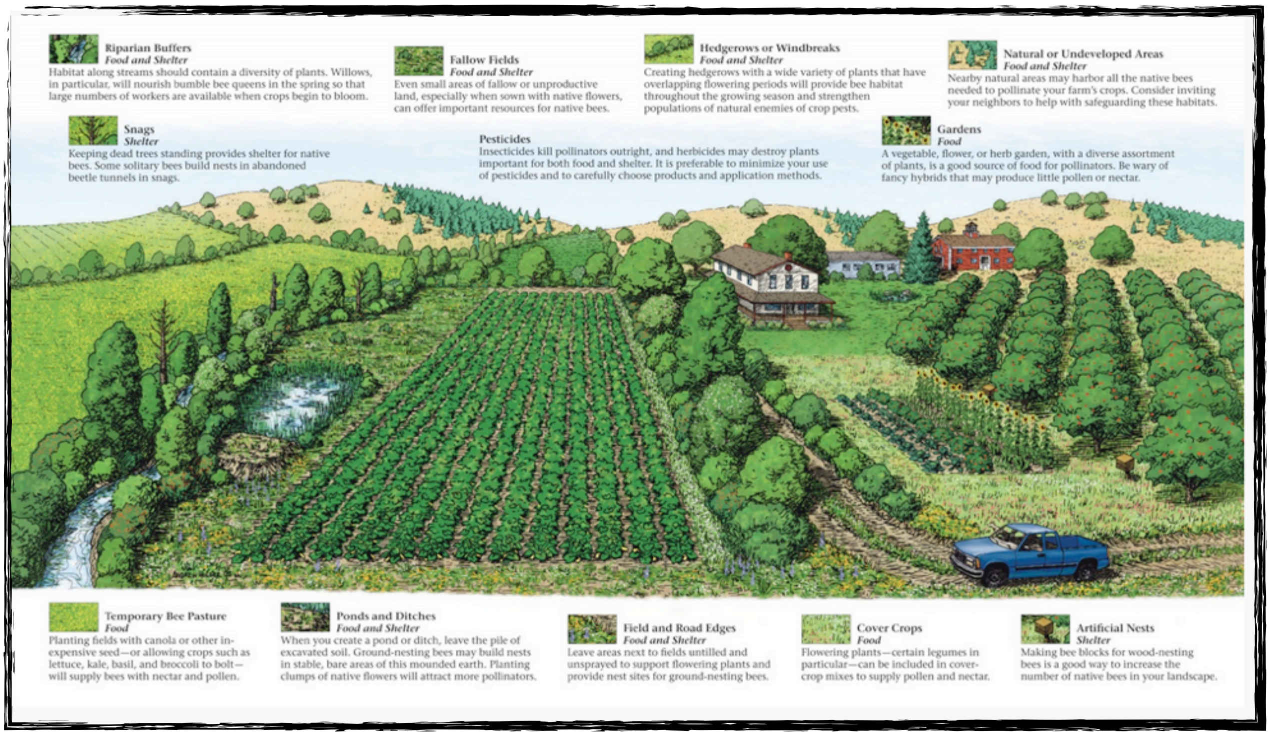
The Conversion Process:
From Monoculture to Multifunctional Agriculture



Learning objectives:

Understand the principles and process of converting from monoculture to multifunctional agriculture

Learn the value of diversified and integrated farming system (DIFS)

Acquire ideas for redesigning farms toward increased productivity, resilience and sustainability

1. Introduction

Poverty, land conflict, relocation – all these could exert pressure on dwindling resources tragically causing environmental degradation and destruction that require communities to adjust and evolve to survive. Ecological knowledge and practices of managing ecosystems and biological diversity to secure flow of natural resources and ecological services to people who depend on them, is central to the survival of communities.[1] People's access to resources done sustainably is critical in managing ecosystems.

Over generations, agriculture has evolved as a response to the changing social and environmental conditions. However, due to economic pressure, ecological and sustainable shifting cultivation practices throughout Asia have given way to more permanent, extractive cash-crop monoculture that is dependent on external inputs and external market. Pakistan's vulnerability to the impacts of climate change can be traced to its agricultural system of industrial monoculture that dates back to the colonial era and peaked during the Green Revolution in the late 1960s. This agricultural model required the establishment of one of the world's most extensive irrigation system, which propelled the country's capacity to churn out immense agricultural exports. However, it's also responsible for the depletion of the country's groundwater resource, to date pumping out more than 60% of irrigation water from its aquifers or underground reservoirs, placing its food and livelihood security at a great risk. This groundwater depletion is also responsible for saltwater intrusion exacerbated by monsoon floods.

Pakistan is one of the world's top producers of some important agricultural products like wheat and cotton. Yet ironically it is also one with the highest incidence of poverty, with wheat and cotton farmers among the most stricken, and worst affected by the flood. The flood in 2010 submerged nearly a fifth of Pakistan and displaced about 20 million people, most of them involved in agriculture. Their sources of livelihood were disrupted or destroyed.

In the previous module, we've introduced the seed bank as a strategy to reclaim farmers' control over seeds. In this module, our working assumption is that farmers already have the seeds and are ready to leave monoculture behind. It is time to regain control of the food and farming systems, by reorienting our perspective and redesigning our farms in such a way that economic and food security objectives are met along with environmental resilience and sustainability.

