# From Seed Sovereignty to Peasant Agroecology

*A framework for reclaiming peasant' seeds and re-establishing productive, resilient and sustainable agroecosystems in Pakistan*

## 1. Introduction

Seeds are the foundation of agriculture which forms the bedrock of our food system. Without seeds, agriculture will not thrive, much less sustain the food needs of our population. The seeds we have, define the food we eat. The higher the seed diversity the wider the range of options to shape our food systems. More options to produce food means better food and nutrition security. Unfortunately this is not the way agriculture is structured today. In the last 50 years since the Green Revolution, the model of agriculture that governments and agricultural research institutions have been promoting prescribes the use of genetically uniform modern seeds that are dependent on fertilisers and pesticides and grown in plantation-style monoculture. The result: despite the resulting higher farm efficiency and productivity, there are currently 795 million hungry people (or 1 in every 9 of the 7.3 billion population) suffering from chronic undernourishment, almost all of them live in developing countries where much of the agricultural production take place.[1]

Critical views about the industrial food system have surfaced prominently in recent years. While global grain production has nearly tripled since 1961, only less than half (48%) of the total grain ends up being consumed by people; the rest goes to animal feeds (35%) and a small but increasing percentage (17%) goes to production of ethanol and other fuels.[2] These food and production systems fail to meet our food needs due among other reasons to imbalanced concentration of wealth and power resulting to imbalanced consumption pattern, geographic concentration of production, forced export, food wastage, and crop use diversion (e.g. into biofuels). But not only does industrial agriculture make more people hungry, it is also driving the planet warmer as it accounts for almost 25% of anthropogenic green house gas (GHG) emissions, including $CO2$ emissions from deforestation and peatland drainage, methane ($NH4$) emitted from livestock and rice cultivation, and nitrous oxide ($N2O$) emissions from the use of synthetic fertilizers and animal manure on soils and pasture.[3] Notably, methane and nitrous oxide have higher global warming potential (at least 25 times and 300 times, respectively) than $CO2$ over a period of 100 years.[4]

The failures of industrial agriculture have given agroecology new currency and momentum. Two important reports propped this up. In 2009, the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) concluded that chemical-intensive industrial agriculture has degraded the natural resource base on which human survival depends and currently threatens water, energy and climate security. The report called for a radical transformation of the world's food and agricultural system, practices, institutions and policies, including a shift towards agroecology, a focus on small-scale farmers, and an

---

1 FAO, 2015. *The State of Food Insecurity in the World. Meeting the 2015 International Hunger Targets: Taking Stock of Uneven Progress*. http://fao.org/3/a-i4646e.pdf; See also: *2015 World Hunger and Poverty Facts and Statistics*. http://www.worldhunger.org/articles/Learn/world%20hunger%20facts%202002.htm#Number_of_hungry_people_in_the_world

2 FAO. *Crop Prospects and Food Situation*.http://www.fao.org/giews/english/cpfs/ ; also Worldwatch Institute, *Grain Harvest Sets Record, But Supplies Still Tight*. http://www.worldwatch.org/node/5539

3 Frances Moore Lappé, 2016 April. *Farming for a Small Planet: Agroecology Now*. http://www.greattransition.org/publication/farming-for-a-small-planet#section-title-seven

4 US EPA. *Overview of Greenhouse Gases.* https://www3.epa.gov/climatechange/ghgemissions/gases/ch4.html

emphasis on food democracy.[5] In 2013, the UNCTAD's Trade and Environment Review (2013) participated in by 60 international experts, drew attention to the inability of monoculture and industrial farming methods to provide sufficient and affordable food, while at the same time causing massive environmental damage including nitrogen contamination of soil and water and loss of biodiversity. The report concluded that a shift is necessary towards diverse production patterns that enhance closed nutrient cycles and reflect the "multi-functionality" of agriculture.[6]

## 2. Understanding agroecology beyond the rhetoric

### *2.a. Agroecology as science*

A number of literatures define agroecology as the science of applying ecological concepts and principles to the design, development, and management of sustainable agricultural systems. These include concepts of biological regulation, diversity, efficiency and interactions, and the principles of recycling and synergies – all of them shaped inherently by the prevailing social and ecological contexts including natural resource management practices across communities and landscapes. As a scientific discipline, agroecology questions the dominant agronomic model of production that is reliant on intensive use of external inputs. It also questions the dominant ecological model that separates the protection of biodiversity and nature from the production of food and other natural goods, such as in the case of driving away communities. Instead it proposes that both objectives should coexist complementarily and sustainably, as the basis of human-environment and nature-society interactions.

To understand this, it's important to recognise the concept of ecological "goods and services" such as biodiversity, soil quality, habitat for living organisms, maintenance of clean water and air, etc. These are goods and services found in nature provided through a complex chain of interdependent systems which could be harnessed or interrupted by human-environment interaction. Natural disasters such as typhoon or volcanic eruption, or human-induced degradation like mining, forest clearing, and plantation monoculture can lead to disruption of those interdependent systems resulting to partial or total ecosystem collapse. Take soil health, for example. By constantly using pesticides (which always ends up in the soil), the population of soil bacteria that mobilise various nutrients in the soil (like fixing nitrogen) and make them available for plant uptake, may be highly reduced disabling them to perform such function. In this situation, even if a farmer adds fertilisers (e.g. urea, DAP) it would take a very long time for the plant to take them up, if at all. Yet thinking the amount of fertiliser added was not enough, the farmer adds more urea, further increasing the acidity of the soil which then kills other soil microbes responsible for mobilising other nutrients. This is an example of a soil ecosystem collapse.

