a

SMALL FARM

in the

MOUNTAINS

Shunya farm, Bir,
Himachal Pradesh, India

Farm established in 2014
Land area: 3000 sq. metres (0.75 acres)
Average altitude: 1800 m
Climate zone: Humid temperate/Sub-tropical
Average annual rainfall: 2000 mm
Average annual temperature: 24 deg. C. (min 0 – max 30 deg C.)

Document published in 2020

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The reason behind writing this short book was to introduce the travelers, volunteers and future farmers to the story of this farm, the experiences of people who have worked here and the philosophy that serves as the foundation for this project, feeds it and makes possible for it to continue to thrive. As this documentation could also be useful for more farms in the region and in similar climates, some background on the practices and refrences for planting and harvesting have been included.

We write this with deep gratitude to all the people who we interacted with at the farm and about the farm, our teachers, our friends and family and most importantly the people of Bir who supported us on this journey and generously and unconditionally shared their time, knowledge and wisdom..

Our hope is that this document will serve as a good record of our experiences, saving the people some time, by not having to re-invent what has been learnt. However, a farm changes everyday and there is no substitute for the knowledge one gains while working with the feet and hands in the soil.
There is no better way to discover the wonders of Nature and Life and connecting with ourselves than growing our own food. It is a skill which will become more and more important and useful as we wake up to the implications of our dominant worldview and systems and look for ways to deepen our understanding of the Laws of Nature.

We invite the future farmers at this farm to add their own observations and experiences to this book making it a living document that grows with the farm and the aspirations and learnings of its farmers and we offer the aspiring farmers, staying at this farm or just passing through, our deepest appreciation and gratitude and wish them Force and Light on this remarkable adventure!

Angelica Bernal
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November 2020

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Introduction

"The ultimate goal of farming is not the growing of crops,
but the cultivation and perfection of human beings."

— Masanobu Fukuoka

The beginning

The land that is now Shunya farm belongs to three different land owners, all part of the large Paul family. For many years, it had been a family farmland but as the family grew, the land got divided into smaller and smaller pieces for the successive generations, and as more and more people from the village moved to adjacent towns and bigger cities for work, these farmlands were either left fallow or leased out to family members in the village or the landless villagers for farming. The land along the upper road was hardly cultivated and had ended up as as accumulator of waste from the houses above it. The lower fields were being used to grow corn, wheat and cow grass.

In 2013, Spero Latchis and Robin Jameson, an American couple who lived in Bir from 2009 to 2017 took these fields on lease with an intention to start organic farming and demonstrating practical solutions for local farmers on making the shift from chemical to organic agriculture. Both Robin and Spero had a background in therapy. They were working with the Nishtha foundation based in Rakker (near Dharamshala) which helped them set up a Homeopathic clinic in Gunehar. The rising incidents of pesticide and insecticide related health issues among the local farmers and their own need of eating clean, wholesome and healthy food encouraged them to start the farm.

They left Bir in 2017 and we had the good fortune of meeting them while they were looking for someone to take the project forward.
We ourselves were looking for a piece of land to farm. We had a few years of experience with Permaculture, living on the land and farming, and wanted to settle down for a while and farm to explore how we could sustain ourselves in terms of nutrition and economy from a farm. This was the beginning of our journey as full time farmers and we realised that the farm and our work on it needed a direction and an aspiration. This led to the crystallisation of our experiences and yearnings into Shunya and to the birth of Shunya farm. We worked physically on the farm from December 2016 until June 2019.

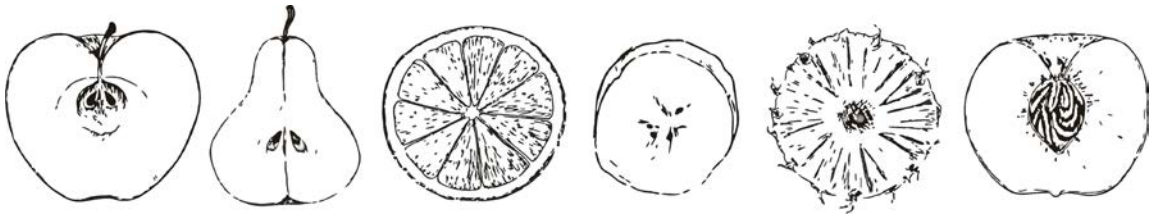
This farm started, dealt with the transitions in 2016 and 2019, and still continues because of Matasharan. He is the force of the farm and the reason why the soul of the farm continues to evolve. Learning by working with people from all over the world, Matasharan is perhaps the only full time young farmer involved in natural/organic farming in Bir. Having started as a helper in the farm, he is now managing the farm on his own. He is truly a living example and aspiration for the local children of a future farmer in the village.

Food

There are two main reasons why many people want to start their farms today. One is that they want to move closer to nature, put their hands in the soil and connect with that feeling of being a part of something beyond human, that resides deep within all of us. The other is to eat clean and healthy food. Both are of course interconnected and serve each other.
Everything in nature is food, used up by one or the other organism to satiate their hunger and maintain their vitalities. This energy that sustains life comes primarily from the Sun.
Only plants have the unique ability to gather the forces of the Sun (*Agni*), Air (*Vayu*), Water (*Jal*), Earth (*Prithvi*) and cosmological forces in the Space (*Akash*), and transform them into food for animals. This energy flows through nature as food, goes back to the soil, again as food for microbes and comes back as food for higher animals.

Rudolf Steiner, founder of the Anthroposophical Society and one of the greatest visionaries and thinkers of the 19th century has beautifully captured the role of food in our lives. Food, he says, is beyond nutrition. It is not just the physical that food feeds, it is also the spiritual that relies on the food for its nourishment. As human beings develop ways and techniques to progress materially and spiritually, their food and its quality remains the foundation for all growth. Food with high consciousness can aid the ascent of consciousness in human beings. Thus, food, or rather the quality of the food we eat, is fundamental to the growth of human consciousness, to help human advancement keeping with the law of evolution that we all are a part of. This understanding of food is well described in ancient Indian texts, in the Yogic philosophy on food and the system of Ayurveda which considers food as medicine and recommends food based on individual constitution to help human being in his work towards perfection.

Our connection with food goes beyond our instincts to feed ourselves. It makes us a part of the larger whole and weaves us into the complex natural ecosystem where the energy is flowing continuously and human beings are but one medium for this energy to manifest.
Food has been central to the human communities and intertwined with growth of cultures and civilisations and the current deterioration in our cultural and social lives comes hand in hand with our degrading connection with our food. Thus, coming closer to our food, learning how it is grown, where it comes from and possibly growing some or all of it ourselves is a step in the direction of learning again what we are losing quickly, the essence of being a truly natural being, and discover the lost connection with our nature, culture, body and spirit.



Farming

It is believed that farming evolved from horticulture and hunting-gathering cultures about 10,000 years ago, perhaps the second biggest leap in human evolution after domestication of fire (a million years ago). The implications of *agri-culture*, a culture based on land, have been enormous on human life and life in general. Farming changed our relationship with nature as we could now consciously grow the food that we desired and store it. It also led to the development of a complex social organisation to manage sedentary communities and ownership stemming from permanence, a novel concept for hitherto nomadic communities. Thus we can see a pattern of growth from man as a primarily ecological being learning to develop as a social being with the advent of agriculture. This realisation that farming is essentially a social activity has been our biggest learning during our time on Shunya farm.

The evolution of civilisations and farming is deeply interrelated and agriculture could have led to the genesis of complex communities and the concept of families. Land was (and still is) passed on from one generation to the other as a responsibility and a promise. The large number of people in a family find their respective roles on the land and in the house to grow food, rear animals, and take care of each other. As we take the next step in realising individual potential outside the social units, we wonder if the society would have been created to serve the individual and not otherwise, caught on the egde of self and others, in a balancing act between the unitary and the collective. In the face of our social evolution, it is natural then to question the evolution of farming that correlates to ts foundational social principle.
The second principle of farming then would be stewardship of life. We all have been entrusted with our own lives by the cosmos but we realise the responsibility we have when we start taking care of a land and the life on it. The cycle from a seed to fruit (or shoot, or stem, or leaf or flower) and seed is the story that connects deeply to where we come from and to where we aspire to be. It informs us of our place in this complex web of life. It liberates the power of creation that nature has vested in all beings, and empowers to take control of one's food, health and being.

Growing food is indeed the biggest revolution of our times, that can even start from a backyard, and is the key not only for healing individual health but also the health of our society and mother earth. However, at least for the time beling, it is hard to imagine a world where everyone will grow *all* of their food and thus farming itself is required as a service for the society. The work of the new farmer will be as much to discover and design a new culture where farming is viable socially, as it is to develop on the ecological and economical aspects.
The future of farming or the farming of the future, is perhaps somewhere connected to how we choose to form (or reorganise) communities and what culture we design for our individual and collective growth. The first condition of collaboration in farming will lead to the empowerment of the future of the farmer and the farmer of the future, without which no method of sustainable farming can work.
There must be a synthesis of what has existed and what might exist for us to manifest our present approach to farming.

Natural farming

Life, in its creation and sustenance maintains an inherent balance. In a natural system, growth is an inevitable fuction of birth and death of growth. Within this cycle of life and death and death and life, the entire play and drama is conceived and manifested. There exists a web, a large invisible network of beings that embody this Life force and in their striving for growth, they are constantly seeking more energy to feed themselves. This energy they get through the plants, other animals or through dead organisms from which Life has passed. All organisms look for food, to fulfill in themselves the desire for assimilation and completion. It is not a philosophical desire, it is a biological instinct, that forces us to seek, gather and/or farm.
The farming system of human species has evolved with the changing ecology and socio-political contexts. From hunters and gatherers who had to find and hunt for food, to horticulturists who propagated, intentionally or unintentionally, plants useful for food and other needs, to agriculturists who grow a crop intensively on a piece of land, our diets and lifestyle have come a long way.

Natural farming, is a general term for a farming that is based on nature's invisible laws rather than on humans imposing their understanding or will on a natural system.
One of the great propounders of natural farming was Masanobu Fukuoka, a Japanese farmer and philosopher. He believed and taught that human intellect is limited and even inferior to the vast intelligence of Nature. His farming philosophy is based on transcending the arrogance of human mind and finding unity with Nature. This, he said, could be achieved by *doing nothing*. This principle of doing nothing cannot be explained mentally for that definition itself will be its contradiction. It can only be an experience that could be found not in a passive but an active oneness with Nature.

Practically, Natural farming has four golden principles:

1. No tilling
2. No chemical fertiliser
3. No weeding or herbicide
4. No pesticides

In India, many farmers like Bhaskar Save, Subhash Palekar and Shripad Dhabolkar, just to name a few, have pioneered and explored the philosophy of 'natural farming' and farming in harmony with Nature, with different names and methods but the underlying idea of healthy food for land and human spirit. For us, 'natural farming' is something that needs to be discovered personally by individuals as it connects with the center of their own nature. Farming is a lifestyle and the limits or potentials of the naturality of farming will depend on the mind, body and spirit of the farmer. Natural farming is an invitation for farmers to surrender to a higher principle and work with it for the health and perfection of all Life.

Permaculture

Started in the late 1970s, Permaculture has grown massively as a movement sweeping across cultures and nations, offering possibilities for alternative futures. What distinguishes Permaculture from other design models and solutions is its foundation in ethics. It put values at the center of human activity in a scientific manner, going beyond the language of religion. In a time when religion is more political than spiritual, the new generations find themselves without the tools a religion or culture can offer in learning about our identities and our roles in the social and ecological realms. We have in the last 50 years tried very hard, and successfully, to some extent, to break the old paradigms but without creating new frameworks that can support a new birth.