2. Shifting from extractive monoculture to multifunctional agriculture

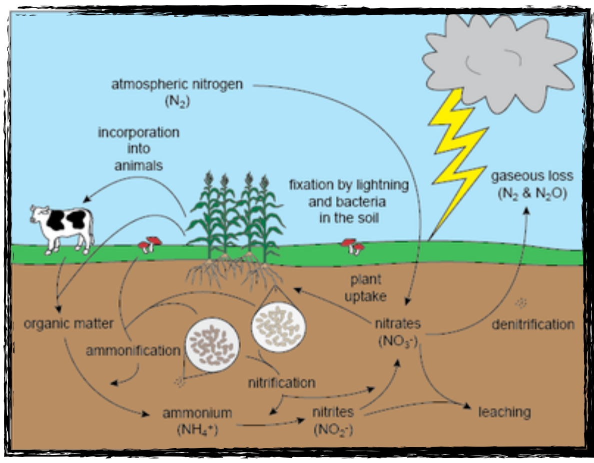
A lasting legacy of modern farming by way of the Green Revolution is that it has cultivated a certain mentality amongst farmers that associate chemical fertilisers and pesticides a necessity in agricultural production. It makes habits, like calendar spraying (i.e. scheduled application of chemical sprays) difficult to break. This perspective consider agriculture to be a one-dimensional enterprise: farmer does the work, inputs are added, harvest follows. Agricultural production is then converted to cash. In this extractive mentality, the soil and other ecological factors of production are taken only as a medium to grow food, not a system to take care of, rehabilitate or replenish. As a result, farmers may have the temporary cash but the quality of environmental resources decline progressively over time

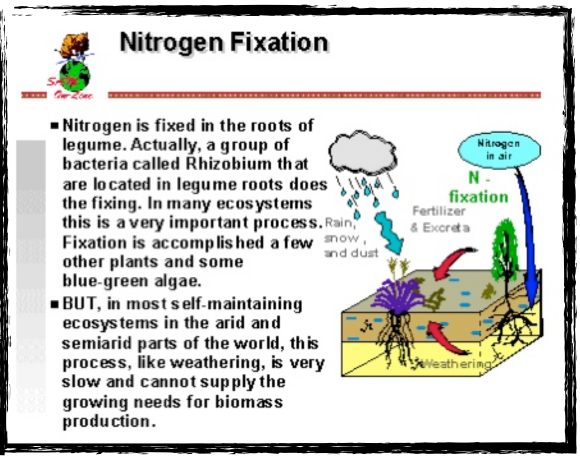
1 Fikret Berkes, Johan Colding, and Carl Folke, 2000. *Rediscovery of Traditional Ecological Knowledge as Adaptive Management*. Ecological Applications 10:1251–1262. http://www.fws.gov/nativeamerican/pdf/tek-berkes-2000.pdf

and productivity of the farm suffers in the long run.

For many farmers raised in the “modern is good” and “monoculture is productive” mentality, warming up to the agroecology philosophy will not be an easy process. Transforming their farm into a diversified and integrated agroecosystem will even be more difficult. This is because changing the monoculture mindset requires a thorough reassessment of long-held beliefs. This is why agroecology as a practice embodies not just a set of agricultural production techniques, but an ethos of managing the environment and sustainably using its resources. Transitioning to agroecology is guided by the following principles:

- Improving soil conditions by reducing or eliminating dependence on external, synthetic inputs. This means improving organic matter content of the soil through the addition of compost and manure, as well as planting of cover crops (e.g. cowpea, groundnut, mungbean, sesbania, sunnhemp) and minimising tillage. It also implies increasing the biological activity of the soil through recycling of biomass and optimising the nutrient cycles (e.g. recycling of rice and wheat straw into the soil to become fertilisers instead of burning them, thereby storing carbon along with nitrogen into the soil rather than emitting them into the air). Not only is this environmentally sound but also economically sensible. Remember that the foundation of any agroecosystem is a healthy soil that teems with life capable of moving nutrients into the plants’ roots.





- Promoting genetic diversity of crops and animals by integrating the objectives of biodiversity conservation with that of food production. This means the choice should not be either to conserve biodiversity or to produce food, but how to completely move away from monoculture and start to diversify **crop selection** (i.e. what to plant), **crop cycle** (i.e. when to plant them) and **cropping pattern** (i.e. proportion of area under various crops at a point of time), in addition to integrating livestock and other farm animals into the food production. It's important to remember that the more diverse the farm, the more resilient it becomes against pest epidemics, genetic pollution (such as cross-pollination of unwanted GM crops), and climate variability such as excessive rain or prolonged drought. A diverse farm is also more food secure. Take for example a 2-hectare farm with fruit trees, firewood trees, banana trees, plots of land planted with pulses, a small chicken coop, a small fishpond, plots of land planted with herbs and vegetables, a strip of land grown with maize, another strip of land with millets, all of this on top of areas devoted to wheat and rice. Compare this with a 2-hectare farm with only either wheat or rice. Which farm would most likely survive a prolonged drought, or a stem-borer pest epidemic? Which farmer would have likely survive for a month should there be a market shutdown? A farmer with only 1 crop ravaged by stem-borer would be done with instantly. A farmer with 10 crops, 2 of which got ravaged by stem-borer, would still have 8 more crops to look forward to.

- Minimising resource losses by increasing soil cover (i.e. through cover crops mentioned above, which prevents erosion at the same time conserves soil moisture), facilitating water harvesting (e.g. from small springs or from rain water through the establishment of small water-impounding pond) or managing micro-climate (i.e. the climate within the farm, by planting trees that act as windbreaks or shield against too much sunlight) which all add up to a productive, resilient and sustainable agroecosystem. Water is the second most important resource for agriculture next to the soil, and needs to be conserved.