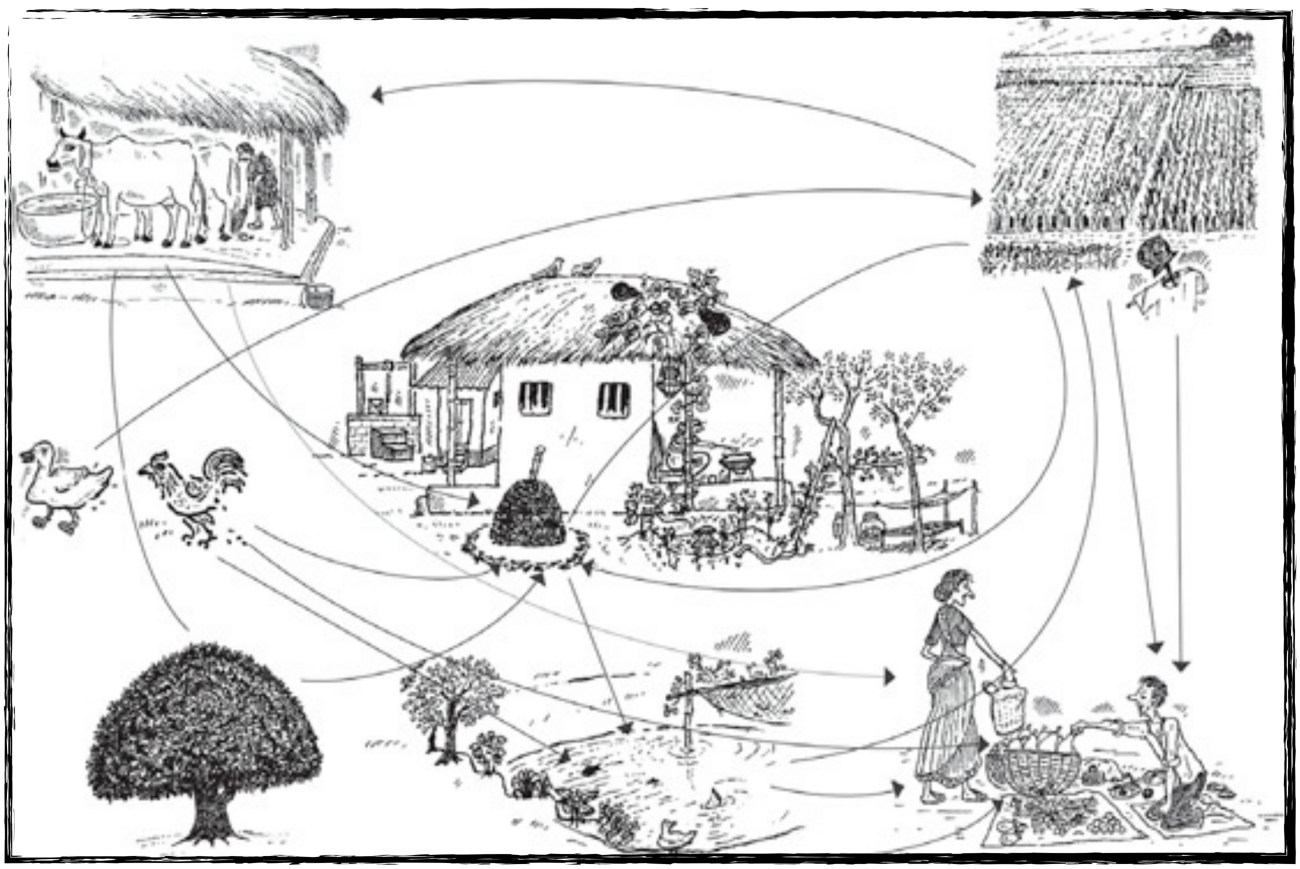
Compared to other agricultural systems, an agroecosystem intentionally includes functional biodiversity, or those plants and animal species that serve particular functions in the farm

---

5 McIntyre, Beverly D., Hans R. Herren, Judi Wakhungu and Robert T. Watson (ed). 2009. International Assessment of Agricultural Knowledge, Science and Technology for Development. Island Press, Washington DC. http://www.unep.org/dewa/Assessments/Ecosystems/IAASTD/tabid/105853/Default.aspx

6 UNCTAD, 2013. Wake Up Before It's Too Late, Trade And Environment Review. http://unctad.org/en/pages/PublicationWebflyer.aspx?publicationid=666

such as sources of fodder (grasses), fuelwood (fast-growing trees), biomass for composting, fertilisers (like cow dung), erosion control (cover crops, grasses, and hedges), pest control (like botanical pesticides from various herbs), etc. Unlike natural biodiversity in the wild or in a forest ecosystem which tend to be more random, “functional biodiversity” in an agroecosystem is rearranged by humans for specific functions and purpose that drives the productivity and sustainability of the farm. In other words, the configuration of the diversity that one will find in an agroecosystem is not what nature originally intends it to be, but what a farmer has designed it to be. Designing a farm is much like building a house, one includes components that serve particular uses and arranges them in ways that link them functionally with each other (e.g. the food and drink pantry being in or close to the kitchen, the garage in front, etc.). Unlike house components, functional biodiversity in an agroecosystem promote “biotic interactions” among them that complement or reinforce each other's existence (e.g. fodder grasses gets eaten by animals whose manure becomes fertilisers that enrich the soil that in turn makes fodder grasses and other crops grow well). Hence, as the structure and function of the farm ecosystem evolve, these functional links within biodiversity also evolve, making agricultural production the conduit in the sustainable generation and regeneration of ecological goods (such as soil, water and habitat) and services (such as erosion control).[7]



[7] 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

### *2.b. Agroecology as practice*

Practitioners of agroecology take conscious effort to balance the interest of supporting human livelihood through agricultural production and the sustainability of provisioning ecological goods and services. Thus, as a practice, agroecology embodies not just a set of production techniques, but an ethos of managing the environment and sustainably using its resources. Below are some general principles in the practice of agroecology:

- Improving soil conditions by reducing or eliminating dependence on external, synthetic inputs. The foundation of any agroecosystem is a healthy soil that teems with life capable of moving nutrients into the plants' roots. This means improving organic matter content (which is increased through addition of compost and manure, as well as planting of cover crops and minimising tillage) and 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 instead of burning them, thereby storing carbon along with nitrogen into the soil rather than emitting them into the air).
- Promoting genetic diversity of crops and animals by integrating the objectives of biodiversity conservation with that of food production. This means completely moving away from monoculture and starting 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.
- Enhancing interaction of different elements of the agroecosystem by integrating crop and animal production, designing agroforestry systems, or employing pest management strategies rather than pest eradication. This means integrating short-term and long-term objectives by considering optimum total farm productivity (including by-products of crops and animals) rather than aiming obsessively for maximum yields of specific crops. This implies that the emphasis should be in improving the overall farming system including the integration of its different components rather than just the varieties of crops or breeds of livestock.
- Minimising resource losses by increasing soil cover (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.
- Enriching and further developing farmers' innovations that conserve, revalue and allow exchange of agroecological practices particularly those coming from traditional ecological knowledge systems.