Permaculture offers some tools that can help in the birth of a new system for our interactions, founded on three principle ethics:

Earth care *People care* *Fair Share*

These *ethics of care* could be a good starting point for us to start building a relationship with ourselves, our communities and the planet. This is the reason why so many people, not necessarily working with the land, find Permaculture attractive and easily mealiable to work with.

The farm has been inspired by the ideals of Permaculture and many of its techniques have been employed and experimented with here.
The intention however, has never been to ¨be a permaculture farm¨, if at all something like that exists. The farm has an identity of its own and Permaculture has and continues to serve as a tool in realising the highest potential for the land and the community it is nestled in.
Design allows human beings to manifest a thought into an idea and that into a reality. The farm has a design that aims at abundance, holistic health, relationships and endless learning. The design on the land and in the social aspects of it, is of course, continuously evolving and is informed by the intuition of the people working on and with it.

Design

"As above, so below, as within, so without, as the universe, so the soul…"

— Hermes Trismegistus

The language of patterns

Our quest for sustainability is ill-founded on the assumption that sustainability is a human responsibility and that we have to finally invent it somehow. Nature and life are inherently sustainable. We find ourselves struggling to sustain because of our discord with the patterns of nature. We are constantly working against the flows and laws of this planet and the universe, creating obstructions and challenges in our individual and collective lives. Most of us have not only disconnected ourselves from nature´s workings but also lost the faculty of learning, listening and observing, that could allow us to find our way on the road back to nature.
To start working with nature would require us to re-learn communication with nature and this would require us to learn the language of nature. The language of nature is Patterns.
Patterns are coded pieces of immense amount of information in time and space. All of nature expresses itself through patterns. The most effective way of learning this language is by observing deeply. By listening the structure and nuances of these patterns, we can learn how to communicate and participate with natural processes and align our own actions within their schemes and frameworks. In doing so, we become the co-creators of our environment, serving our role in the ecosystem with minimum impact and disturbance.
The processes on the farm have been intended to follow these patterns closely while leaving space for learning and adapting to the continuously changing context and actors.
The broad patterns on which the farm design and activities are based on are:

1. <u>Circularity</u>

Human beings, life, the planet earth, this universe are all a part of cycles of different scales. What appears linear to us is only a small fragment of a large circular. These cycles can be observed in our own bodies, in day and night, in seasons, water cycles, nutrient cycles, cycles of growth and decay and of social and the universal involution and evolution.
Cycles maintain information and resources within a system. Different cycles in nature are connected to each other, often sharing resources, thus waste from one process becomes the food for another and the energy keeps flowing in a large web of connections. Cycles also help in course-correction by giving feedbacks and thus maintain a harmonious balance. e.g. too much food in a system would lead to increase in population of a particular animal, which will then decrease the amount of food leading to eventual decline of the population of the animal, creating a dynamic balance between the food availability and animal population.

2. <u>Diversity</u>

Nature thrives in multiplicity and diversity. The foundation on nature's resilience is built on the diversity of life. A forest is possibily the best example of a self sustaining relisient system and what makes a forest such a strong system is its diversity horizontally and vertically.
Diversity creates new opportunities for relationships and learning and allows functions and harvests across niches.

3. <u>Interconnection</u>

A healthy system cannot sustain its diversity without interconnections. The relationships between diverse elements are what create the energy for the system to grow. We are all connected in varying degrees and our life is about receiving and giving to maintain these connections. The quality of the relationships, and not only the quality of the elements, define the health of a system which is truly greater than the sum of its parts.

4. <u>Collaboration</u>

Within these relationships the dominant pattern of interaction is collaboration. We normally see competiton as an underlying force of nature, but this is true only at a particular scale of existence. Zooming out in space and time, we will see that nature has grown with collaboration, synthesis and merging of disparate organisms and ideas. This is an evitable instinct of our evolutionary process. We grow better and create more by collaborating. As human beings, we find the abundant results when we collaborate with nature, other human beings and our own inner self.

Farm as an organism

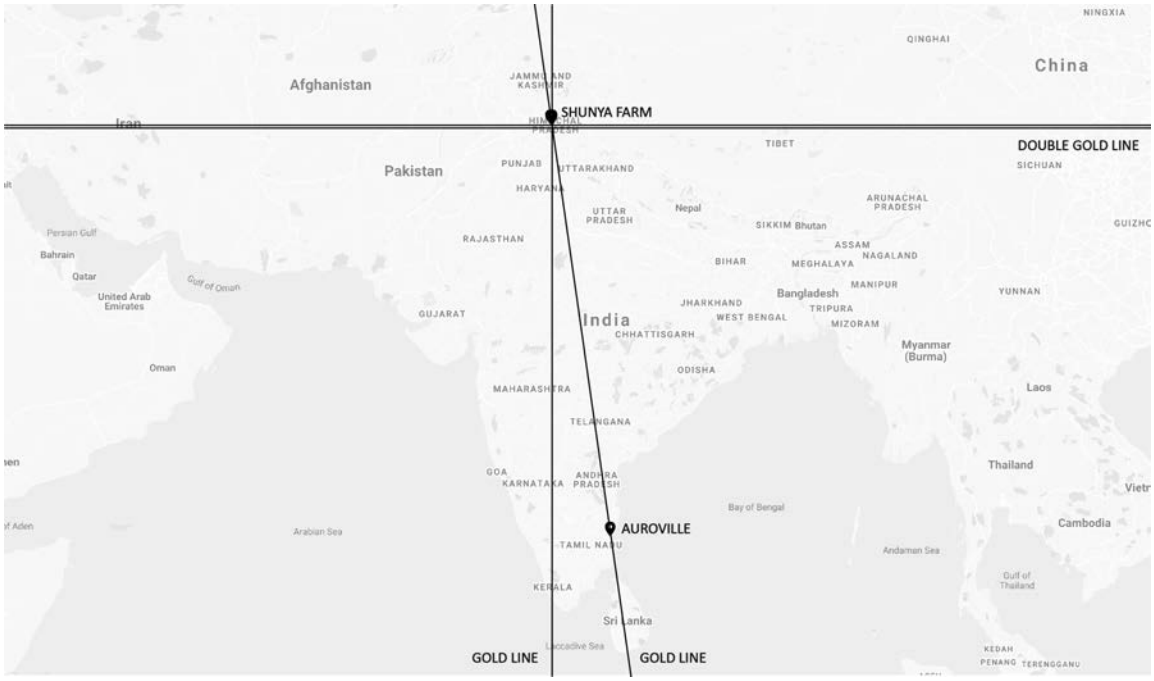
Every system is composed of physical elements most of which we can perceive and work with. However, there is a great deal of impercetible relationships, the invisible that holds the visible together. It is far more challenging and exciting to observe and work with the invisible as here lies the secrets of how the physical manifests.
When we look at any farm, we can see the land, the water, the structures, the trees and the plants, insects, worms and so forth. It is as important to recognise that they exist within the framework of life, the cycles of nature, the unsaid and unwritten stories of the community and are as much an integral part of the life of the people working on and associated with the farm. The farm itself is an organism relating to the environment, the community and its cultural aspects and has its own life, its own soul.

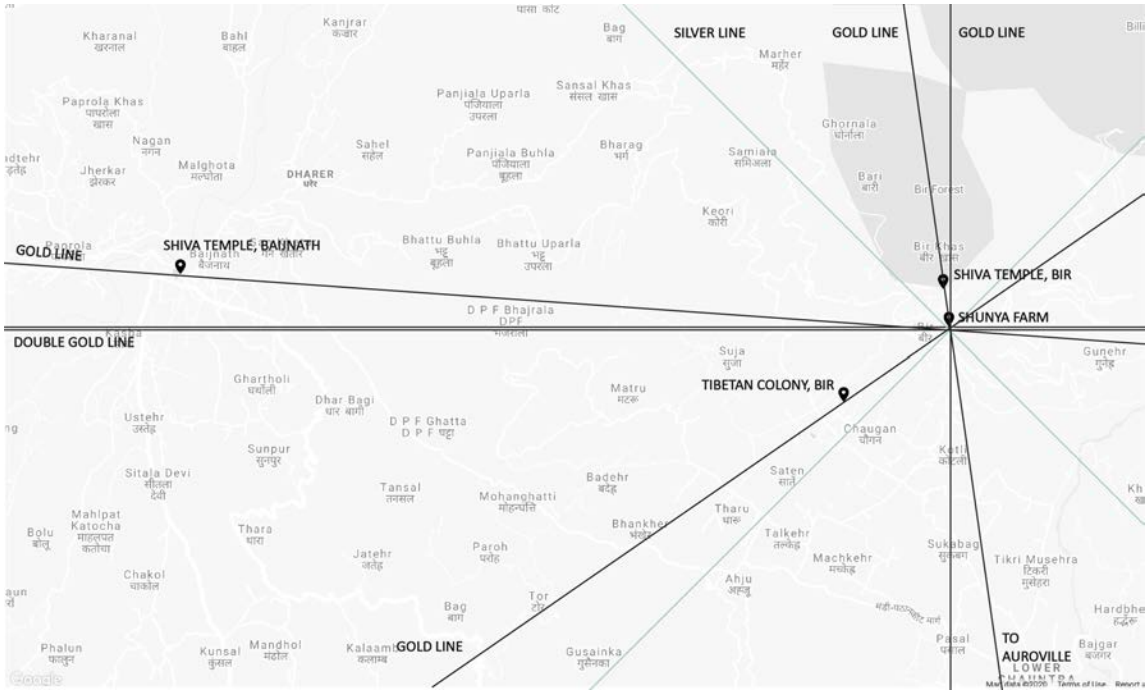
As a farmer, it is useful to have the ability to recognise the invisibles that guide all aspects of life and at varying scales and recognise the macro within the micro and vice versa. When we work on the farm, we work both with these physical and invisible aspects aspiring for the growth and evolution of the soul of the farm which is inexticrably tied to the growth and evolution of our own souls.