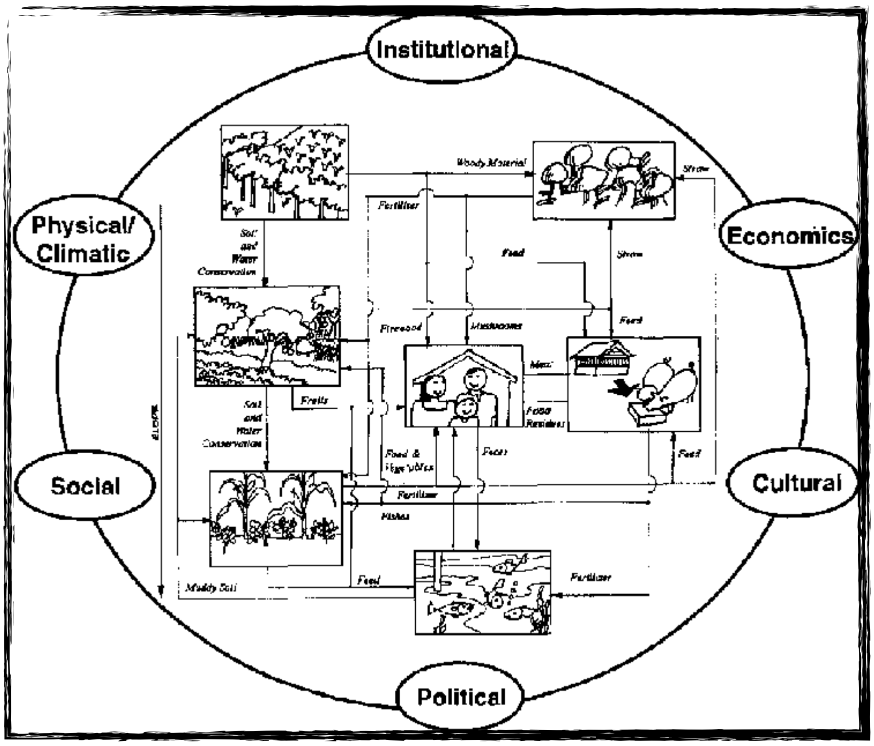
- Enriching and further developing farmers' innovations that conserve, revalue and allow exchange of agroecological practices particularly those coming from traditional ecological knowledge systems. Simple innovations such as use of insect traps (could be made from local materials) instead of insecticides that harm other non-pest insects, or use of animal drawn plough instead of a tractor to minimise soil compaction, or terracing the uneven rice field instead of flattening it to conserve soil. There are many existing examples farmers' innovations derived from indigenous knowledge systems, thus intrinsic in this principle is the idea that farmers should learn from fellow farmers especially from the long traditions of indigenous farming. Farmers can and should rediscover the old practices. This is where farmers' exchanges and farm visits are useful. Agroecology is a process of continuous learning that builds up knowledge and practice. This is why at the core of agroecology is the use of traditional seeds in the context of rediscovering and reviving traditional ecological knowledge systems – that indigenous body of knowledge, practice, way of thinking and revaluing things that goes beyond the metrics of science and economics.

Exercise # 1: *Let's review your collective experience with the old and modern way of farming. Please group yourselves in two: those who were born in the 1950s or earlier and those who were born in the 1960s or later. Before the 1960s, what crops were you or your father / grandfather growing? How much income did you or your family make per cropping* season? Was it enough for the family's needs, or did you incur debts from usurers or banks? When modern farming came – seeds, fertilisers, pesticides, machineries – was it a big change for you in how you prepare the land, manage soil fertility and grow crops? Was there a big improvement in your income, or did you still incur debts?

Compare the experience. What are the benefits of modern seeds and modern farming? What are the disadvantages or negative impacts, if any? What are the benefits of traditional seeds and traditional farming? What are the disadvantages or negative impacts, if any? Write your observations in four columns and discuss it with the rest of the group. What is the common picture that emerges? Was modern farming a big improvement from the earlier farming system? Did it change the way you think about agricultural production? What are the main lessons you learned from the shift to modern farming?

3. The conversion process

There are no fixed rules in transitioning to agroecology. Farmers take different approaches in their farm conversion. Some take a drastic overhaul of their farming system in one season, others take a longer period adding or modifying one farm component after another (e.g. integrating *insectary strips* or strips of land planted with insect-repellant crops in between plots of vegetable crops to deter insect pests). It all depends on the existing resource conditions and available human capital (knowledge and creativity) in the farm. Those in the uplands or rolling hills sometimes prioritise adding components that conserve water, prevent erosion and build soil fertility at the same time. This can include creating small water impounding system (to collect rainwater), establishing hedgerows or a mini-forest in steep inclines, or planting cover crops on exposed soil. On the other hand, those in the lowlands with access to irrigation may prioritise experimenting on different crop combinations that complement each other and have different harvesting period, maximise economic returns and minimise pest epidemics. This can include mixing annual and perennial crops, planting feed and fodder crops, raising ducks or a small fishpond.



Generally, the conversion process can be divided into three different phases outlined below.