There are many examples of an agroecosystem and its components, which may include polycultures, crop-livestock integration, non-crop plantings such as insectary strips, rotation of crops or livestock over time including cover cropping and rotational grazing, living fences and hedgerows. The configuration may vary but at its core are agroecological principles that represent both a farming system and a natural resource management regime. The traditional practice of shifting cultivation entails rotation of crops and livestock in combination with fallow periods, which then ensure the recovery of soil fertility. Spain's *dehesa* systems represent an example of integrated land use, utilising shifting cultivation of cereals and pulses in sparse wood pasture used for animal grazing. The *satoyama* landscapes in Japan are characterised by a mosaic of terrestrial and aquatic systems including woodland, grassland, paddy field, farmland, irrigation ponds and canals. The *Hani* rice terraces in Yunnan, China is another good example (Box 1). Notable among these examples are the extensive use of locally available and renewable resources, recycling of nutrients, management of diversity across seasons and geographic areas (e.g. through crop combination and rotation), reliance on local crop varieties, decision-making based on local knowledge and culture, and equal participation of men and women in the management and use of such systems.[8]

**Box 1: The Hani Rice Terraces in Yunnan, China**

*The 1,300-year old Hani rice terraces in the southeast part of China's Yunnan Province is home to rice diversity sprawled in 70,000 hectares of carved out paddy fields along the southern slopes of the Ailao Mountains. Though the number of traditional rice varieties has disappeared tremendously over the years, particularly with the Chinese government's drive to promote hybrid rice, more than 40 varieties have survived to this day, still being cultivated amongst the local farmers. The Hani people have conserved them by saving and exchanging seed varieties with surrounding villages.*

*Apart from rice, the terraced fields are also home to a large variety of aquatic flora and fauna such as fish, snail, eel, loach, shrimp, stone mussels, crab, ducks as well as aquatic plants. In the ridges between fields, crops like soybeans are planted. The system itself is said to constitute a unique system of energy and material flows. Part of surface rainfall runoff percolates into the underground water system, while the balance of the runoff and springs flow through the forests, villages and terraces. The flowing water carries nutrients from the forest litter, village sewage and waste, and soil into the layers of horizontal terraced fields. These nutrients and sediment are trapped*

8 Blasiak, Robert and Ichikawa, Kaoru, 2012. *Revitalising Socio-ecological Production Landscapes*. United Nations University. http://ourworld.unu.edu/en/revitalising-socio-ecological-production-landscapes

*and filtered in the terraced fields, improving soil fertility.*

*The spatial distribution of the different components of the system performs multiple ecological functions, including soil and water conservation, control of soil erosion, maintenance of system stability and water-purification. This shows how every space in the terraces is maximised and optimised to support a highly diversified and integrated food and farming system that can sustain itself and its people for many generations.*

Sources:
1. World Heritage Site http://worldheritagesite.org/tag.php?id=605
2. Globally important heritage systems http://en.wikipedia.org/wiki/Globally_Important_Agricultural_Heritage_Systems
3. FAO GIAHS booklet http://www.fao.org/fileadmin/templates/giahs/PDF/GIAHS_Booklet_EN_WEB2011.pdf

### *2.c. Agroecology as a burgeoning social movement*

Beyond the science and practice, agroecology encapsulates the antithesis of industrial agriculture and the globalised market economy that drives the pervading inequitable and unsustainable food system. In a broader sense, it embodies a post-development paradigm that challenges "growth" and "progress" as a result of western-style modernisation hinged on a number of flawed assumptions. That people starve because we are not producing enough. Hunger can be solved by increasing food production. Progress means replacing local varieties with modern ones. Peasants need to be modernised; agriculture needs to be industrialised. Integrating farmers into the global market increases production, income and quality of life. Biotechnology is the future of feeding the world.

Basic economics tell us that the quantity of production only partially determine the ability to meet the society's needs: whether it is food, other goods or services. Societal rules, norms, power relations – these all ultimately shape whether any given food, good or service produced would meet the needs of society. In many ways, how we grow food determines who can eat and who cannot, no matter how much we produce. During the Green Revolution in the 1970s, India was able to increase its production but hunger persisted and many farmers committed suicide out of desperation. An increase in the amount of food produced does not guarantee that hungry people will eat.

One has to look at Haiti, a country in the Caribbean, as a living example that replacing local varieties, modernising the peasants, industrialising agriculture and integrating production into the global market, do not necessarily increase income and the quality of life. It was the opposite, as the world has seen at the height of 2008 food crisis. Haiti was one of the worst hit and with the most number of casualties; a number of people went as far as eating mud to survive. A few decades back, Haiti was a picture of food self-sufficiency. In 1977 it even posted a record high of 67% growth rate in maize production, second most consumed cereal after rice, but it went downhill from there even reaching negative growth (-39%) in 1985.[9] Everything changed when it borrowed money from IMF-WB in the 1980s and restructured its agriculture to use modern seeds, produce export crops for world market, and feed its people through imports. Today Haiti is the world's leading producer of vetiver, a root plant used to

9 IndexMundi, 2016. *Haiti corn production by year.* http://www.indexmundi.com/agriculture/?country=ht&commodity=corn&graph=production

make luxury perfumes, essential oils and fragrances, providing for half the world's supply. For its food needs, the country relies on imports including 80% of its rice.[10]

Growth and progress through modernisation exemplified by industrial model of agriculture hide a number of inefficiencies. For example, the use of chemical fertilisers. On average, only half of the synthetic nitrogen fertiliser added to the soil is made available to plants, the other half is lost immediately to surface run-off (ending into waterways and ultimately oceans resulting in dead zones) and evaporation (adding to the air as potent greenhouse gas). Another inefficiency is the changing dietary pattern that allows the better-off minority (with increasing preference for meat-based diets) to shift production toward grain-fed animal foods, creating extremely poor feed-to-food conversion ratio, greatly diminishing the overall food supply. As a result, more than half of global grain production goes to animal feeds. Only 3% of the calories in those grain gets consumed by humans a beef. This is why agriculture in the United States alone, with a heavy focus on livestock production, is said to be feeding fewer people per acre than that of India or China.[11]

As a global alternative, agroecology is as much about exploring ways of sustainable and ecological production as it is about promoting equitable and socially just consumption. It puts the aspirations and needs of those who produce, distribute and consume food at the heart of food systems and policies rather than the demands of markets and corporations. Hence at the core of the movement is building food sovereignty and seed autonomy by recovering and revaluing peasant and indigenous seeds, offering a strategy to resist and dismantle the current corporate trade and food regime, and redirect it towards food, farming, pastoral and fisheries systems determined by local producers and consumers.

In many ways, the burgeoning movement behind agroecology is a combination of social, cultural and political processes that put emphasis in collective transformation and empowerment. By strengthening collective identity and rural expressions, patriarchy is challenged bringing new familial relationships where women and youth play key roles in the community. By promoting horizontal dialogue, peasants, indigenous peoples and academics bring together a fusion of scientific and traditional knowledge to the fore of agroecology's philosophy and practice. No other discourse on agriculture, food system or ecology with strong focus on indigenous peoples and small-scale farmers, has precipitated into a global alternative with the backing of numerous experts, scientists, intergovernmental bodies and social movements.[12]

---

[10] The Economist, 2013. *Feeding Haiti: A new menu*. http://www.economist.com/news/americas/21579875-government-tries-load-up-plates-poorest-people-americas-new-menu Retrieved 25 May 2016.