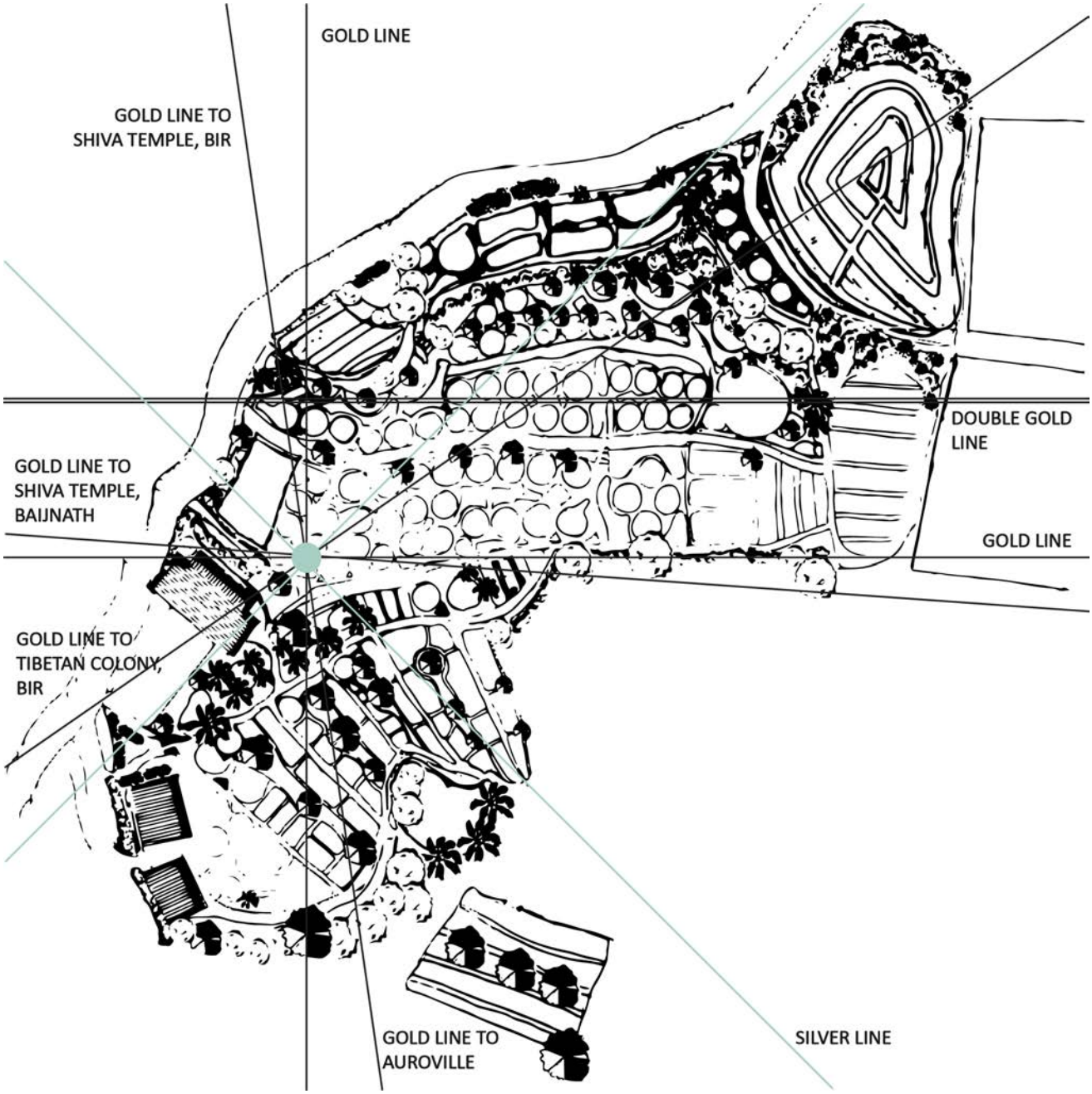
The design of the farm has been developed based on these layers and is inspired by the philosophies and practices of Natural farming, Permaculture, Agroecology and Regnerative agriculture.


NORTH
ACCESS
GRAINS
PERENNIALS
ROAD
POND
CIRCLE
CHICKENS
ANNUALS
TOOLSHED
GREEN HOUSE
3 METERS
SEEDS
COMPOST
ACCESS
HARVEST
NURSERY

Just as an organism had energy centers, the farm also has sacred points on its *body* that connect it to other sacred sites and places of extremely high vibrations through *ley lines*.
These points and lines were marked on the land by dowsing by Geomancist Jean Francois Audic and they inform us of the energetic relationships of the farm with the larger context. People are encouraged to experience the existence of these energy *walls* and *vortices* themselves by contemplating on the place, walking silently and connecting with the spirit of the land.






GOLD LINE
GOLD LINE TO
SHIVA TEMPLE, BIR
DOUBLE GOLD
LINE
GOLD LINE TO
SHIVA TEMPLE,
BAIJNATH
GOLD LINE
GOLD LINE TO
TIBETAN COLONY,
BIR
GOLD LINE TO
AUROVILLE
SILVER LINE

Biodiversity

Since 2017, we have tried to enrich the biodiversity of the farm by introducing all the possible varities and species growing locally and wild in the region as well as trying crops of different kinds in an attempt to find the most optimum configuration that produces ecosystem services and food. This has led to the farm becoming a diversity *hotspot* in the region and a nursery for new farm projects, a living repository of numerous edible perennials, wild plants, herbs and annual crops.

This work is of immense value for preserving the food crops of the region and to experiment with new crops that could provide food security in the context of constantly evolving ecologies.

Diversity in planting

When we look at an old growth forest, also seen in many places within the forest above Bir, we can see plants growing in different layers. There are trees growing at varying heights, typically 2 to 3 different trees of different canopy sizes close together, under which there are shrubs or the woody plants that grow in shade. Under these we can find herbs or other short plants and under them a carpet of different wild plants covering the entire ground. There are also tubers growing underground and of course the vines and creepers growing up on the shrubs and the trees. This diversity in space is what is often referred to as the *seven layers of the forest.* The number of layers is not restricted to seven and can be more or less depending on the ecosystem. These layers densely fill the spaces above and below the soil and create a diverse habitat for animals, birds, insects, microbes and so forth.

This pattern in nature can be used to grow different things together optimising resources of space, the access to the sun and the soil. This form of planting can be observed along the fenceline of the farm, in clusters on the edges of each terrace and spread across the farm with perennial crops i.e. trees, shrubs, groundcovers with a rich diversity of an understorey. The high plants are placed towards the north to allow sun for the shorter plants.

In annual cropping systems, the layers are often less to allow for more sun and for the ease of changing crops from season to season. We often plant two or three crops together as *companions* or *intercrops* to fill the space and of different durations to have a continuing productivity from a bed.

e.g. short duration mustard and other spinaches planted with long duration peas, tall corn planted to support climbing beans, also beans help fix nitrogen in the soil which in turn feeds corn, annual crops like coriandar with perennials like collards and kale etc.
Mixing crops together also adds to microbial diversity in the soil, keeps pests and diseases in control and utilises soil and water to the optimum.

Introducing varities and plants from *outside*

During 2017-2019, the farm grew all local crops and varieties along with *exotics* to learn what grows best, what can be improved while assessing also the market potential of each crop. We have not been averse of introducing new varities and even plants from outside of Bir. This work has been done carefully by assessing the niches in the local ecosystem and complementing the existing plants with the new ones. In our view, sustainable agriculture values the traditional crops while integrating new crops as the people and their diets evolve.
This is the link to the list in progress of all plants on the farm and sorrounding area:
http://bit.ly/bir_biodiversity

The elements

"That is Whole, this is Whole,
from the Whole, what springs forth is Whole,
when the Whole is taken out from the Whole,
what remains indeed is Whole."

— Isha Upanishada

Soil

Soil is the foundation of a farm. The health of the plants depends directly on the health of the soil. A natural farmer works, not to feed each plant with what it needs, but to feed the soil, to grow healthy microbial life in the soil, giving it its fertility, structure, and life.

Different kinds of soils can be seen across the world, depending on the underlyng rock, vegetation and biodiversity, climate, topography and the age of the soil. Soil formation is a slow process involving complex interactions between these factors. It is estimated that in nature an inch of top soil can take over a thousand years to form. Top soil is the layer of soil where the biological activity is the highest, full of roots of plants, insects, worms, organic matter, moisture etc. But roots of plants go much deeper than top soil in search of water and nutrients and to support the plant above the ground.

Temperate soils are slow forming soils and generally have a deep topsoil layer. The richest soils in the world are in the cold temperate forests with deciduous trees due to large amount of leaves falling on the soil in autumn and their slow decomposition in winter (in tropical warm humid climates where the soils form quickly are also lost and depleted quickly with erosion and leaching). However, temperate mountains lose a lot of topsoil due to erosion especially on agricultural lands where vegetation is not perennial and land is ploughed for one season and often left fallow for the following one. Terracing on mountain lands prevents erosion and, if designed well, can help to retain heat from the sun (the vertical edge) and hold and infiltrate water from the rains (the slope).

The soil on Shunya farm is primarily clayey (except the topmost field which has sandy soil).

Since 2013, the soil has improved in structure and organic matter content. These two are the most important characteristics of a soil.

Structure

The structure of the soil is the formation and arrangement of soil particles within which water and air can find space. A good soil structure allows mositure to be retained and be available for the plants' roots, holds nutrients, holds air for soil organisms to breathe and lets the roots pass and spread easily in the soil. The structure of the soil develops naturally depending on its mineral (sand, silt, clay) and organic matter content. The soil mineral content cannot be changed, however adding organic matter feeds the soil life which builds aggregates in the soil and give it a good structure. The bacteria are seen as the bricks (sticking soil particles into microaggregates) of the soil and the fungi its mortar(tying the microaggregates with their web like strands into macroaggregates).

Organic matter

Organic matter is any matter coming from the energy of the plants. Any dead biological matter (leaf, worm, insect, animal) is organic matter for the soil. In soil, the organic matter feeds bilions of bacteria and metres and metres of fungal strands which in turn feed higher organisms like amoebas, nematodes, worms and insects forming a complex soil food web transforming the energy from the organic matter into plant available nutrients and humus, a highly stable nutrient bank which can stay in the soil for many years releasing the nutrients slowly as the plants need them and building soil structure. It is has been found that plants themselves add organic matter to the soil by giving off upto one-third of their food through their roots (exudates) to develop microbial colonies around the root zone.

The majority of conventional farming focusses on nutrients in the soil and adding supplements to compensate for the lack of these nutrients. The lack of nutrients, if there is a lack, is in fact the lack of *available* nutrients in the soil. Nutrients are held in the mineral particles and organic matter in the soil and require the entire soil food web to release these nutrients and make them available to the plants. The fertility of the soil is the vitality of its microbial life. The soil life feeds on organic matter (decomposition) and mineral particles (chelation) to make the necessary nutrients available in the right form and amount in the soil. A halthy soil with a diverse soil life and good amount of organic matter will never be nutrient deficient.

Our method of working on the soil has been based on this understanding and involves the following techniques to improve and maintain soil health:

1. No tilling and minimum disturbance while weeding and planting
2. No compaction by walking on the paths
3. Minimising weeding
4. Returning as much organic matter to the soil as available. Often the crop residue of the bed is returned to the bed itself.
5. Mulching
6. Rotating crops from roots (create spaces in the soil) to legumes (add nitrogen)/ cereal (add carbon) to fruit/ leaf (cycle nutrients)
7. Planting diverse combinations to utilise different depths of the soil and add diverse organic matter.
8. Controlling erosion from wind and water by mulching and channelling water flow

Our work with the soil on the farm has been probably the most important and interesting learning during these years.

We were introduced to the work of Dr. Elaine Ingham by Spero, and we were fascinated immediately by the immensity and depth of the universe of soil microbes. During these years, we learnt more closely with Dr. Elaine and her colleague Dr. Carole how to observe the soil under the microscope, what to observe and how to work with this information.Soil microbilogy and succession are the most advanced and interesting aspects of soil science at this point. By zooming-in into the word of microbes, the story of soil can be unravelled. At 400x soil speaks and shows its own world, its own life (*see references for biology assays done for soil on the farm*).

We also used chromatography as a tool for assessing soil. Different aspects of soil seperate on the chromatograoh at different distances creating a stunning pattern that reveals the nature of the soil. However this technique and its accurate interpretations needs to be developed with more tests and comparisons.

A chromatogram of soil from the upper terraces of the farm made in March 2019.