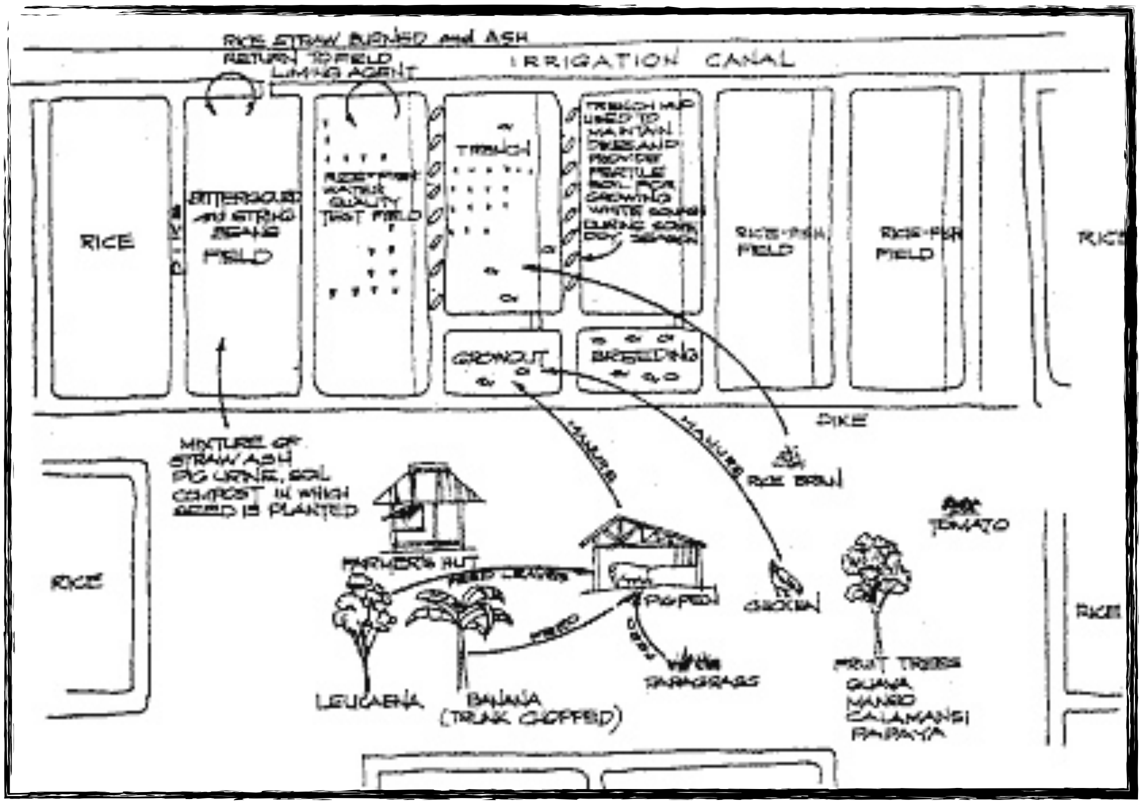
Phase 1: *Farmers start to reduce the use of costly or environmentally damaging inputs like chemical fertilisers and pesticides.* In this starting phase, farmers are still reluctant but nevertheless try reducing the amount and frequency of applying DAP and urea in the farm, as well as synthetic herbicides and insecticides. At times they will be tempted to switch back to the old ways. Thus it is crucial to have a “support system” where farmers are encouraged to soldier on with the planned changes. The additional cost of chemicals and the thought that these destroy the ecological balance in the farm should be used as motivation to reduce chemical use. In this phase, farmers try to be reactive in approach rather than proactive, applying chemicals only when necessary, e.g. only when the crops are being ravaged by pests or leaves are already drying out.

Phase 2: *Farmers start substituting conventional inputs and practices with alternative approaches.* In this phase, farmers recycle nutrients with increased dependence on natural processes such as biological nitrogen fixation. They experiment on other means of soil fertilisation like green manuring (e.g. growing leguminous plants such as groundnut and ploughing them back into the soil) or adding compost to condition the soil. They emphasise the conservation of soil, water, energy, and biological resources through simple erosion control measures like planting cover crops in denuded areas, or constructing a small water-impounding pond that would increase the volume of water to be used by other crops or livestock. In this phase, farmers no longer burn the sources of biomass in the farm (leaves, stalks, branches, etc.) but turn them into compost. Know that all biomass has carbon, so when you burn them, you contribute to carbon emission! Biological resources (plants, animals, insects, fungi, bacteria) both above and below the soil play important roles in the healthy balance of an ecosystem which makes a productive and sustainable agricultural system. They can get easily eradicated with synthetic chemicals. Conserving them means putting a stop to the use of chemical fertilisers and pesticides. The soil is not just a medium to grow crops; it is an ecosystem in itself that needs to be kept healthy for it to be able to sustain life above it.

In this phase, farmers start to manage pests, diseases and weeds instead of “controlling” them through logical integration of various tactics like use of resistant varieties, modifications of pest environment (timely sowing, water management, crop combination with insect repellent crops) conservation and utilisation of bio-control agents (parasitoids, predators etc). Farmers also re-establish the biological relationships that can occur naturally in the farm like allowing the population of beneficial insects (e.g. praying mantis, grasshoppers) and other predators (spiders, frogs, snakes, etc.) to increase and feed on insect pests or animals. In this phase, awareness is raised not to kill these beneficial creatures in the farm. The presence of snakes, for example, can prevent rodents from overpopulating and feeding on crops like wheat or rice. Meanwhile, weeds are a good source of biomass, and instead of spraying them with herbicides, pull them out of the soil and put them in the compost pit. When there is natural balance in the farm, the ecosystem can regulate itself, predators will find new preys, and healthy crops will outcompete weeds.

Phase 3: *Farmers start redesigning agroecosystems to function on the basis of a new set of ecological processes.* In this phase, farmers are no longer just concerned about food production but of the sustainable provision of ecological goods and services. They no longer think narrowly in terms of how many tons of wheat will be produced in a 2-hectare farm in a particular cropping season, but how many different kinds of **goods** (e.g. food, feed, fibre, fuel, herbal medicines, botanical pesticides, etc.) and **services** (e.g. erosion control from soil cover crops, additional labour from draft animals, etc.) can be generated from the farm to sustain the family's needs for the long term.

Also in this phase, farmers make more appropriate matches between cropping patterns (the proportion of area under various crops at a particular time) and the productive potential and physical limitations of the farm landscape. This means when planning to diversify the farm into production of several crops (e.g. farmer decides to grow fruit trees, herbs, leafy vegetables, root crops, maize, wheat), they consider the topography or terrain of the farm landscape and allocate areas best suited for each crop. Example, if it's a rolling area with differing soil quality, then maybe the rocky areas are not best grown with leafy vegetables and herbs because these need good soil, the shaded areas may not be best for maize which needs more sunlight, if there is a swampy area, it may not be the best location to put the orchard as tree seedlings may suffer water stress, etc. In this phase, farmers also value most highly the overall health of the agroecosystem rather than the outcome of a particular cropping season. The long-term sustainability of all the resources needed to grow food and other needs – seeds, soil, sunlight, water, biological resources, etc. – becomes their primary motivation in the agroecosystem design and management.