[11] Cassidy, Emily S., West, Paul C., Gerber, James S., and Foley, Jonathan A., 2013. *Redefining Agricultural Yields: From Tonnes to People Nourished Per Hectare.* Environmental Research Letters 8, no. 3. http://iopscience.iop.org/article/10.1088/1748-9326/8/3/034015/meta;jsessionid=0AB0E7AEA566379DDC70DDA2D4480AC0.c5.iopscience.cld.iop.org

[12] Some governments, like Brazil and France, are adopting agroecology policies as part of entire suite of food and climate change strategies, while at least a couple of international instruments consider the importance of agroecological approaches in land investments, such as the Voluntary Guidelines on Land Tenure, and the Principles for Responsible Investment in Agriculture and Food Systems.

## 3. Agroecology in the context of Pakistan

It is important to seize the global momentum on agroecology for peasants and small farmers to reclaim the very foundation of agriculture and the food system – biodiversity, land, livelihood, seeds – and pursue more autonomous and food sovereign future. However, this is easier said than done in the context of Pakistan, where much of the agricultural lands are degraded, farmers are trapped in monoculture mindset and vicious cycle of indebtedness, and patriarchal culture further reinforce the exploitative feudal structure of land ownership.

### *a. Land*

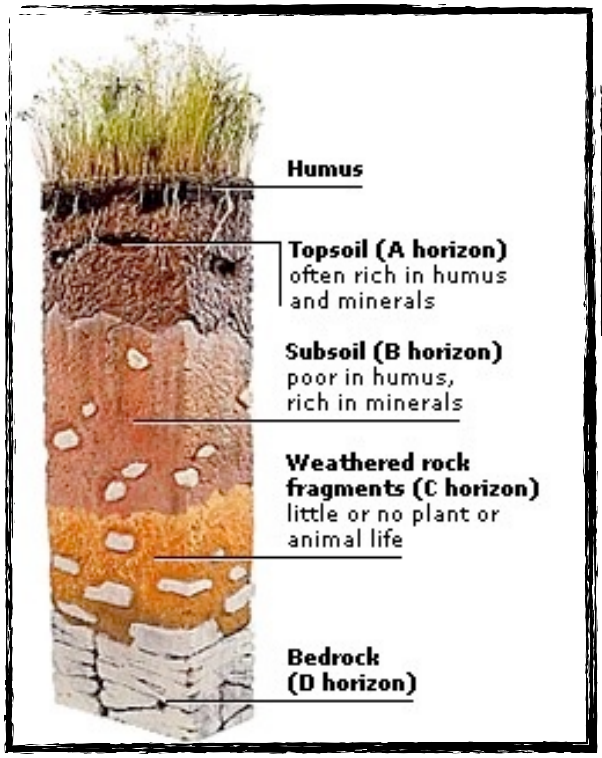
Pakistan's highly skewed land concentration poses the biggest challenge to the pursuit of agroecology. Only less than 1% of the farms comprise more than 25% of the total agricultural land in Pakistan. At the other extreme, about 65% of the farmers hold about two hectares or less, comprising only about 15% of the total farmland. Approximately 50 percent of the farmland is cultivated by tenants, including sharecroppers, most of whom had little security and few rights. An additional large number of landless rural inhabitants worked as agricultural labourers. Farm labourers and many tenants are extremely poor and undernourished. Large landowners retain their power over small farmers and tenants, especially in the interior of Sindh and in Southern Punjab. A third of Pakistan's farmers are tenants, including almost one-half of the farmers in Sindh. Tenant farmers typically give almost 50-60% of what they produce to landlords. In other cases, they shoulder half of the production cost but only get a quarter of the total produce.

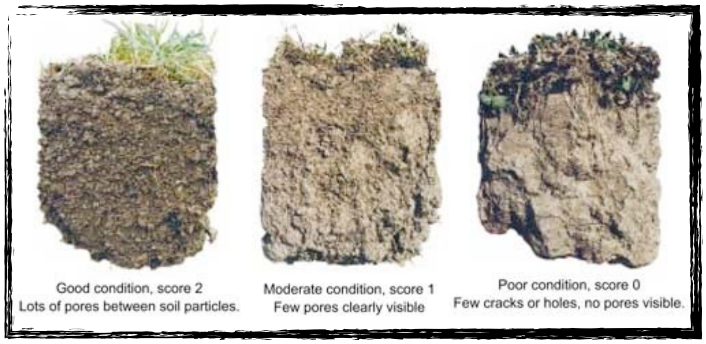
This feudal set-up makes Pakistan a perfect recipient of top-down agricultural modernisation programme – from Green Revolution to hybrids and GMOs. The situation is also conducive to foreign investments from countries looking to outsource their production through farmland acquisition. All this makes it difficult for any agroecological initiative to take root, unless linked to the overall struggle for land reform. It is therefore crucial to pursue agroecology in the context of challenging landlessness. This may mean adopting a multi-prong approach to getting access to land (legal challenge, extralegal, direct land occupation, etc,) or exploring means of collective farming through common land leases, where landless peasants and agricultural workers will have opportunities to participate and reap benefits.

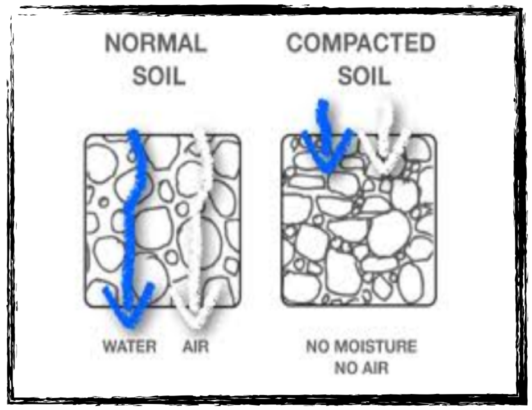
### *b. Soil*

Most of the soil in Pakistan's farmlands have been exhausted by continuous cultivation of rice and wheat and have become deficient in organic matter. The continuous monoculture that is dependent on modern seeds and heavy fertilisation, is the primary source of soil acidity, compaction and other forms of soil degradation. For the last 40 years, farmers have used urea and DAP (di-ammonium phosphate) at varying amounts nearly every planting season. With this alone, there is reason to suspect that most farmlands in Pakistan have already “overdosed” on nitrogen; that much of the reported pest problems and lower productivity have to do with soil acidity and nitrogen toxicity.