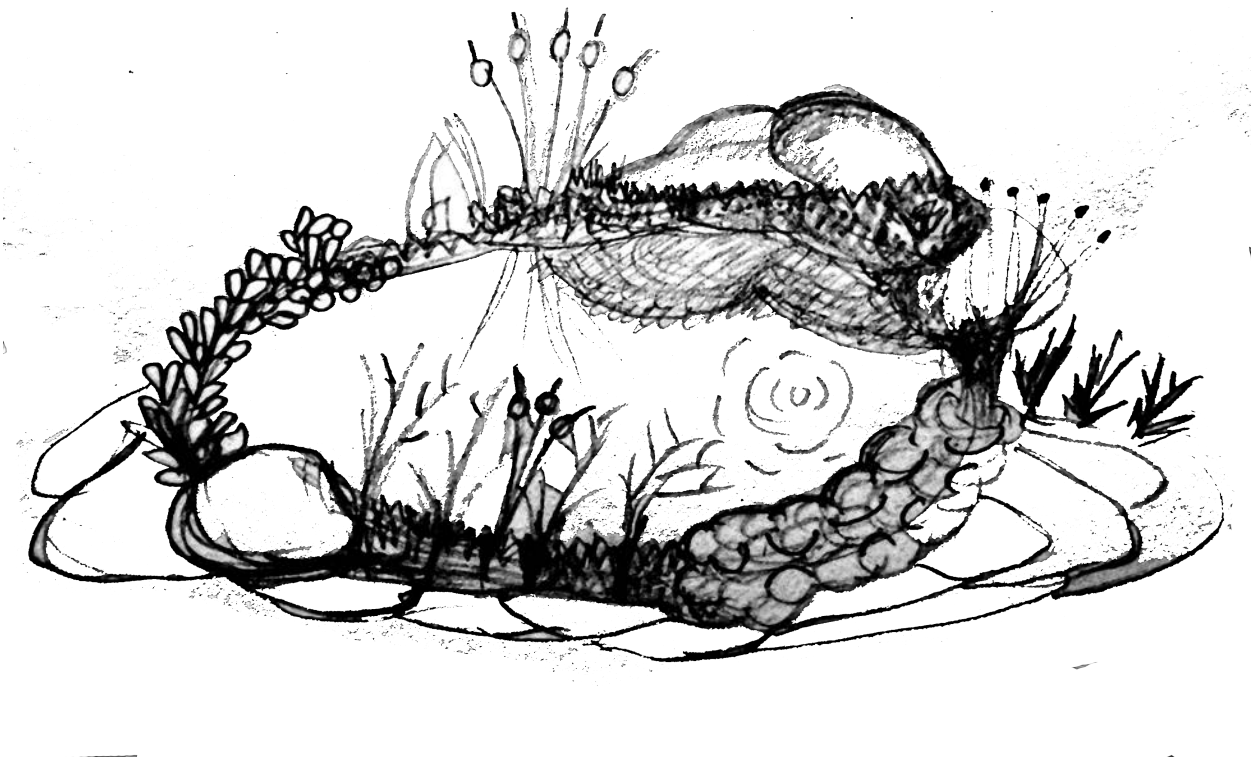
Water

This region of Himachal Pradesh is blessed to have abundant water resources. The water to the farm comes from the small stream flowing from the top of the village. This water has to be diverted into the channels called *kuhls* built for distributing this water across the village for domestic use and farmland irrigation. This water is alive as it gushes down, tumbling and crashing against the rocks picking up oxygen and vitality on the way. As its source is a natural springs and melting ice upstream, it is full of minerals as well.

On the farm, the strategy has been to hold and slow down the flow of water on the land and spread it across each terrace to allow it to infiltrate in the soil as much as possible before leaving the land at the lowest point. There is a system of ponds connected with water channels which fill up from the incoming stream of water or during rains. These ponds allow water to infilterate and create microclimates and habitats for frogs, birds and water loving plants.

Irrigation on the land is by flooding these channels and allowing water to be picked up by the edges of the beds through capillary action. The center of the bed is watered manually from the water in the channel. Although flood irrigation is not the most efficient irrigation system in terms of water use, beacuse of the requirement of significant investment in setting up and maintaining, alternative systems like- drip or sprinklers were not considered. Some of these systems could prove to be beneficial in some parts of the farm and can be explored when the next long term planning is done based on new lease agreements in 2021.

The lower fields specially the field close to the green house is often used as a nursery and for more delicate crops and thus watered by a hose or long range sprinklers attached to the water hose. The best time to water is in the late afternoons/evenings after the sun is already going down. This allows water to infilterate the soil during night without any evaporation loss. Many people suggest watering in early mornings also, but in our experience it is not as effective as watering towards the end of the day.
The irrigation needs on the farm have decreased over the years as the soil has improved, its structure and water holding capacity have improved and as more and more local and rainfed crops have been introduced on the farm. Though endowed with water itself, the farm exists in a country where 60% of all agricultural land is rainfed, and needs to respond to the quickly changing scenarios where even the mountains are facing water shortages. The effort has been to balance dryland farming with economically viable crops. As demand for more local and seasonal produce increases, the water requirements on the farm should decrease even more.



The Sun

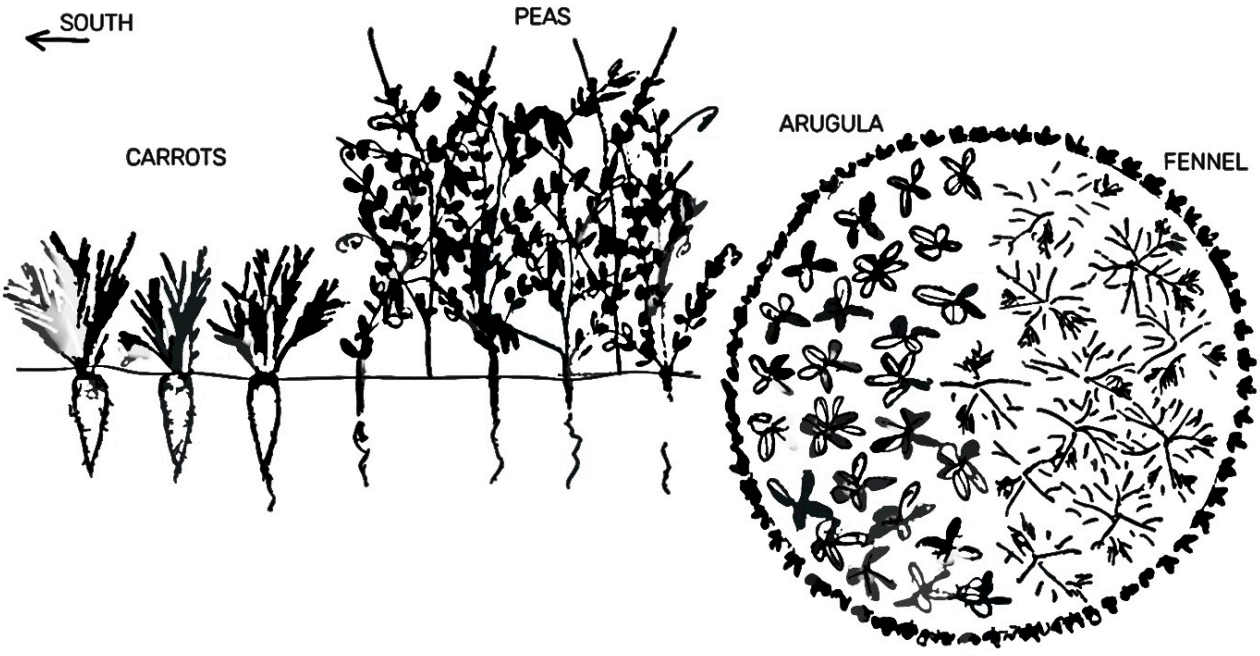
Imagine plants as solar panels and the farm as a large solar energy harvester. The energy from the sun catalyses the sythesis of food in plant body (the process of *photosynthesis*) and in doing so changes from solar energy (light and heat) to chemical energy (sugars) that feeds all the organisms, micro and macro, on this planet. An old growth forest is the most efficient in harvesting the sun as all the sun's light and heat is captured in the dense canopies at varying heights and barely any ray reaches the ground. This makes the forests a powerhouse for converting carbon dioxide in the air to organic carbon and sequestering it in the soil.

It is clear that farming a single crop which occupies only one layer within the vertical strata is quite inefficient. Depending on where on the planet the farm is, crops can be interplanted at multiple levels or layers to make the optimum use of the sun and the space, and in turn optimising and diversifying food production. Such farming also keeps the soil covered with plants keeping the soil temperature optimum for microbial life to thrive. The ideas of edible forests, food forests, agroforestry, multi-layer cropping, complex polyorchards and others are ways of integrating crops of different time and space to achieve this optimum density and diversity.

In the northern hemisphere of the earth, this would mean keeping the southern side open for sunlight to enter. Therefore, taller crops and trees are kept to the northern side with crops of decreasing heights grown on the southern side. If the tallest crop is planted on the southern most edge, it will shade out the rest of the crop behind it. As the sun path is much lower in the temperates and dips further during winter, this means longer shadows and presents the challenge of balancing the sun/shade and space in multicrops.

On the farm, the trees have been planted on the northern side of shorter crops. Also decduous trees have been planted in areas where summer sun needs to be kept out and winter sun needs to be allowed in. E.g. the mulberry tree on the southern face of the chicken coop gives shade and fruits to the chicken in the summer and in winter, loses its leaves to allow the sun to keep the chickens warm. Other examples are peas planted on northern side of mustard and pokchoy, willow (also deciduous) planted along the path, shrubs like cape goseberries planted on the southern side under trees etc.

An area which is open to the sun with trees growing on the north side to proetct the area from cold northern winds is called a *Sun trap*. Sun traps create a microclimate and benefit both tree and vegetable crops by reducing the stress from cold strong winds and by optimizing the sun exposure to all plants. In a typical Sun trap design, the trees on the north, curving to both east and west directions, are often of evergreen habit to ensure a dense windbreak during winter and there could be trees of the deciduous habit on the south side to protect the area from summer sun and allow sun in winters. We have tried this on a very small scale without evergreen trees on the north. We planted trees of varying heights on the north side and even though some of them lost their leaves, their structure still protected the shorter plants to the south from northern cold winds.

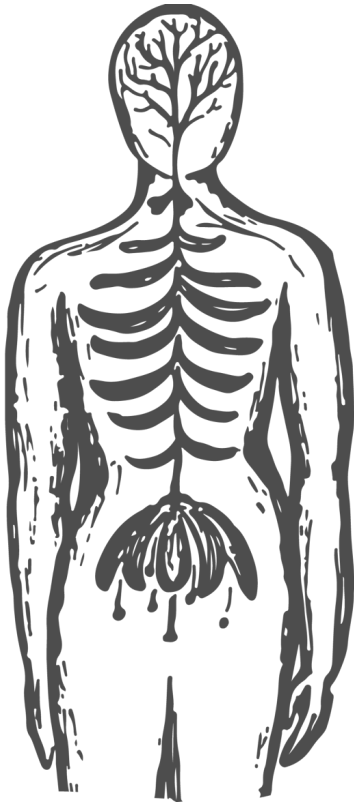


Plants

What makes plants unique from any other living being is they are autorophic, which means they have the ability to make their own food. By harnessing the energy of the five universal elements (air, fire-sun, water, earth-soil and space) and synthesising them, plants create sugars and all the other organisms depend on plants for their food.

Typically, all plants have a root system, a central stem and branches and either cones or flowers which develop into fruits or pods.

The physiology of plants and that of human beings is not that different and corelates to the elements beautifully.



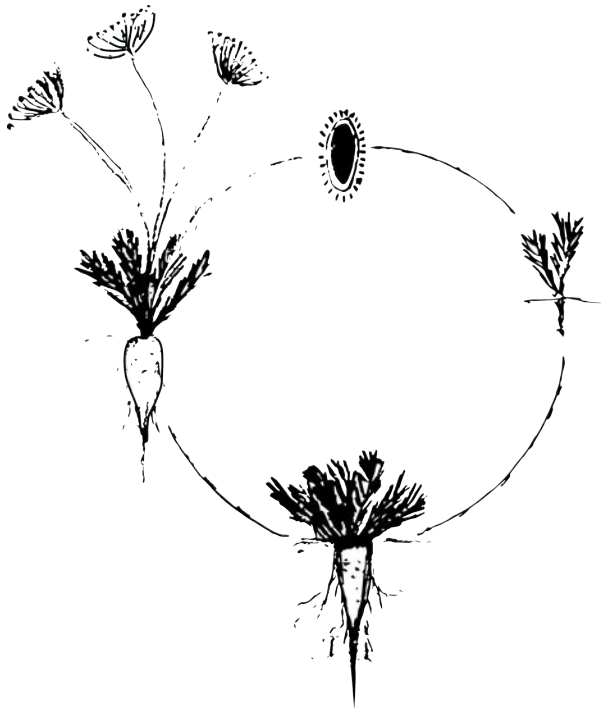
Plant	Roots	Stem & Leaves	Flower/Fruit
Human	Thinking	Feeling	Willing
System	Nervous system	Circulatory system	Reproductive system
Elements	Earth	Air and Water	Fire

The root system of a plant is responsible for anchoring the plant in the soil and absorb water and the dissolved nutrients as per the plant's requirements for its growth. They are the connection between the plant and the soil. Roots often end in microscopic root hair that are covered with millions of bacteria and fungi forming a vast network wherein water and food are shared within the soil. It has been well studied and documented how plants can communicate with each other through this network.
In nature, many different kinds of root systems can be observed. Some common ones are ***fibrous*** (like monocots, cereals, grasses), ***tap roots*** (in dicots, beans, okra, carrots, most vegetables, papayas), ***creeping roots*** (most trees), ***adventitious roots*** (maize, bamboo etc.) and ***tuberous roots*** (tapicoa, potato)

The shoot system of the plant is responsible for distributing the water, nutrients and the food prepared by the leaves throughout the plant. The shoots and branches organise themselves to receive the optimum amount of sunlight.