As one transitions into agroecology though these phases, it is important to keep track of the progress by monitoring changes in the farm of ecological processes (e.g. predator-prey balance) and yield changes associated with the changing of practices, inputs, designs, and management. For example, since the time of reducing the amount of environmentally damaging chemical inputs, notice the presence of spiders, grasshoppers or frogs. These beneficial creatures are indicators of a healthy predator-prey balance that could easily arrest any insect pest resurgence. Since the time of substituting those chemical inputs with alternative approaches in soil fertilisation (like composting) and pest management (like planting insect repellant crops beside plots of vegetable crops), notice the improvement in the quality and quantity of agricultural produce. All these changes need to be monitored and understood in the context of sustainability vis-a-vis efficient energy and resource use, as well as profitability.

Exercise #2: *Watch the videos on diversified and integrated farming systems. Take note of the different components of the farming system, as well as the process and techniques employed. Now conceive your ideal farm as an exercise whether you have understood the concept of diversification and integration. Draw your conceptual farm in a piece of paper and share with the rest of the group. Describe its terrain – is it all flat and irrigated or rolling hills in the upland? What resources are available – is there a source of irrigation water, etc? What sort of crops and livestocks are you going to cultivate and raise? What sort of non-crops (e.g. grasses used erosion control and animal fodder, fast-growing trees for fuel wood, etc.) are you planning to cultivate and in which part of the farm? Try to identify at least three ecological goods and services that are present in your ideal farm.*

4. Diversified and integrated farming system

Diversity exists in different hierarchical levels: ecosystem, habitat, biological resources or "biodiversity", species, and genetic. When you hold a seed of traditional wheat cultivar, you can say that it represents one of the many genetic diversity of wheat, that represents one of the many diversity of plant species, of the millions of living kinds, that can be found in one of the many different wheat agroecosystems. In short, the seed you hold is a tiny speck in a multitude of diversity.

Genetic diversity is the diversity of genes within a species. It describes the genetic variability among the populations and individuals of the same species. Example: rice has different cultivars and wild relatives that have different characteristics such as being early or late maturing, having resistance to pest and diseases, tall or short height, and so on. **Species diversity** on the other hand refers to the variety of species of animals, plants or micro-organisms. Examples of animal species are chicken, cow, goat, monkey, ox; examples of plant species are eggplant, ladyfinger, pumpkin, rice, wheat. Species of microorganisms include bacteria and fungi. When we refer to **biodiversity** it refers to the living entities in a particular ecosystem or habitat. For example marine animals, mountain insects, forest-dwelling mammals, temperate and tropical crop cultivars, etc. On the other hand, **habitat diversity** is the combination of all biotic (living) and abiotic (nonliving) factors in a defined area, interacting and functioning as a loose unit. It is dynamic and complex. Examples of habitat diversity includes a decaying wood home to termites, marshlands home to crocodiles and eels, a cave that serves as refuge for bats. **Ecosystem diversity** is the variability in ecological conditions, resources and carrying capacity of an area determined by its existing climate, topography, vegetation and other biotic and abiotic factors. Examples are marine or coastal ecosystem, upland or terrestrial ecosystem.

Diversity alone may not always result to greater agricultural productivity. An unperturbed forest, for example, may have a very high diversity but have zero agricultural productivity. Thus our interest is in functional diversity, where integrating different farm components and deliberately creating links between them, enhances resource use efficiency resulting to a productive and sustainable system. It should be clear by now that when we talk about agroecology, we cannot include monoculture in our conversation; rather our reference point is always diversity, more specifically, functional diversity as exemplified in a diversified and integrated farming system (DIFS). There are many advantages of DIFS over a monoculture farm including provision of diverse source of food and income at various times of the year, while providing ecological stability throughout its productive lifetime.

Box 1: Advantages of a Diversified and Integrated Farming System

- Results in higher production of nutritious food and animal fodder by cultivating a range of crops and raising livestocks that are rich in carbohydrates, fats, fibre, minerals and vitamins.
- Ensures regular and stable income through various farm products (e.g. eggs, milk, mushroom, vegetables, honey, silkworm, etc) from the linked activities in integrated farming.
- Reduces production cost and promotes soil fertility and productivity through recycling of organic wastes and by-products.
- Helps solve the energy crisis and preserve the natural forests by integrating agro-forestry and bio-gas production that can meet the fuel and construction needs of the family.

In DIFS, the farming system is designed not just to produce food, but fulfil other objectives such as biodiversity conservation, environmental protection and natural resource management. The ability of the system to perform all these functions add up to its being food secure and ecologically resilient amidst climate change. Below are some examples of this functional diversity used by farmers to manage pests and increase soil nutrients:

(1) Use of "trap crops" to attract pests so that they can be easily eliminated by destroying the trap crop and the pests all together. Trap crops can be cultivated either in between or surrounding the main crop. Examples: beans and legumes are intercropped with corn to control leaf hopper and stalk borer; Cotton bollworm prefers the corn crop but lays eggs on cotton when it is grown as a sole crop. When a few rows of corn are grown alongside cotton, the eggs that are preferentially laid on corn are collected and destroyed; tomatoes are planted in pineapple plantation to serve as host for nematode. Tomatoes are harvested and destroyed before the nematodes can multiply.