The need to establish a good baseline information on soil quality in Pakistan is crucial. At one level, this can be done through a simple soil test which measures the acidity as well as the nitrogen (N) phosphorous (P) and potassium (K) content in the soils used for agricultural




production. Agricultural research institutions usually have this soil test kit composed of a few chemicals and a *soil pH chart* (a chart indicating the soil acidity or alkalinity in colour gradient) which guides the observer/tester. In using this, soil samples are collected and then mixed with the appropriate chemicals, the resulting mixture resembles a particular colour in the chart which indicate the soil's acidity/alkalinity. The next step would be to test the presence or level of NPK using the other chemicals. This simple soil test kit – which is normally available at soils department in agricultural universities or at the agriculture ministry – has an instruction manual guiding a farmer or lay person in using it. However, this test kit has many limitations. Hence for a more comprehensive knowledge of the existing soil system in Pakistan, a more thorough assessment would be necessary – one that is done professionally at soils laboratories that looks into availability of other macro and micro nutrients, as well as other aspects of the soil system necessary for plant growth (Box 2).

**Box 2: The Soil System**

The soil is a complex system that has many properties. Soil pH is a measure of the acidity and alkalinity in soils. pH levels range from 0 to 14, with 7 being neutral, below 7 acidic and above 7 alkaline. The optimal pH range for most plants is between 5.5 and 7.0; however, many plants have adapted to thrive at pH values outside this range. Soil structure describes the arrangement of the solid parts of the soil and of the pore space located between them. It is determined by how individual soil granules (aka soil granularity) clump or bind together and aggregate, and therefore, the arrangement of soil pores (aka soil porosity) between them. Soil porosity or pore space is the amount of air space or void space between soil particles. Infiltration, groundwater movement, and storage occur in these void spaces. Soil structure has a major influence on water and air movement, biological activity, root growth and seedling emergence.

As soil structure influences biological activities in the soil environments, biological entities influence the soil and the plants that depend on it. Earthworms, for example, passively and mechanically alter the nature of soil environments. Bodies of dead worms passively contribute mineral nutrients to the soil. The worms also mechanically modify the physical structure of the soil as they crawl about (bioturbation), digest on the moulds of organic matter they pull from the soil litter. These activities transport nutrients into the mineral layers of soil. Worms discard wastes that create worm castings containing undigested materials where bacteria and other decomposers gain access to the nutrients.[13]

Soil testing and analysis are an important basis for rehabilitating a degraded soil, and the kind of intervention strategies that need to be employed such as: adding agricultural lime, in the case of highly acidic soils; using bio-inoculants on the roots of plants (i.e. soil organisms that facilitate nitrogen absorption) in the case of calcareous or alkaline soils; or growing saline-tolerant crops to absorb salt from the soil. To improve physical health of soil, green manuring (with *dhaincha* / sunnhemp or *guara* / cowpeas) or inclusion of legumes (i.e. crops that produce beans and peas) in between rice and wheat crops is must. Similarly, incorporation of rice and wheat straw (instead of burning them) along with animal manure into the soil can also help in increasing organic matter and soil health.

There are many strategies for dealing with different kinds and degrees of soil degradation, but for a successful transition into agroecology, a very important aspect is to give the soil time to rest and recover. For many farmers, leaving the land fallow for a certain period will have direct economic consequences. In this case, perhaps an option can be to partition the farm into “fallow areas” and “cultivated areas” and sequencing them for a specific period, until every part of the farm has been “rested”. It is important to consider that short-term sacrifices will be necessary to achieve long-term benefits of agroecology.

### *c. Community*

Women's role is crucial in agroecology since they have better understanding of the seed system. In traditional societies women were the foremost seed keepers, hence they understand the seed better than the men, and have a better sense of food security. However, in a highly patriarchal society such as Pakistan, women play a secondary, nearly insignificant, role in agriculture. Usually, as mere additional labour in harvesting. They are typically not given any cropping, financial or food security decision-making role in the household. If decision making is shared more equally at home between the male and female members of the family, the potential for a more food secure household can be achieved. Particularly in the case of Sindh, where it’s common to find families in one village belonging to the same clan or tribe, there is opportunity for women to take more active participation in decision making.

---

[13] Barot, S., Ugolini, A., Brikci, F. B. 2007. *Nutrient Cycling Efficiency Explains the Long-term Effect of Ecosystem Engineers on Primary Production.* Functional Ecology. ***21****:1-10. doi:10.1111/j.1365-2435.2006.01225.x.*

Pursuing agroecology in Pakistan would mean not just reviving the seeds and redesigning the farming systems, but reorienting the culture and mindset where farmers can identify themselves as part of the community and everyone can own the process, be they men, women or youth.

### *d. Agroecological zones*

There are 10 agroecological zones in Pakistan (see Box 3) based on physiographic characteristics, climate, soil type and agricultural land use. Knowledge of these diverse agroecological zones in Pakistan is crucial in the design, mechanism and process of implementing the strategies of pursuing agroecology.

### Box 3: Agroecological zones in Pakistan

| | |
|---|---|
| **1. Indus Delta** | *This zone comprises Thatta district and parts of Badin and Hyderabad districts.*<br><br>**Physiographic and Climatic Characteristics**<br>Represents the Indus Delta. Climate is arid tropical marine; mean daily maximum summer temperature ranges between 30-40 C; and winter temperature between 19-20 C; mean monthly summer rainfall is 75 mm and winter is less than 5 mm; relative humidity is 67-68% in the morning and 30-35% in the afternoon.<br><br>**Soil Type**<br>Two types of soils; clayey and silty; clay soils found in shallow basins and silty soils in nearly level flat areas; strongly saline-alkaline soils are barren and parts of clayey soils are under cultivation.<br><br>**Agricultural Land Use**<br>The main Kharif crops include rice, sugarcane and cotton, whereas the major Rabi crop is wheat, however, other crops like millet, maize, barley, rape and mustard, gram, fodder, pulses and vegetable crops are also common. |