The reproductive part of the plants is the flower. Flowers can be ***unisexual*** (only male flower or only female flower) or ***bisexual*** (both male and female parts in the same flower). Further, the unisexual flowers could be on the same plant (both male and female flowers on a single plant, ***monoecious*** plants like cucumbers, pumkins, gourds etc.) or on different plants (a male plant with only male flowers and a female plant with only female flowers- ***dioecious*** plants like papaya, kiwi etc.). Again, all plants are not flower bearing (***angiosperms***). Some plants are cone bearing (***gymnosperms***) like pine and deodar.

Life cycle of a plant



seed – plant – flower – fruit – seed

A seed germinates under the right conditions of air, water and temperature and sometimes light. Germination means that the seed breaks from its dormancy and produces a short root to absorb water and nutrients to grow further. After the root, the shoot appears which develops into leaves. Uptil the leaves appear, the energy required by the seed to grow is supplied by the seed itself! After the leaves appear, they can photosynthesise their food which the plant uses to grow further. Leaves make their food during day time and this food is transported througout the plant body. At night all parts of the plant respire to through pores present on their surface to release energy from this food.
Studies show that besides feeding themselves, plants also share upto one-third of their food with the soil life around the root to encourage microbial activity and nutrient cycling.
Once the plant reaches maturity, it produces a flower (or a cone). Through the process of *pollination*, the male pollen unites with the female egg in a process called *fertilisation*. The fertilised egg then develops into a seed which then grows into a new plant altogether.

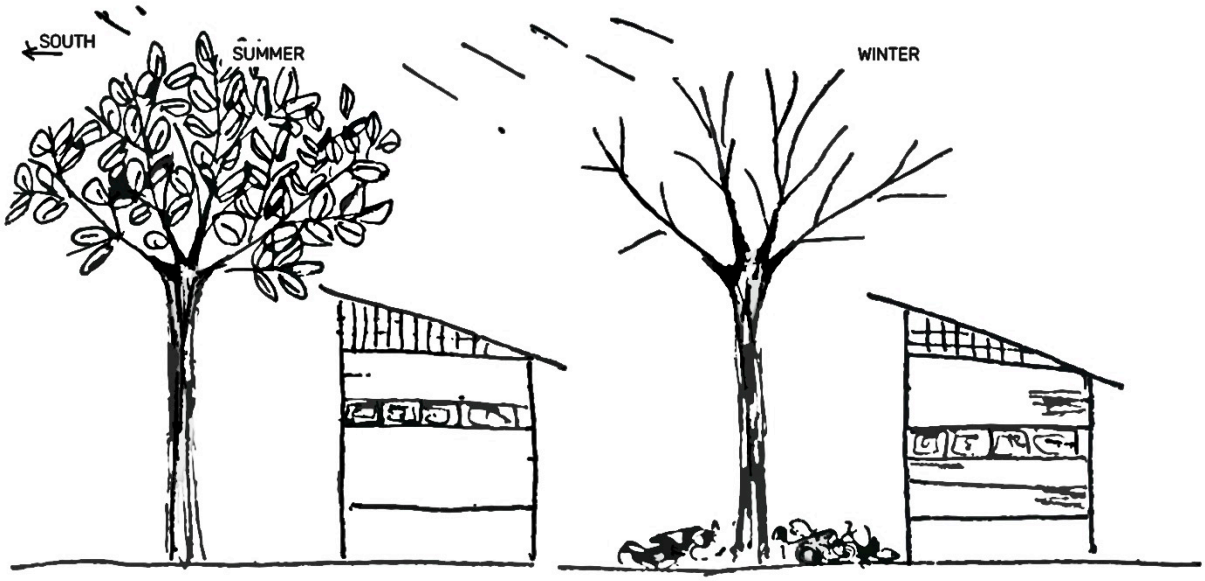
Depending on wether the flower is unisexual or bisexual and the plant monoecious or dioecious, the agent of pollination will vary. Bisexual flowers are often ***self-pollinated*** (pollen uniting with egg from same flower) and unisexual flowers are ***cross-pollinated*** (pollen from one flower unites with egg from a different flower on the same plant or a different plant altogether). The agents of pollination are gravity, wind, insects, bees etc. The variation in the method of fertilisation contributes to genetic diversity within a plant specie. Self pollinated plants are genetically consistent (successive genertions are closely similar to the parents) while cross pollinated plants are genetically diverse and evolve and adapt faster as genes from different plants mix and create new combinations.

Plants have a wonderful diversity in also how long they live for. There are grasses that die within a few months and there are trees that have existed for thousands of years.
Annuals are plants that complete their life cycle, produce seeds and die within a season.
e.g. most vegetable crops, cereals etc.
Biennials are plants that complete their life cycle, produce seeds and die within two seasons.
e.g. carrot, cabbage, wild onion etc.
Perennials are plants that survive for a number of years. They do not die off after producing seeds. Once they are mature enough, they keep producing seeds in a particular season every year until they reach the end of their life cycle.
e.g. shrubs and trees

As perennial plants live for many years, they go through the cycles of shedding and renewing their leaves. Plants which shed all their leaves in a particular season every year are called **deciduous** plants. Deciduous plants lose their leaves to avoid loss of water, conserve energy and reduce resistance to extremely hot/cold winds. The trees that lose their leaves before summer are called *summer deciduous* and are mostly found in warmer climates with extremely dry summers. The trees that shed their leaves before winter are called *winter deciduous* and are mostly found in colder climates. They regrow their leaves once the extreme season has passed. In the case of *Evergreen trees*, old leaves fall and new leaves appear throughout the year and thus they are green irrespective of the season.

Deciduous trees generally have higher growth rates and shorter life spans as compared to evergreen trees. Most of the fast growing pioneer tree species are of deciduous habit. Deciduous trees provide shade in summer and lose all their leaves in winter to allow the lower Sun to pass through. This habit can be used interestingly to create microclimates for houses and crops. Also deciduous trees create a lot of biomass in autumn/winter as they shed their leaves. Some of the fast growing species can also be cut down in winter to provide biomass for soil or for fuel, to grow back again the following season. Such trees can be densely planted between young fruit and on the edges of the terraces.

While planting, the path of the sun must be considered and the tall plants and trees must be planted to the north of the shorter plants in the northern hemisphere and to the south of the shorter plants in the southern hemisphere. By integrating evergreens and deciduous trees and combining with different shrubs, herbs and crops, it is possible to create food forest with at least seven layers of vegetation.



The list of plants growing at Shunya farm classified by their strata of growth is given in this list: http://bit.ly/bir_biodiversity

This is just an overview of the fantastic diversity of the plant life. This diversity has co-evolved and continues to do so with the changing environment, soil conditions, water availability, patterns of grazing etc.

Weeds

Weeds are seen as a farmers worst enemy as weeding is a time-consuming and back breaking work and counts for majority of the work on a market farm. To understand weeds, we need to understand the cycle of ecological succession. Every ecosystem is growing, becoming more and more complex over time. This is how barren lands, if undisturbed, would turn into grasslands, then shrubberies which will slowly turn into forests of growing diversity and complexity. This is a general example of ecological succession. Of course, every piece of and will have a diffrent trajectory on this succession depending on the climate, topography, water availability and other local context. This succession is an extremely slow process and can take about a couple of thousand years depending on different factors. Any disturbance during the course of succession, like a flood, forest fire, or humans cutting the vegetation and burning or even turning the soil, will *reset* this cycle. Weeds are the pioneers of the succession process. To maintain a farm to grow cereal crops and annual vegetables is to maintain the land on an early succession stage. This is the reason why effort is required always to work against succession and supress natural vegetation that we have come to call as weeds.

Weeds teach us a lot about our soil. Weeds are compensating for what is lacking in the soil. They are a way for nature to heal the soil. So before we take the weeds out, we must learn to observe what weeds grow where and how that could help us in managing our farm differently to work with nature and not against it.

Weeds often can also be utilised in cooking and/or as natural medicine. Discovering the benefits of weeds for human or animal health will add to the productivity of the farm and utilise a naturally growing resource. When a weed cannot be used directly, often a close or distant cousin of that weed that is useful can be introduced to the field. E.g. Dock is a naturally ocurring weed on the farm. It grows in places where the soil is moist. Although it's roots has medicinal properties, we cannot use all of it. There are varities of dock however of which the leaves are edible. We have introduced one such variety and it is doing really well. It is not competing with the native dock. This is an example how weeds can help us to learn and diversify the system. Also, we often planted different crops based on what kinds of weeds were growing on the land. Simple grasses (early succession) were replaced by cereals which are domesticated grasses, carrot grass was replaced by carrot etc.

Also keeping the soil covered by mulch or a crop will prevet weeds. Weeds grow to cover the soil, to protect it from erosion and utilise the sun to make food and feed the soil. If we plant densely or just grow a ground cover or green manure, there will be no space or need for weeds to grow.

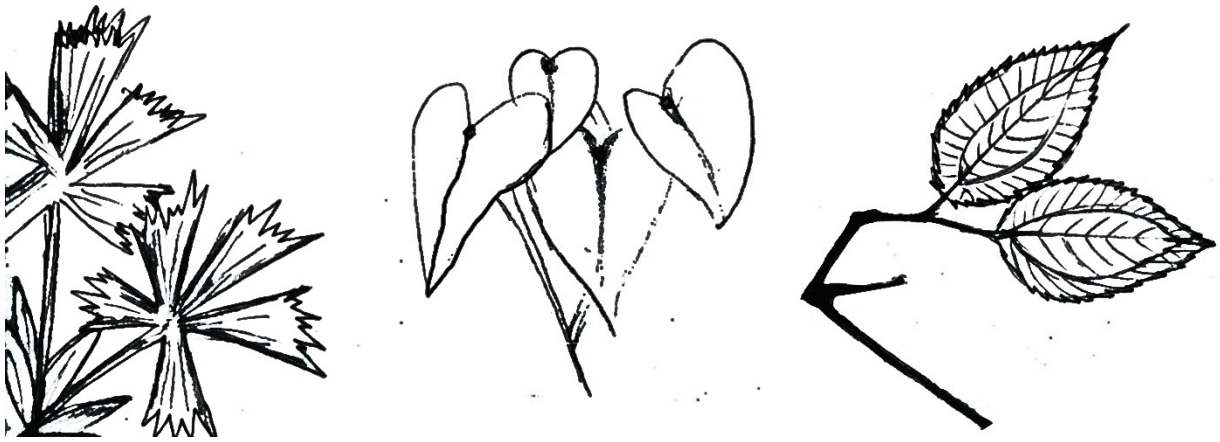
Times for weeding:

1. At the begining of planting
2. After the plants are 5-10 cm tall
3. During the life cycle of the crop only if the weeds are smothering a plant and not allowing enough sun to the plant. This is very unusual. By the time the plant is matur, it is high enough to receive all the sun and its roots deep enough to not allow shallow rooted weeds to compete with it for water and nutrients.