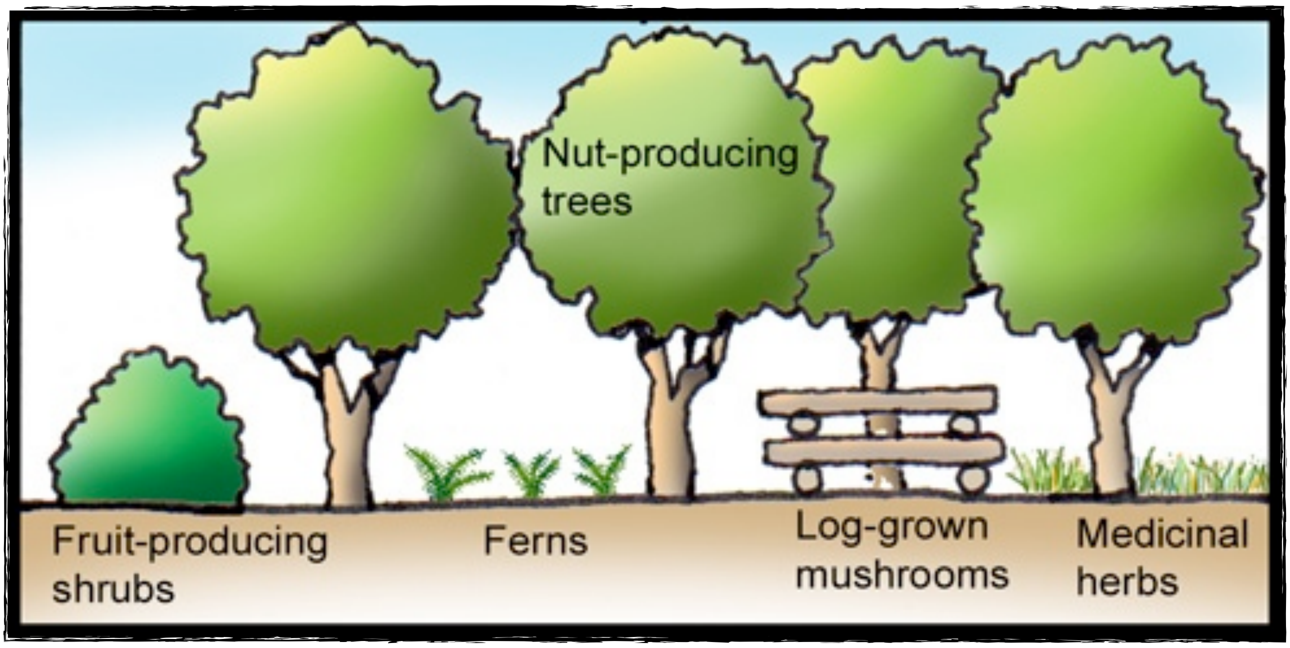
(2) Biochemical pest suppression using plants that release chemicals (from the roots, stems or leaves) that suppress or repel pests and protect neighbouring plants. For example, Marigold (*Calendula officinalis*) naturally releases *thiopene (also commonly*

known as thiofuran), a nematode repellent chemical compund, that makes it a good companion for a number of crops infested with this pest.
(3) Planting companion plants to provide a desirable environment for beneficial insects and other arthropods, especially those predatory and parasitic species that help in keeping pest populations in check.
(4) Maximising symbiotic nitrogen fixation using leguminous plants (beans, peas) that can fix atmospheric nitrogen for their own use and for the benefit of neighbouring plants through symbiotic relationship with rhizobium bacteria.
(5) Protecting the soil surface from intense sunlight, wind erosion and rain using cover crops. Plants used as cover and green manure usually belong to legume family like mungbean (*Vigna radiata*), sesbania (*Sesbania rostrata*), pigeon pea (*Cajanus cajan*).

5. Examples of DIFS

☛ Multi-storey cropping

In multi-storey cropping, land is maximised by planting different kinds of perennial and annual crops. Different crops of different root depths are combined to avoid competition in water and nutrients. Plantings consist of an overstory of trees or shrubs with an understory of specialty or agronomic crops or forage. Tree-to-tree distance is kept sufficiently wide to allow adequate light to the understory crops or forage and permit passage of the widest field equipment width. Generally, mature tree canopy ranges from 5 to 40 percent crown cover.



The objectives of multi-storey cropping are: to produce wood or tree products along with agronomic crops or forage; improve crop or forage quality and quantity by enhancing microclimatic conditions; improve utilisation and recycling of soil nutrients for crop or forage use; reduce excess subsurface water or control water table depths; provide favourable habitat for species beneficial to crops or forage.

One of the most productive and profitable cropping system in the Philippines is the multi-storey system developed and practiced in the Cavite and Batangas, both coffee-producing provinces. Farmers use coffee as the main intercrop where they derived income of more than PhP 300,000 (US$ 6,200) per hectare per year. In other provinces, farmers use coconut as main intercrop. Some combinations include:

Coconut + Papaya + Pineapple + Taro
Coconut + Upland rice + Pineapple + Daisy + Banana + Sweet potato + Chayote + Ginger
Coconut + Coffee + Upland rice + Corn + Papaya + Pineapple
Coconut + Banana + Lanzones + Coffee + Taro
Coconut + Papaya + Banana + Gliricidia sepium + Black pepper + Gabi + Pineapple

☛ Sloping Agricultural Land Technology

The Sloping Agricultural Land Technology (SALT) is a way of farming in hilly areas that can turn a sloping parcel of land into a highly productive agroforestry farm. It enables farmers to stabilise and enrich the soil while growing food crops of nutritional and economic importance. It is a relatively simple, practical, low-cost, and appropriate method of diversified farming on sloping land that aims to sustain maximum benefit and minimise soil erosion at different altitudes.