| | |
|---|---|
| **2. Southern Irrigated Plain** | *This zone includes lower Indus Basin covering districts of Dadu, Larkana, Jaccobabad, Sukhur, Sibi, Shikarpur, Badin, Tharparkar, Sanghar, Khairpur, Nawabshah, parts of Hyderabad and Rahim Yar Khan.*<br><br>**Physiographic and Climatic Characteristics**<br>Represents lower Indus Plain formed by meandering of Indus River. Climate is arid subtropical continental with hot summer and mild winter; mean daily max. temp. is 40-45 C and minimum temperature is 8.5 C in the northern areas, and 38-43 C and 8-12 C in the southern areas, respectively; mean monthly summer rainfall is 18 mm in the north and 44-55 mm in the south; winter is practically dry.<br><br>**Soil Type**<br>Soil is silty and sandy loam associated with the active flood plain, upper areas of the flood plain is calcareous, loamy and clayey.<br><br>**Agricultural Land Use**<br>Crops grown: cotton, wheat, mustard, sugarcane, berseem on the left bank of Indus and rice, wheat, gram and berseem on the right bank; sorghum is the main crop in Southern Dadu. |
| **3. Sandy Desert** | *This zone comprises Bahwalpur, Tharparkar (partially), Khairpur, Nawab Shah, Sanghar, Rahim Yar Khan and Bahwalnagar districts, as well as parts of Muzaffargarh, Mianwali and Sargodha districts.*<br><br>**Physiographic and Climatic Characteristics**<br>a) Sandy desert with xerophytic vegetation (i.e. plants that need little water); central part occupied by salt lakes; southern part has rainfall of 300 mm.<br>b) Area covered with various forms of sand ridges and dunes and sand sheets with profuse short trees and vegetation; northern part has rainfall of 300-350 mm.<br><br>**Soil Type**<br>a) Sandy soils and moving sand dunes, undulating sand ridges 20-25 m high and 1-3 m long; western part has strips of clayey soils.<br>b) Sandy and loamy fine sandy soil, stable ridges; moderately to strongly calcareous.<br><br>**Agricultural Land Use**<br>The major Rabi crops are millet, wheat, rape and mustard and fodder whereas the major Kharif crops are cotton, fodder, sugarcane and remaining crops are millet, sorghum, rice, maize, pulses etc. The major crops in Kahrif are cotton, sugarcane and rice and in Rabi are wheat and gram. The other crops include rice, maize, sorghum and millet, pulses and vegetable. |

| | |
|---|---|
| **4. Northern Irrigated Plain** | *This zone comprises Multan, Vehari, Sahiwal, Lahore, Kasur, Faisalabad, Jhang, Shiekhupura, Gujranwala and parts of Bhawalnagar, Rahim Yar Khan, Muzaffargarh, Sargodha, Gujrat, Peshawar and Mardan districts.*<br><br>**Physiographic and Climatic Characteristics**<br>Areas between Sutlej and Jhelum rivers; different flood plains and bar upland; Climate semi-arid to arid (east to south west) subtropical continental; maximum (summer) and minimum (winter) temperature is 39.5 C and 6.2 C respectively; in the east and 41-42 C in the south west; mean annual rainfall 300-500 mm in the east and 200-300 mm in the south west. Alluvial valleys of Peshawar and Mardan plains Climate semi-arid subtropical continental; mean daily maximum (summer) and minimum (winter) temperature 43-44 C and 5 C respectively, mean monthly rainfall range 20-32 mm both in winter and summer<br><br>**Soils Type**<br>Soil sandy loam-clay loam; southern and central part calcareous silt loams and about 15 percent saline-sodic; northern part loam and clay, calcareous, saline sodic in local areas.<br><br>**Agricultural Land Use**<br>Canal irrigated agriculture; crops: wheat, rice, sugarcane, oilseeds and millets in the north and wheat cotton, sugarcane, maize as well as citrus and mangoes in the central and southern parts. |
| **5. Barani (rainfall)** | *The parts of D.I. Khan, Banu, Mianwali, Abbotabad, Rawalpindi, Gujrat, Gujranwala, Attock, Jhelum and Sialkot are included in this zone.*<br><br>**Physiographic and Climatic Characteristics**<br>Covers the salt range, Potowar Plateau (generally open and undulating) and the Himalayan Piedmont plains. Narrow belt along the foot of mountains nearly humid mean daily maximum (summer) temperature 38.5 C; mean monthly rainfall 200 mm in summer and 36-50 mm (Jan-Feb) in winter.<br>Southwestern part is semi-arid and hot; mean daily maximum) temperature 38 C and minimum (winter) temperature 4-7 C; mean monthly rainfall is 85 mm in summer and 30-45 mm in winter.<br><br>**Soil Type**<br>Eastern part dominantly non-calcareous to moderately calcareous silt loams; west southern part mainly calcareous loams.<br><br>**Agricultural Land Use**<br>Rainfed agriculture is the main land use. The major Kharif crops are rice, sorghum, millet, maize, pulses, groundnut and sugarcane, whereas main Rabi crops are wheat, gram, rape seed and mustard and barley. |

| | |
|---|---|
| **6. Wet Mountains** | *This zone includes Mansehra district and part of Rawalpindi and Hazara districts.*<br><br>**Physiographic and Climatic Characteristics**<br>Covers high mountains (intervented by wide and narrow valley plains) and plateaus. Eastern part is humid with mild summers and cold winters; mean daily maximum (summer) temperature 35 C and minimum (winter) temperature 0-4 C; mountain tops covered with snow in winter and spring; mean monthly rainfall 236 mm in summer and 116 mm in winter. Western part is sub humid Mediterranean, with dry summer; rainfall confined to winter and spring.<br><br>**Soil Type**<br>Soil is silt loam to silty clays, non-calcareous to slightly calcareous (pH 7.5-8.1); organic matter 1 percent in cultivated fields and 2-4% in forest areas.<br><br>**Agricultural Land Use**<br>Only 25 percent of the area under rainfed agriculture, the rest under the forest; main crops maize and wheat (rice grown in small areas irrigated from springs and streams); fruits (mainly apples) in areas at more than 1500 m altitude; olives grown in low hills; on 1500-5000 m altitude coniferous forests and scrub vegetation and about 5000, permanent snow |
| **7. Northern Dry Mountains** | *This zone comprises Chitral, Dir, Swat, Tribal areas of Peshawar and Kohat and some of the agencies.*<br><br>**Physiographic and Climatic Characteristics**<br>Includes Gilgit, Baltistan, Chitral and Dir valleys irrigated by glacier-fed streams; climate is undifferentiated; tops of high mountains covered with snow, greater part of the year; mild summers and cold winters; mean monthly rainfall 25-75 mm in winter and 10-20 mm in summer.<br><br>**Soil Type**<br>Soils in valleys is deep and clayey and on mountain slopes shallow; non-calcareous acid (pH 5.5-6.5) above 2100 m altitude and calcareous at lower altitude<br><br>**Agricultural Land Use**<br>Most of the area is used for grazing. Wheat and maize grown rainfed in valleys and lower mountain slopes and rice irrigated in local areas; fruits grown in flank streams. |