Where the weeds end up growing, make sure to cut them and drop them where they grow adding organic matter to the soil. This is called chop and drop and is also a way of utilising the natural biomass resource that weeds provide. Weeds should be cut as soon as they flower, before they go to seed. If sets have set, cutting the weeds will only spread the seeds in the soil, creating more work for dealing with the weeds in the future seasons.

We gradually learnt to make friends with the weeds on the farm and tried to learn why weeds keep coming back despite years and years of weeding. Allowing diversity in the soil, least disturbance while planting and harvesting, minimum weeding and maintaining soil structure by allowing good drainage and water movement will keep the soil healthy and reduce the pressure of weeds in the farm.

The basis of our farming has been to work with succession and introduce shrubs and trees everywhere to optimise the horizontal and vertical space of the farm, creating a multilayer edible forest by accelerating succession by ways of mulching, chopping and dropping and ading high fungal compost to the soil.



The edge

The concept of edges in Permaculture design is fascinating. Edges are boundaries of a system and as no system is isolated, edges are places where two systems meet. This makes an edge a very interesting and creative space. Edges dont only exist in physical systems and spaces.
The edges of cultures, ideas, human beings are as interesting and potent. Because the edges are not that obvious in most cases, they are often overlooked. As a designer, our role is to observe and value the edges. These are the places where even the impossible is possible!

The village of Bir itself is on the edges of the mountains, the forests and the relatively flat landscape. Then there are the edges of an ancient mountain Hindu culture and the spiritual Tibetan Buddhist spirituality, while also being on the edges of the traditional farming family systems and the new aspirations. These edges make Bir a hotspot for ideas and people.
That the farm is also on some interesting edges within Bir, makes it even more special.

Within the farm, the edges present immense possibilities for growing. The perennial vegetation mix of trees, shrubs, flowers and herbs making a living fence around the farm, the cow grass on the eddge of each terrace, bananas and other water loving plants on the edge of the channels are all examples of how physical edges can be used. As described before in the design chapter, some of these plants are grouped together based on their physiologies and durations optimising space and energy for cultivation.

Animals

Since the begining of agriculture, animals have been an integral part of the culture of farming and have been domesticated within the farming families for companionship, food, transport and as a source of labour and soil fertility. Farming in India is always associated with animals but even more so in the temperate cold regions. Here the families depend on the animals not only for dung, labour and milk/eggs but also for their meat. Traditionally the animals have been a source of food for communities in the mountains to compensate for the limited plant based food due to short growing seasons. Animals have also been integrated within human habitats examples of which can be seen in the traditional houses where big animals on the lower level provide warmth for smaller animals living with them and for humans on the upper level of the house. In Bir, the most common domesticated animals are cows, sheep, goats, rabbits and chickens and for many farmers are an inseperable part of the farm and their own lives. They care for the animals deeply and consider them as family.

However, at a larger scale, the recent industrialisation of agriculture has reduced the relevance of farm animals substituting their services of labour by machines. Also, industrial rearing (which is often called factory farming) of animals for their products has destroyed the sacred connection between animal and man, raising ethical questions and the ecological impacts of such farming and consumption. Use of antibiotics to sustain hybrid animals in cramped spaces, growth hormones for increasing production of milk and eggs further has immdiate and long term consequences on the health of the consumers of these animals. This alongwith the reducing number of people in farming families, is making it more and more difficult for only a few people in the family to farm, take care of the animals, each other and themselves. Thus animals in farming has become a rather controversial subject with its far reaching ecological, economical and social impacts.

Also, as communities become more and more fragmented, care for animals on community and even family levels has become a challenge, particularly for large animals like cows. For us, having animals on the farm adds diversity to the life, activities, relationshps and harvests of the farm. The ethic of integrating animals on a farm is to allow a good and full life to the animal, to allow the animal, as any other element on the farm to express its nature wholly. The role of the farmer will be to integrate the nature of the animal, its habits of eating, sleeping, resting, reproducing and excreting within the activities of the farm and its elements. A healthy and happy animal is a member of the farm family and to use its products such as manure, eggs, milk, meat etc. is finally the choice of the farmer. But if a farmer doesnt use any of these animal products, it is irrelevant to have an animal on the farm and adding an element to the farm system that will not feed the system somehow. Even a farmer exists within the farm system to serve the land, the plants and the animals for his/her food.

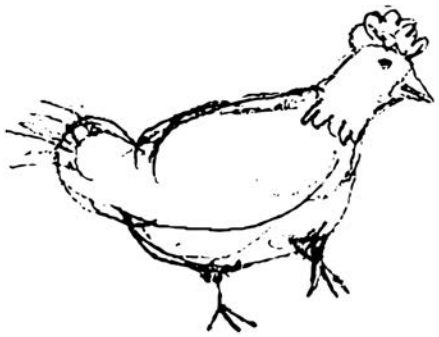
For Shunya farm, we decided not to have a cow or goats on the farm because of the following reasons:

1. A cow either requires a pasture land for grazing or food needs to be cut and brought to the cow every day. Taking the cow to graze in the forest or cutting and bringing food for it is a time consuming task and was not feasible for a three member team involved all day on the farm. Goats too need to be taken out to graze in the forest every day.
2. The products from a cow/goat, milk and dung are easily and abundantly available in the village and thus keeping your own cow/goat has little motivation.
3. Limitation of space on the farm, and limitation of funds to invest in a pen for cows or goats.

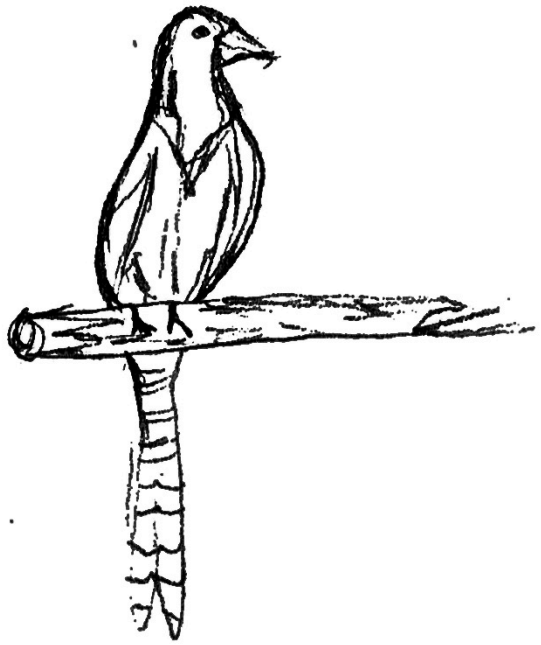
Chickens, however eat scraps from the kitchen and the farm, have much smaller footprint and are easy to keep. There were also not too many 'free range' desi (country) chickens in the village and we saw eggs from these chickens as a healthy adition to the harvests of the farm. The chickens were brought from Sehl, a small village about 10 km west of Bir from a farmer who had a big flock of country chickens.

Before the chickens were brought, a coop and a fenced off area was constructed and prepared keeping in mind their protection from dogs, mongoose and other predators, their needs for space in the coop and the free range area, sun/shade, food requirements etc. Three hens and one cock were brought in January 2019 as a minimum flock size to address the animal's social needs.The chickens eat all their food from the farm, their manure adding fertility and diversity to the compost and the soil and their wholesome eggs feeding the people working on the farm and the community that buys food from the farm. The emphasis, however, has been on the well being of the chickens and not on egg production which is only an outcome of healthy and happy chickens. The bedding from the chicken coop is cleaned every week or couple of weeks and this straw, corn material mixed with nitrogen rich chicken manure is utilised for composting.

There are ways of allowing chickens into the fields after a harvest to let them peck at the weeds and bugs. We never tried it because the chickens were still quite small and also that on a small intensive farm a strong protection to the ongoing crops would be required. Such systems (chicken tractors etc.) could be tried in the future depending on time and resources. Besides the obvious products, the chickens added a much required livliness to the farm, another layer of learning and ecosystem relationship making the entire place and the work around it richer.



Integrated pest management



Pests and diseases are an indication of a system that is inherently week and are nature's way of cleaning up a system. Monocropping encourages only a single insect associated with the standing crop to grow and multiply without providing a foodcrop for the predators to maintain the balance. Stress to the crops due to unhealthy soil, lack of water, lack of robust seeds to begin with, unfavourable climates or time of the year also make the crops susceptibe to pests and diseases. A healthy farm will have diversity of insects and no particular insect will become a pest. Chemical interventions against pests and diseases are even more detremental to the health of the system as they kill more life than they are supposed to. Also, such interventions put us in a retaliatory response against nature. Beside polluting the soil and destroying life, these chemicals enter the food chain and are responsible for many immediate and long term genetic health complications in humans and animals. Even the so called *biological* sprays and pest controls only solve the symptoms of a deep health issue.

During our work on the farm we found that the aphids (pests for brassicas and many other crops) decreases substantially as we improved the diversity of planting, added flowers and aromatic plants to attract more insects. Within a year, we saw a large number of ladybugs "*appearing*" on the farm and balancing the aphid population. We still had aphids on some crops, but it was a much small proportion of the entire crop and seemed a healthy part of the overall system. Similarly as the soil structure and seeds improved, fungul diseases on tomatoes and leafy greens started reducing. To combat diseases, we found focussing on really good quality seeds (self grown and open-pollinated) was the most effective strategy.

The edges of the farm and every terrace have been planted with wild native shrubs and flowers to create a habitat for a diversity of insects to keep a healthy prey predator relationship. Finally, these are the strategies we have found to be most useful:

1. Observing what plants get the pest and the disease
2. Removing diseased plants to prevent spreading
3. Adding diversity
4. Working on soil health
5. Using strong seeds

Pests and diseases provide an opportunity to learn what is lacking in the system and do what is required to build the strength and vitality of the soil and the farm. This process is much slower than adding a bio or chemical pesticides but is a much more effective and permanent solution. This is the way of a natural farmer, of observing and making the least change for the system to heal and restore its balance.

Humans

As human impact on the planet increases due to incresing population and growing industrial activity, many have wondered if earth would not be a better place without humans at all. It has become common to think of humans as pests. This line of thinking is not only unethical but also deprives us from the power we have to transform the current situation, to utilise the tools nature have given us, and to move forward and manifest the seed of the potential of humanity on this planet.

Farming is an activity on the edge of human and nature. However, it is not only humans who farm. Ants have been farming fungi since before humans could walk on two feet. All organisms modify their environments to sustain, feed themselves and reproduce. In our journey, we have the current system of agriculture as our way of farming. This, no doubt, needs to and will change as we learn and understand better. It is important to see a farm and the farmer together as it is important to see the farm with all its plants, microbes, birds and insects. The health and spirit of the farm is intricately linked to the conciousness of the farmers. As we learn and grow and make better choices for ourselves and our social and natural environment, our farm becomes richer and so does our life.
The evolution of the farm and the farmer are the same thing.

While we must focus on soil, water, plants, etc. we also must take time to listen to our selves and each other, empowering our conciousness as we will the spirit of the soil, working not for the farm but for life of which we are an integral part.
By observing closely, we can continue to learn about our selves and each other as much as about farming.

For most new farmers, farming can be physically intensive. Working with the body is a skill that can be developed slowly. Work on a natural farm is not about power and stregth but about thoughful and rhytmic actions. Such a work also allows to see the insvisble and to listen to the unspoken. It is as important to take care of oneself on the farm as it is to take care of other people working with you. The care for earth and care for people are integral to the working of a natural farm.