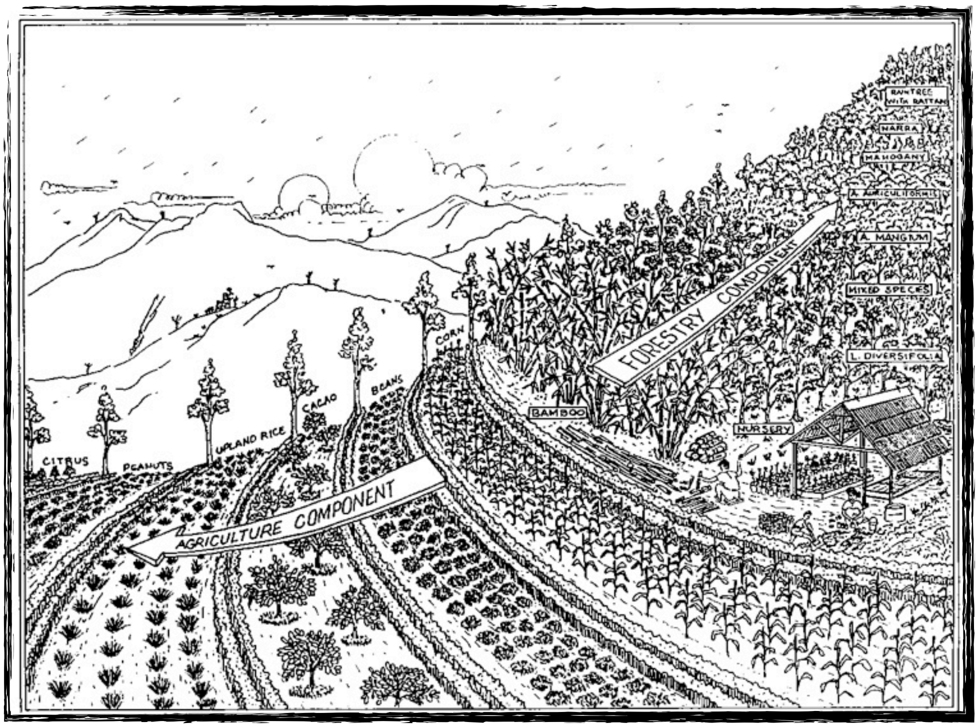
There are four models of SALT:

a. Forestry and staple crop combination (SALT model 1): This model focuses mainly on food crop production. It is simple in application, low in cost, but is an effective agroforestry technology with agricultural crops and forestry in a ratio of 3:1. Compared to traditional upland farming management practices, this technology substantially decreases erosion. This phase is staple food introduction and forestry rehabilitation.

b. Agro-livestock Integration (SALT model 2): This model focuses on agro-livestock technology. It is a simple modification of SALT 1 in the sense that it integrates livestock rearing with crop cultivation. The livestock species that can be raised under the system are cattle, sheep, and goats. The manure is a good source of fertiliser. Goats are potential source of milk, meat, hair and skin.

c. Agro-forestry diversification (SALT model 3): This model has three components – SALT 1, SALT 2, and a separate plot of land to produce valuable timber. Farmers owning landholdings of about two hectares can use this model.

d. Agro-forestry diversification and enterprise (SALT model 4): This focuses on agro-forestry or crop-based system known as the agro-fruit livelihood technology. To improve hill agriculture and economics, commercialisation of hill agriculture is required. The objectives of this model are to produce food, increase cash income, and conserve soil on farmlands.



Whatever model one chooses, the high productivity of diversified and integrated farms is elaborated by Rosset (2000) who found that in every country where data are available, smaller farms which typically mix and integrate different crops are anywhere from 200 to 1,000 percent more productive per unit area than large monoculture farms. This is because farmers in smaller farms tend to maximise the space resulting to more complex farming system that gets more total production per unit area, as rows of crops are combined to produce something useful to the farming household.[2] In a study of peasant farming in Latin America, Altieri (2009) described the common configuration of DFS as having grains, fruits, vegetables, fodder, and animal products in the same field or garden.[3] He noted that productivity of harvestable products per unit area is higher by 20-60% yield advantage than under a single crop with the same level of management.

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2 Rosset, P. 2000. *The Case for Small Farms, an interview.* Multinational Monitor, Vol. 21, Numbers 7 & 8. http://www.multinationalmonitor.org/mm2000/00july-aug/interview.html

3 Altieri, M. A. 2009. *Agroecology, Small Farms, and Food Sovereignty*. Monthly Review, Vol. 61, Issue 3. http://monthlyreview.org/2009/07/01/agroecology-small-farms-and-food-sovereignty

Compared to other agricultural systems, diversified and integrated farming system mimics more complex natural systems and highlights the critical reciprocity between functional diversity and ecosystem services that provide critical inputs to agriculture. These include energy and water use efficiency, pest and disease resistance, pollination, soil fertility, water-holding capacity in surface soils, and resistance to climate change. The generation and regeneration of these ecological goods and services become its own incentives to maintain the system thereby increasing its ability to provision such goods and services sustainably.[4]

Resistance to climate change is a particularly noteworthy attribute, as the worst hit during typhoons, floods or severe drought are usually farming communities engaged in monoculture. In a study by Holt-Gimenez (2001) in Central America, farmers using sustainable practices such as intercropping and agroforestry suffered less damage from Hurricane Mitch in 1998, compared to conventional farms. The study surveyed 360 communities across Nicaragua, Honduras, and Guatemala, and found that this was because diversified farms had 20-40% more topsoil, greater soil moisture, and less erosion" compared to conventional farms that suffered tremendous economic losses.[5]

A research study analysed the productivity, resilience and sustainability of diversified and integrated farming system in an agrarian community in the Philippines.[6] Productivity was indicated by the utilisation of multiple farm space for different crops that serve various purpose and usage, and satisfies household consumption on top of deriving income from farm surpluses. Resilience on the other hand was indicated by tolerance or adaptability to climatic disturbance, stress and variability. Sustainability was indicated by the integration of nutrient cycling and soil and water conservation, as well as promotion of food and nutrition security and collective action to manage resources. The study found that farmers who cultivate more annual crops (or short duration crops) tend to be more productive than those growing more perennial crops (long-term crops). Those whose systems grow more perennial crops and cover grasses tended to be more resilient to climatic disturbance, stress and variability. Farmers whose systems grow more multipurpose trees and perennial crops tended to be more sustainable. However, it was the combination of annual and perennial crops with multipurpose trees and grasses that tended to have the highest