| | |
|---|---|
| **8. Western Dry Mountains** | *This zone includes districts of Kohat, Zohb, Loralai, Kallat, Sibhi, Quetta, part of Karachi, Banu and its tribal areas and agencies.*<br><br>**Physiographic and Climatic Characteristics**<br>Composed of barren hills (1000-3000 m) with steep slopes. Climate is undifferentiated; greater part is semi-arid highlands with mild summers and cold winters. Southern areas mean daily maximum (summer) temperature 30-39 C and minimum (winter) temperature -3-7.7 C mean monthly rainfall 30-35 mm. Extreme north western area sub humid, mean daily maximum (summer) temperature 32 C and minimum (winter) temperature 2 C; mean monthly rainfall 95 mm in summer and 63-95 mm in winter.<br><br>**Soil Type**<br>Soils in valleys are loamy, deep and strongly calcareous; mountains have shallow soil.<br><br>**Agricultural Land Use**<br>Major land use is grazing; part of the loamy soils grown to wheat with the flood water; very small portion is irrigated and fruits (apples, peaches, plums, apricots, grapes) wheat and maize are grown. |
| **9. Dry Western Plateau** | *This zone comprises districts of Karachi, Makran, Kharan, Chagai, Lasbella and Mehal Kohistan tehsil of Dadu.*<br><br>**Physiographic and Climatic Characteristics**<br>Mountainous areas with inter-mountain basins and plateaus, steep and rugged with narrow valleys in between. Climate is arid (desert) tropical; mean daily maximum (summer) and minimum (winter) temperature 40.5 C and 3-6 C respectively; in the north and 33-34 C and 11.5-15 C respectively along the coast; mean monthly rainfall 36-37 mm in summer in the southeast and other parts 2.4 mm. Coastal belt receives sea breeze.<br><br>**Soil Type**<br>Soils in plains are silt loam, deep and strongly calcareous, and hill slopes are shallow. The lower regions have xerophytic vegetation and grasses and higher altitudes have juniper forests and wild olives.<br><br>**Agricultural Land Use**<br>Land use is mainly grazing; melons and sorghum quite extensive; fruits, vegetables and wheat grown where spring or “Kareze” water is available. |

| | |
|---|---|
| **10. Sulaiman Piedmont** | *This zone comprises districts of D.I. Khan and D.G. Khan, Dhadar, Bagh tehsil of Kacchi District.*<br><br>**Physiographic and Climatic Characteristics**<br>Comprises piedmont plains of Sulaiman Range and alluvial fans built by streams. Climate is arid and hot, subtropical continental; mean daily maximum (summer) temperature 40-43 C and minimum) temperature 5.8-7.6 C; mean monthly rainfall 13 mm in summer.<br><br>**Soil Type**<br>Soils are loams in gently sloping areas but clayey further away; strongly calcareous, with narrow strips of salinity sodicity at the junction of piedmont plain and river flood plain.<br><br>**Agricultural Land Use**<br>Torrent-watered cultivation is the main land use, and wheat, millets and some gram and rice main crops. |
| **Source**: Khan, Abdul Ghaffar. 2004. *Technical Report on The Characterisation of the Agro-ecological Context in which Farm Animal Genetic Resources are Found; Development and Application of Decision Support Tools to Conserve and Sustainably Use Genetic Diversity in Indigenous Livestock and Wild Relatives.* | |

## 4. Strategies for moving forward with agroecology

### *a. The community seed bank strategy: from seed saving to seed sovereignty*

Seed banking is a complex and laborious work involving systematic collection, identification, multiplication, evaluation and maintenance of various seeds. Most seed banks were established to collect and conserve germplasm (i.e. genetic resources) that are used for breeding and selection. This is the case with nearly all formal seed banks (e.g. all government research and agricultural institutions, the Global Seed Vault, and the institutes under CGIAR system like IRRI and ICRISAT) that are involved in crop improvement. However, in our case, the focus is not so much to breed and improve crops but to conserve and select from various native seeds (landrace, traditional, heirloom, heritage, or farmers selection) cultivated in Pakistan before Green Revolution (see Box 4). This may also include improved varieties from pureline selection (those that did not require breeding such as Basmati 370 developed in 1933). Pureline method of selection means selecting the seeds with uniform quality of colour, size and shape from the landrace and replanting them in rows, further selecting those with uniform qualities until they are “purified” in physical terms.

**Box 4: Examples of pre-Green Revolution cultivars of major crops in Pakistan**

| Crops | Cultivars |
|---|---|
| *wheat* | Bansi, Dharra, Gandausi, Katia, Kandhwa, Lal Kanak, Lal Pissi, Malwi, Pakwani, Pusa, Sharbati |
| *rice* | Basmati, Dhud Malai, Jhona, Kasarwala, Mallar, Mushkan, Palman, Sathra, Son Pattar, Suffaid |
| *maize* | Azam, Jalal, Mansehra, Mingora, Parachinar, Swabi |
| ***Source:*** *various Pakistan literatures dated 1982-2014* | |

It is important to emphasise that these pre-Green Revolution seeds are crucial in pursuing seed sovereignty. Breaking away from chemical fertilisers and pesticides requires abandoning the use of “modern seeds” – or those that came after Green Revolution that were bred to respond to chemical inputs, more specifically nitrogen fertilisers that enhances plant growth, development and reproduction. The pre-Green Revolution seeds may not give as much production as the modern seeds, especially in the beginning. Traditional or heirloom seeds tend to be late-maturing and less productive. But they have natural resistance and can tolerate the different agro-climatic conditions in Pakistan, and thus can survive without chemical fertilisers and pesticides. Once they get adapted into the local condition, taken care of properly, provided the best nutrition in the soil, they can also reach optimum production. It is always important to remember that when farmers have control over the seeds, it becomes possible to take control of the food and farming systems.