Seeds

As described earlier, all plants propagate by producing seeds. A seed is the most powerful asset of a farmer and saving seeds a duty every farmer has. Seeds are the promise of a resilient culture of food to the future generations.

With the transformation of agriculture into an industrial process over the last 60 years, high yield varieties of seeds and emphasis on standardization and monoculture have led to the disappearance of local seeds and the knowledge to cultivate and propagate them. Desi seeds (or native/indigenous seeds or heirloom seeds) are the heritage of a community that not only represent the culture of a community but also holds the memory of its larger environmental context. These seeds are open-pollinated and thus are diverse and resilient to changes in the climate they grow and evolve. Communities also save their seeds based on the food they like to eat, the health of the plant in their context and the needs of the plant that can be met easily.

Thus, a farmer saving her/his own seed is not only independent of the exploitative industrial seed corporation but also has autonomy and power in deciding what food they want to grow and eat creating a culture of food sovereignty. Open-pollinated seeds are also resilient and more productive over the long term than the "high yield" varieties of seeds available in the market, especially in the rapidly changing climate and environmental context.

During 2016-2019, we managed to grow and conserve a bank of diverse seeds, some native and some naturalized in Bir over the years and made them available to the local farmers and to urban migrants aspiring to grow their food. The seed bank continues to grow in diversity and amounts and the seeds continue to get better every year and are less resource-intensive and more productive for the amount resources they use.

List of seeds available on the farm:

CEREALS	**OIL SEEDS**	**TUBERS**	**ROOT VEGETABLES**
Wheat desi	Sunflower	Potato	
Barley naga	Flaxseeds	Colacasia	Radish green
Oats	Soybean white	Sunchoke	Radish white
Corn desi	Soybean black	Air potato	Carrot
Corn colombian	Mustard rai	Turmeric	Beet root
Amaranth	Mustard yellow	Ginger	Turnip
Buckwheat	Fenugreek		
LEAFY GREENS	**SALAD**	**GOURDS**	**VEGETABLES**
Spinach	Lettuce green	Pumkin white	Onion
Bokchoy	Lettuce purple	Pumpkin red	Garlic
Collards	Arugula	Pumpkin desi	Tomato cherry
Kale		Sparrow gourd	Chili
		Bottle gourd,	Green peas
		Ridge gourd	Snow peas
		Cucumber desi	
BEANS	**HERBS**	**FRUITS**	**FLOWERS**
Bean french	Basil Tulasi	Cape Gooseberry	Cosmos
Bean Colombian	Basil Genovese	Mulberry	Dahalia
Bean Piriguya	Basil Himachali	Tree Tomato	Peruvial marvel
Rajma	Corriander		
Fava bean	Parsely		
	Celery		
	Fennel		
	Dill		

Saving hybrid seeds

Seeds are saved from a plant grown from a hybrid seed, will not produce the same characteristics of the hybrid seed (F1) itself. When necessary, seeds from F1 hybrids can be saved but need to be carefully selected for desired characteritics in the successive generations.

Seed saving

Different kinds of seeds require different ways of harvesting and cleaning. These are some common ones:

Fruit vegetables

Tomato

i. Let the fruit ripe on the plant and harvest when it is ready to eat.
ii. Squish the tomatoes and remove the seeds in a jar or a bowl and add a little water.
iii. Leave the jar/bowl with the water and the seeds for a couple of days to ferment. This fermentation helps to dissolve the jelly like coating around seed. In nature, this fermentation happens naturally within the fruit as it rots.
iv. Make sure to not let the seeds ferment so much that they start rotting or germinating.
v. After a couple of days, remove the seeds from the jar, wash them and dry them on a piece of thin cotton cloth is shade.
vi. Once dried, remove the seeds from the cloth and pack.

Pods

e.g. Mustard family- Mustard, Radish, Arugula,Bokchoy, also same for Lettuce (Aster family)

i. Let the pods dry on the plant but harvest before they pop and lose the seeds.
ii. Cut the plant stem 3- inches above the ground and keep carefully in a sac or a tray as you go along the field collecting. Excessive movement or shaking of the plants can make the pods open and the seeds to fall.
iii. Tie the stems in a bundle and put them in a sac with th pods facing down. Hang the sac and the bundle in a dry shaded places for a few days.
iv. After the pods and the stems are completely dry, shake the stems within the sac to dislodge all the seeds. Collect the seeds in a container and leave them to dry for another couple of days after which they can be packed.

Legumes

e.g. Peas, Beans

i. Let the pods dry on the plant but harvest before they pop and lose the seeds.
ii. Collect the pods from the dry plant and dry them in shade.
iii. Remove the seeds from the pods and leave them to dry in shade for a day or two after which they are ready to pack.

Cucurbits

e.g. Bottle gourd, Ridge gourd, Sponge gourd

i. Let the gourd ripe on the vine well above the edible stage.
ii. Harvest when the vine is completely dry and the gourd covering turns hard.
iii. Hang the gourd from the tip in a shaded dry place.
iv. Let the gourd dry completely. The outside covering will lose all its colour.
v. Gourd seeds conserve well inside the shell and can be kept like this for years.
vi. Break open the gourd or cut a hole at the bottom to remove the seeds when required. The shell can be used as a container or a bird house.

Pumpkin

i. Harvest the fruit when it is ready to eat.
ii. When the pumpkin is cut for eating, remove the seeds and wash them under running water to remove the pulp.
iii. Dry on a thin cotton cloth and pack.

Cucumber

i. Let the fruit ripe completely well above the edible stage. The fruit will become hard and change colour.
ii. Harvest the fruit once the vine or the connection between the vine and the fruit is completely dry and breaks off easily.
iii. Open the fruit and scoop out the seeds and put them in a container.
iv. Pour water in the water and massage lightly the seeds to get the pulp out.
v. Leave the container for a day or two to ferment. This is required to break the jelly like covering from the seed.
vi. After a couple of days, remove floating seeds if any and sieve the water and the pulp out.
vii. Dry the seeds on a thin cotton cloth in shade. The seeds will stick to the cloth once dried.
viii. Remove the seeds from the cloth and pack.

Herbs

e.g. Rosemary, Thyme, Fennel, Celery, Tulasi etc.

i. Let the seeds dry on the plant as much as possible and harvest before the plant dries completely and the seeds fall on the ground.
ii. Cut the plant stem 3- inches above the ground and keep carefully in a sac or a tray as you go along the field collecting. Excessive movement or shaking of the plants can make the seeds to fall.
iii. Tie the stems in a bundle and put them in a sac with th pods facing down. Hang the sac and the bundle in a dry shaded places for a few days.
iv. After the pods and the stems are completely dry, shake the stems within the sac to dislodge all the seeds. Collect the seeds in a container and leave them to dry for another couple of days after which they can be packed.

These are only some examples. Most other seeds can be saved similarly depending on the kind of plant. The basic requirements are that seeds mature to the fullest on the plant itself, are dried in shade and packed and stored carefully.

Packing and storing seeds

Seeds are best kept in a breathable materials like paper, cloth or ceramic pots.
In humid regions, the seeds can be put into paper or cloth and then put into glass jars or pastic packets for long term storag and viability.
Seeds packed directly in glass jars and kept away from light, as is the case on the farm currently, will keep well for a couple of years.
The seeds need to be stored in a cool, dark and dry place to keep the three things that facilitate germination away from the seeds- warmth, light and moisture.

Starting seeds in a nursery or direct sowing

The ideal way to grow plants is by directly putting the seed in the ground and letting the plant grow without any disturbance. However, sometimes plants are started in a nursery earlier than the season to make use of a short season or for efficiency. All seeds planted in the field may not germinate and caring for young plants in a large area can be difficult in some cases. Preparing a nursery and then taking well established plants to the field can save time and resources in these cases.

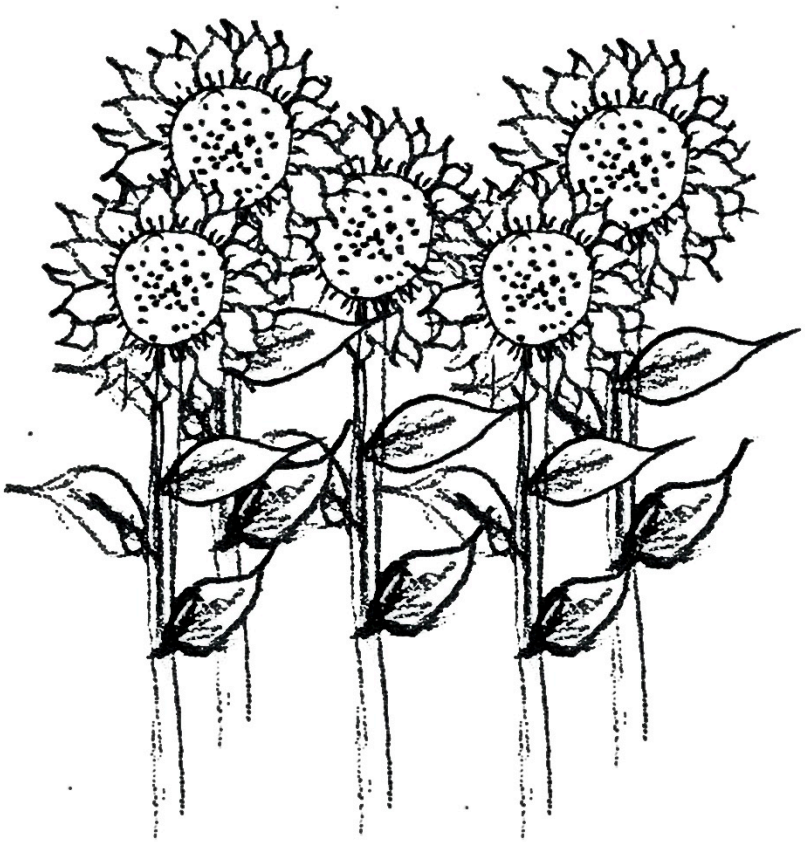
All seeds need water, air and warmth for germination but there could be seeds than need some particular conditions to be able to break dormancy. The balance of air and water is critical for seed germination and development of a healthy young plant. For this good draining nursery soil (1/3 garden soil + 1/3 compost +1/3 sand) is the best medium. The stream flowing from top of the village brings sand with it in the irrigation channels and deposits it in the uppermost pond. This sand is not only good for the structure of the nursery soil but is also rich in minerals.

Typically seeds are planted at a depth from the surface same their longest edge. In extreme summers some hardy seeds can be planted deeper to save them from drying out too close to the surface or in winters some seeds are planted deeper to give them the required warmth to germinate. Seeds planted too deep will not have the energy to produce a shoot long enough to reach the surface.

If planting in the nursery, care should be taken for which seeds and plants need more sun than others. Plants like beans, cucumbers, pumkins, gourds, need good sunlight to grow. If these seedlings are kept in shade, they will grow thin and tall stems (trying to reach higher for the sun) that are weak. Most leafy greens and herbs saplings can tolerate shade.

Transplanting

Transplanting from the nursery to the beds should be done in the evenings to allow the plant to settle in its place overnight before it starts activity the following day. Evenings also keep the soil moist which is essential for the plant to adjust and establish its roots in the soil.
Care should be taken to avoid any damage to the roots of the young transplants. Watering the plant well before the transplanting can help to remove the plant with least disturbance to the roots.



Vegetative propagation

While all plants propagate through seeds, some plants have also the ability to grow a completely new plant from a small part of the mother plant. This is called vegetative reproduction. As this reproduction is asexual, the new plant is an exact genetic copy of the mother, a clone of the mother plant. Plants grown in this way grow faster than from seed are sometimes desirable as the exact characteristics of the mother plant can be replicated e.g. in fruit trees. But, having all the plants of a species with the same genetic makeup will make the crop/plantation susceptible to disease and will lack the diversity of form and flavour.
Where possible, plants should be started from seeds to allow nature to diversify and evolve, however in some cases, vegetative reproduction is unavoidable.

