and knowledge with their neighbors. This horizontal exchange of ideas and innovations set the foundations of a grassroots movement called Campesino a Campesino, which emerged in Central America and over the last three decades has expanded throughout Latin America. CAC has been key in the scaling up of agroecology. The ensemble of traditional crop management practices represent a rich resource for modern workers seeking to create novel agroecosystems well adapted to the local circumstances of peasants. By studying these systems, agroecologists enhance their knowledge of the dynamics of complex systems, the relationship between biodiversity and ecosystem function, and derive practical principles for the design of more sustainable agroecosystems appropriate to small farmers.



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AGROECOLOGY *is the integrative study of the ecology of the entire food system, encompassing ecological, economic and social dimensions. It focuses on working with and understanding the interactions between plants, animals, humans and the environment within agricultural systems. By bringing ecological principles to bear in agro-ecosystems through ecological intensification, novel management approaches can be identified, building on key interactions and strengthening "virtuous cycles" in agricultural production that would not otherwise be considered.*