***b. The conversion process: from monoculture to multi-functional agriculture***

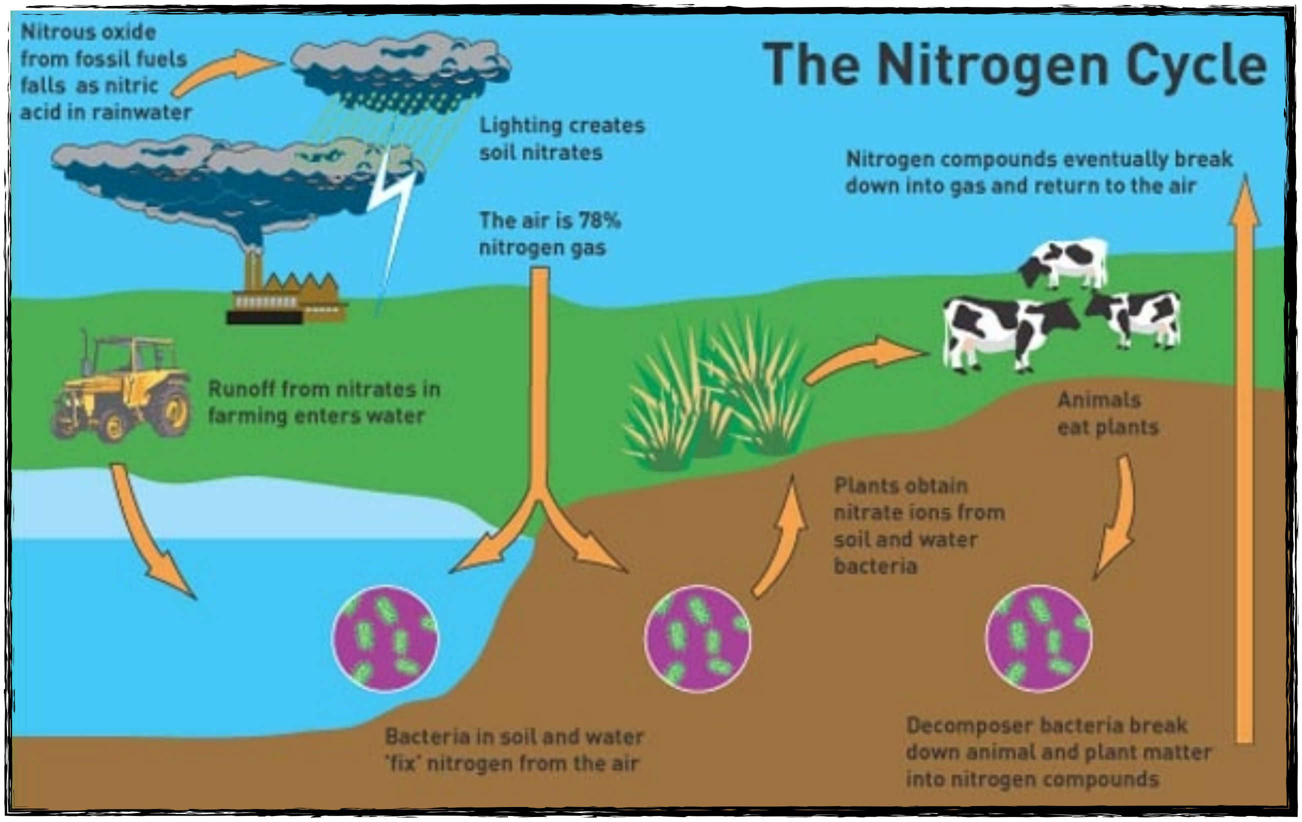
When farmers have taken control of the seeds, the next step is to take control of the farming systems, to redesign them in such a way that economic and food security objectives are met along with environmental resilience and sustainability. Transition from monoculture to a fully diversified and integrated farming system is not an easy process. It requires careful planning, commitment, and patience. The conversion process can be divided into different phases:

| | |
|---|---|
| Phase 1: | Reduce use of costly or environmentally damaging inputs, starting with chemical fertilisers and pesticides. |
| Phase 2: | Substitute conventional inputs and practices with alternative approaches / practices. |
| Phase 3: | Redesign agroecosystems according to a new set of ecological processes. |

During these phases, it is important to keep track of the progress by monitoring changes in the farm of the 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 you reduced the amount of environmentally damaging chemical inputs, have you noticed more 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 you substituted those chemical inputs with alternative approaches in soil fertilisation (like composting) and pest management (like planting insect repellant crops beside plots of vegetable crops), were there noticeable 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.

Some general principles of the conversion process are outlined by Stephen Gliessman, professor emeritus at the University of California, and a preeminent leader in the field of agroecology:

- Recycle nutrients with increased dependence on natural processes such as biological nitrogen fixation. Eliminate the use of non-renewable off-farm human inputs that have the potential to harm the environment or the health of farmers, farm workers, or consumers. Use naturally occurring inputs instead of synthetic ones when materials must be added to the system.




- 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). 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. Increase awareness of farmers not to kill these beneficial creatures. The presence of snakes in the farm can easily 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.

- Emphasise conservation of soil, water, energy, and biological resources. These are the main "capital" of an agroecosystem and should be used sustainably. Simple erosion control measure such as planting cover crops in denuded areas can be done to conserve soil. If there is a small spring in the farm, make sure that it is put into optimum use by constructing a small water-impounding pond that would increase the volume of water to be used by other crops or livestock. All biomass from the farm (leaves, stalks, branches, etc.) should not be burned but turned 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.

- 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), it is important to consider the topography or terrain of the farm landscape and allocate areas best suited for each crop. 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. Farmers instinctually know this, but unfortunately those who have been raised in monoculture may have difficulty understanding it at the outset.

- 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. – should be a primary motivation in the agroecosystem design and management. Keeping the soil healthy for a long time should be an equally important objective than just using its maximum capacity to grow crops.

***c. The collective transition process: organising communities toward agroecological objectives***

The potential of agroecology as the default agricultural practice and development agenda would require an enabling framework that takes into account how different patterns of agrarian transitions affect access to land, availability of labour, localisation of agro-food industry, and so on. This includes institutional or policy framework on agriculture, environment, land ownership, seed industry, trade, or the food system itself. It also means addressing several policy constraints like inadequate research and extension support, lack of incentives (including payment for ecosystem services), insecure land, and agricultural and trade policies that favour the localisation of agro-food systems. Peasant and small farmers cannot do all this by themselves. They need the support of government institutions and the broader public, to procure all the possible technical, institutional and political solutions to overcome such constraints.

As a framework for re-establishing productive, resilient and sustainable agroecosystems in Pakistan, agroecology needs a strong movement behind it to propel its objectives forward. This means broad and wide support for agroecological practices on the ground reinforced by policies that incentivise the transition from monoculture to multifunctional agriculture. The more farmers shift to agroecology, the better chances of building a movement behind and around it. At the same time, support from decision-makers, authorities, opinion makers, is crucial to convey the viability of agroecology as an alternative framework for agricultural production at various scales (village, province, country) where the food system is also targeted to be reoriented and restructured. This means that the farmers movement need to organise themselves first before the wider public can be mobilised. Agroecology is a big concept; organising communities to adopt agroecology requires not just skills in community organising but knowledge of agroecology itself – the science, the practice and the movement.

A strategy for pulling all these together, is to develop a platform for exchange on agroecology. The idea is to have a space for different groups and individuals (who share a common analysis of Green Revolution and industrial agriculture) to work together or complimentarily with each other, in promoting agroecology in Pakistan. In a sense, it will be a forum for challenging the government's usual thrust for modernising agriculture, and the strong corporate lobby that drives policies in support of industrial agriculture. It will be an open workspace where groups can collaborate and analyse current trends on agroecology, initiate researches, formulate campaigns and advocacies, share experience, mobilise resources, plan mutual exchanges and learning visits, find new contacts and useful networks, learn funding directions and opportunities – without the pressure of having to agree on a common or single political line. Any group in this platform can promote agroecology with its own links to other organisations or people. This way, the burden of promoting agroecology in Pakistan will not be confined to Roots / PKMT.

**“From Seed Sovereignty to Peasant Agroecology: a framework for reclaiming peasant' seeds and re-establishing productive, resilient and sustainable agroecosystems in Pakistan”** 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