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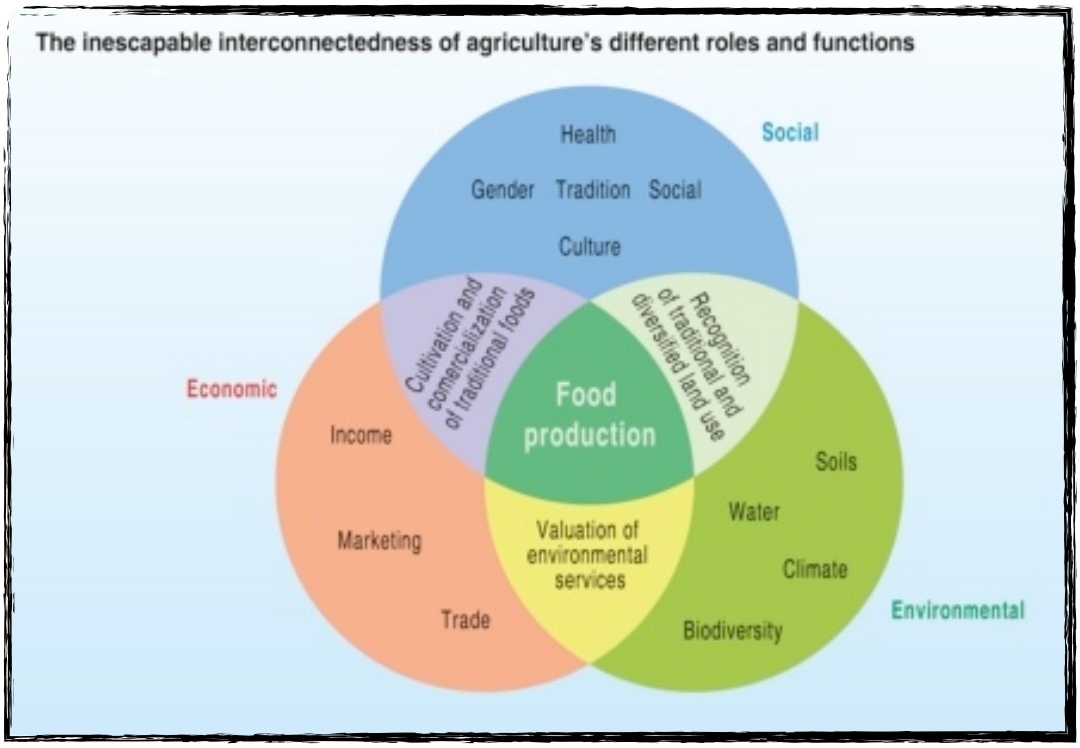
5 Kremen, C., A. Iles, and C. Bacon. 2012. *Diversified Farming Systems: An Agroecological, Systems-based Alternative to Modern Industrial Agriculture*. Ecology and Society 17(4): 44. http://dx.doi.org/10.5751/ES-05103-170444

6 Holt-Gimenez, E. 2001. *Measuring Farms Agroecological Resistance to Hurricane Mitch*, LEISA 17: 18-20. http://pubs.iied.org/pdfs/6354IIED.pdf

6 Rivera, V.E. 2015. *Assessing the Productivity, Resilience and Sustainability of Diversified Farming System as an Agroecological Approach to Upland Resource Management*. Journal of Management and Development Studies. http://fmds.upou.edu.ph/journal/upload/pdf/RiveraVladymir-Abstract.pdf

All of the studied farmers were cultivating various combinations of **annual crops** such as green beans (Paseolus vulgaris); string beans (Vigna unguiculata); cabbage (Brassica oleracea); chili pepper (Capsicum annuum); cowpea (Vigna sinensis); cucumber (Cucumis sativus); eggplant (Solanum melongena); bitter gourd (Momordica charantia); bottle gourd (Lagenaria siceraria); sponge gourd (Luffa cylindrica); lettuce (Lactuca sativa); mustard greens (Brassica juncea); okra (Abelmoschus esculentus); peanut (Arachis hypogaea); pechay (Brassica rapa); squash (Cucurbita maxima); sweet potato (Ipomoea batatas) and tomato (Solanum lycopersicum); **perennial crops** such as mango (Mangifera indica); banana (Musa x paradisiaca); coffee (Coffea liberica); jackfruit (Artocarpus heterophyllus); papaya (Carica papaya); pineapple (Ananas comosus) and rambutan (Nephelium lappaceum); **insect-repellant crops** such as cillantro (Coriandrum sativum); oregano (Origanum vulgare) and marigold (Tagetes patula); **multipurpose trees** such as ipil-ipil (Leucaena leucocephala); madre de cacao (Gliricidia sepium); and **cover grasses** such as napier grass (Pennisetum purpureum) and vetiver grass (Chrysopogon zizanioides).

productivity, resilience and sustainability regardless of the size of farmland. The study concluded that farm diversification and integration results in higher productivity because it allows farmers to maximise farm space to cultivate a range of crops and plants that serve different purpose and usage. This optimises the interactions between farm components and widens the range of available ecological services.



Exercise 3: *Plan a farmers exchange in either Nepal, Sri Lanka, Thailand, or Philippines to visit examples of diversified and integrated farms. Try to learn how the farmers have gone through the conversion process, and the lessons to be learnt from their experience.*

"The Conversion Process: From Monoculture to Multifunctional Agriculture" was researched, written and developed by **Vlady Rivera** for **Roots for Equity** as part of a training module series on agroecology. For comments and questions, contact: rivera.vlady@gmail.com