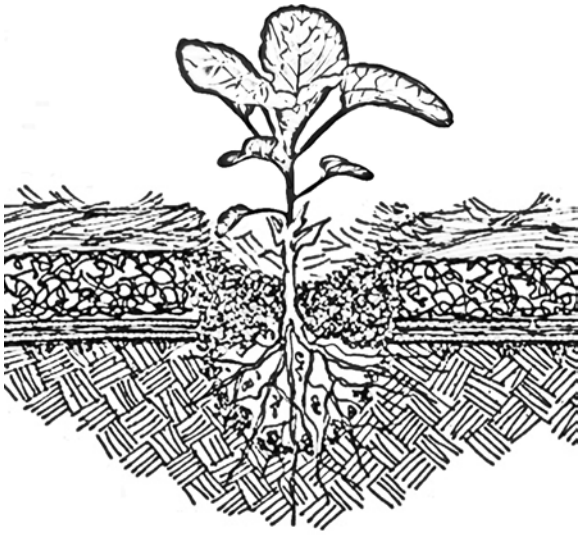
Division is the process of splitting the mother root crown (the interface between the root and the shoot systems) into smaller crowns. Suckers, tubers and runners can be propagated this way. The best time to divide the roots in the context of Bir is just before plants start to grow and spread vigourously in monsoon.
e.g. Banana, cana lily, mint, lemongrass, perennial garlic, strawberry etc.

Cuttings of stems from the mother plant can also be made to grow new plants.
Once planted in soil, these cutting give off roots and develop into a full plant by themselves.
Cutting must be done carefully so as to not harm the mother tree. Sharp and clean tools are absolutely essential for this. Cuttings are usually made when the plant has finished fruiting/seeding. This is a dormant period for the plant and the shock of cutting the stems from the mother is the least. The stem cuttings do well if they are about 30 -45 cm long. The part of the cutting going in the soil should be cut at a slanting angle to give maximum area in contact with soil for rooting. The end on the top should be cut perpendicular to the length of the cutting to minimise the surface area from which water can be lost. The soil in which the cuttings are planted should be well draining and must remain moist throughout. Drying of the soil will kill the cuttings.The rooting should take a couple of months. Once the leaves on the stem appear and grow big enough, the cuttings can be transplanted where needed.
e.g. Mulberry, blackberry, Himalayan raspberry, willow etc.

Layering is a method where stems start producing roots as they come into contact with the soil while still attached to the parent plant. Long stems from blackberries and wild berries touch the soil as they get heavy and root naturally to produce a new plant. In this way they spread in space. Strawberries do the same. Such plants are also called runners.

Some plants can also be propagated from cuttings of roots and leaves but we never had to do that on this farm.

Mulch



Any biomass that is used to cover the soil is called mulch. Mulching is a strategy inspired from natural forests where dry leaves falling from trees keep the soil covered throughout the year. Mulching is absolutely essential for a natural farm irrespective of geography and season.

The benefits of mulching for the soil and the plants:

1. Reduced evaporation of soil moisture helping to reduce irrigation needs
2. Reduced compaction from rain and animals/humans walking on the soil
3. Reduced erosion from wind and surface run-off
4. Habitat creation for critters and soil microorganisms
5. Decomposing mulch adds organic matter and nutrients to the top soil

As natural farmers, we must value every bit of biomass and return it to the soil directly or through compost. The farm should produce its own food and for this many fast growing trees and shrubs have been planted along the edges of the farm and the beds. The diversity of the biomass is as important as its quantity. A diversity of biomass means a diversity of food for the microrganisms which in turn supports a diversity of microroganisms in the soil.

What kind of material can be used for mulching?
Any natural material can be used for mulching, but the best mulching material is what grows on the land itself. Diverse plants that grow fast and can tolerate frequent cutting and chopping should be utilised for this. A diverse and local mulch is the most appropriate food for the soil.
Material which is rich in cellulose and lignin will add more carbon to the soil and material wich is green and freshly cut will add nitrogen. These materials must be alternated within the mulching layers to maintain the carbon-nitrogen ratio and give a balanced food to the top soil microorganisms.

Fast growing trees and shrubs for biomass:
The foundation for soil work is adding organic matter to the soil to feed the life in it. In temperate zones, plants grow slowly and therefore a farm needs to have sufficient trees and plants that can generate enough biomass to be added to the soil throughout the year. Some of these plants that we have found to be effective in Bir are:

PLANTS	LOCAL NAME	BOTANICAL NAME	DECIDUOUS / EVERGREEN	PRUNING HABIT
White willow	Beyuns	Salix alba	D	Pollard in winter
Weeping willow	Beyuns	Salix babylonica	D	Pollard in winter
Beul / Bhimal	Beul	Grewia optiva	D	Pollard in winter
Mulberry white	Toot	Morus alba	D	Pollard in winter
Orchid tree	Kachnaar	Bauhinia variegata	D	Pollard in winter
Nepal alder	Unis	Alnus nepalensis	D	Pollard in winter
Nettle tree	Khirk	Celtis australis	D	Pollard in winter
Banana	Kela	Musa	E	Coppice after fruiting or in autumn
Black elderberry	Kali beri	Sambucus Nigra	D	Prune back in winter
Stinging nettle	Aen	Urtica dioica	E	Coppice in winter

Besides these there are several trees like Oak (*Quercus leucotrichophora)* and Bhadrol (*Machilus odoratissima)* that provide large amounts of biomass through their thick foliage that sheds itself every winter, but they take a long time to grow. The plants listed above are all native species. There are also fast growing grasses like the tall fescue which is popular in the region of Bir as a cow grass. Such grasses are good for mulching or could even be exchanged with local farmers for cowdung or dry biomass. Other potential plants that we think have potential in this regard are Castor (it grows naturally along roadsides and where the soil is dug to make bridges etc.) and Black locust (*Robinia pseudoacacia*) which can also be seen in the recently afforested areas managed by the local Forest Department.
The foreign pioneer species can initially be used to generate biomass and feed and recuperate the soil and can be replaced completely in 3-6 years with native deciduous and evergreen tree species. While choosing native or foreign species, in our experience, it is better to create an integrated plan where both natives and new species can exist and have their role. This creates diversity and possibilities for the changing ecological and social systems.

Compost

Compost is decomposed organic matter rich in soil life and nutrients. The compost is as much an innoculum of a diverse microbiology as it is a fertiliser for the soil. In natural systems, compost is made continuously on the forest floor as dry fallen leaves layer upon each other mixing with animal dung, dead plants, water from rain, etc. The rate of decomposition varies with temperature and humidity of a place. Decomposition is faster in warm-moist conditions and slow in cold-dry conditions.

For making compost, we rely on the natural process of decomposition and thus we must mimick the forest floor - good aeration, moisture, shade and protection from direct rain and wind. Accelerating this process, where required, can help us heal the soil faster and move forward in succession in a much shorter time. A good compost can be to soil health what Yoga is to human conciousness.
In a composting process, we can accelerate this decomposition by the using some or all of the following methods:

1. Shredding or cutting the organic matter for higher surface area
2. Creating heat in the pile by controlling the C:N ratio
3. Maintaining moisture to keep the biological activity going
4. Adding and maintaining worms to devour the organic matter quickly
5. Turning the pile to mix the undecomposed material

Each of these strategies have their advantages and limitations and the composting method for each farm will evolve based on:

1. Locally available organic material
2. Proportion of carbon/nitrogen material available
3. Requirements of the compost
4. Availability of machine/labour to shred and/or turn the compost
5. Availability of water

<u>Is compost really necessary?</u>
Composting is definitely an additional activity on the farm and many natural farmers dont see the necessity to make compost. If organic matter is added directly to the soil as mulch or in trenches along the bed, it will decompose on its own over time. However, a good quality compost can add the necessary humus and biology to the soil in a short period of time, specially if the soil health is poor to begin with. In a compost, it is much easier to maintain a balance of kinds of organic matter and ensure aerobic decomposition. Also, organic wastes such as humanure and kitchen wastes cannot be added directly to the field unless composted. Compost can also be made into a liquid extract which can then be broadcasted over a large area which may be a useful strategy for young farms which do not have enough biomass to add to the soil directly.

Composting is also a good way to learn how natural decomposition works and the processes of the microbial activity in the soil. Composts can also be made according to the soil biology required to grow particular crops. For example, high fungal composts for trees and orchards, a fungal-bacterial balance for grains and cereals and bacterial dominated compost for annual crops.
The choice of composting or adding biomass directly will depend on the availability of biomass, time, labour and intention of the farmer.

Compost foods

The organic matter that feeds the compost is typically classified as:

1. Carbon rich- basic building block of life
2. Nitrogen rich- crucial for growth of microorganisms and plants, required for formation of proteins, enzymes and DNA.

The ideal C/N (carbon to nitrogen) ratio for composts is 30:1.
At lower ratio i.e. a nitrogen rich pile, the nitrogen is lost as ammonia as there isn't enough carbon to bind it. Also, high nitrogen leads a tremendous growth of bacteria. As bacteria grow in enormous numbers, they create heat and suck up oxygen from the pile, making it anaerobic. This is the case with most stinky piles. At a higher C/N ratio i.e. a carbon rich pile, there is not enough Nitrogen for the growth of microbes and the decomposition is very slow.
All kinds of organic matter can be added to compost, however, in a balance. A diverse pile will create diverse compost with a variety of nutrients and microbes. Too much of a particular kind of food may be detrimental depending on the type. Like in all living processes, balance is the key to a healthy compost.

Kinds of compost

1. ***Thermal composting*** relies on heat generated by high Nitrogen biomass like animal dung to *cook* the compost faster. As bacteria multiply in huge numbers in such a pile, it is important to turn it and aerate to prevent it from going *anaerobic*. Turning also helps in bringing all the biomass to the center of the pile where the temperature is highest for even decomposition.
2. ***Worm/vermi composting*** relies on compost worms to digest the biomass and excrete *worm castings,* which are inoculated with a diversity of bacteria residing the gut of the worms. The worms used for composting are the surface dwellers (*epigeic*) different from worms found inside the soil. The surface dwellers live in a moist organic matter rich environment. While they are very effective for composting, they will not aerate the soil by digging into it. We have indegenous epigeic worms helping us with the composting and they can be found naturally in a cowdung pile or in the banana circles on the farm.
3. ***Static composting*** is piling together the biomass as available or in desired C/N ratio and leaving it undisturbed till the the time it decomposes by itself. Most farmers in India use this method for animal dung, leaf waste etc. Though it is less work, a static pile has the risk of going anerobic, leeching and not enough carbon, nitrogen or moisture for a steady and even decomposition.

Thermal compost for Shunya farm

For the farm we have been making thermal compost since 2017 inspired by the principles and strategies from Dr. Elaine Ingham's work. The material used to make compost is collected seasonally from the farm and nothing is bought from outside. We have been using some cowdung from the neighbours' cows as the high nitrogen part of the compost.

We have two recipes now- one for *high fungal compost* for trees, perennial crops and poor health terraces and the other for *balanced bacteria-fungal compost* for most annual crops developed over a year of experimentations with different materials, proportions and desired temperatures (see next page). During this experimentation, we also observed the compost under the microscope to assess its biology, the ration of bacteria and fungi and thus were able to establish the relationship between the proportions of carbon/nitrogen and fungi/bacteria.

Recipes (percentage by volume):

High fungal	Balanced
60% carbon	50% carbon
30% green	40% green
10% high nitrogen	10% high nitrogen

40 full vegetable crates are enough to fill one compost pit of 1m x 1m x 1m.

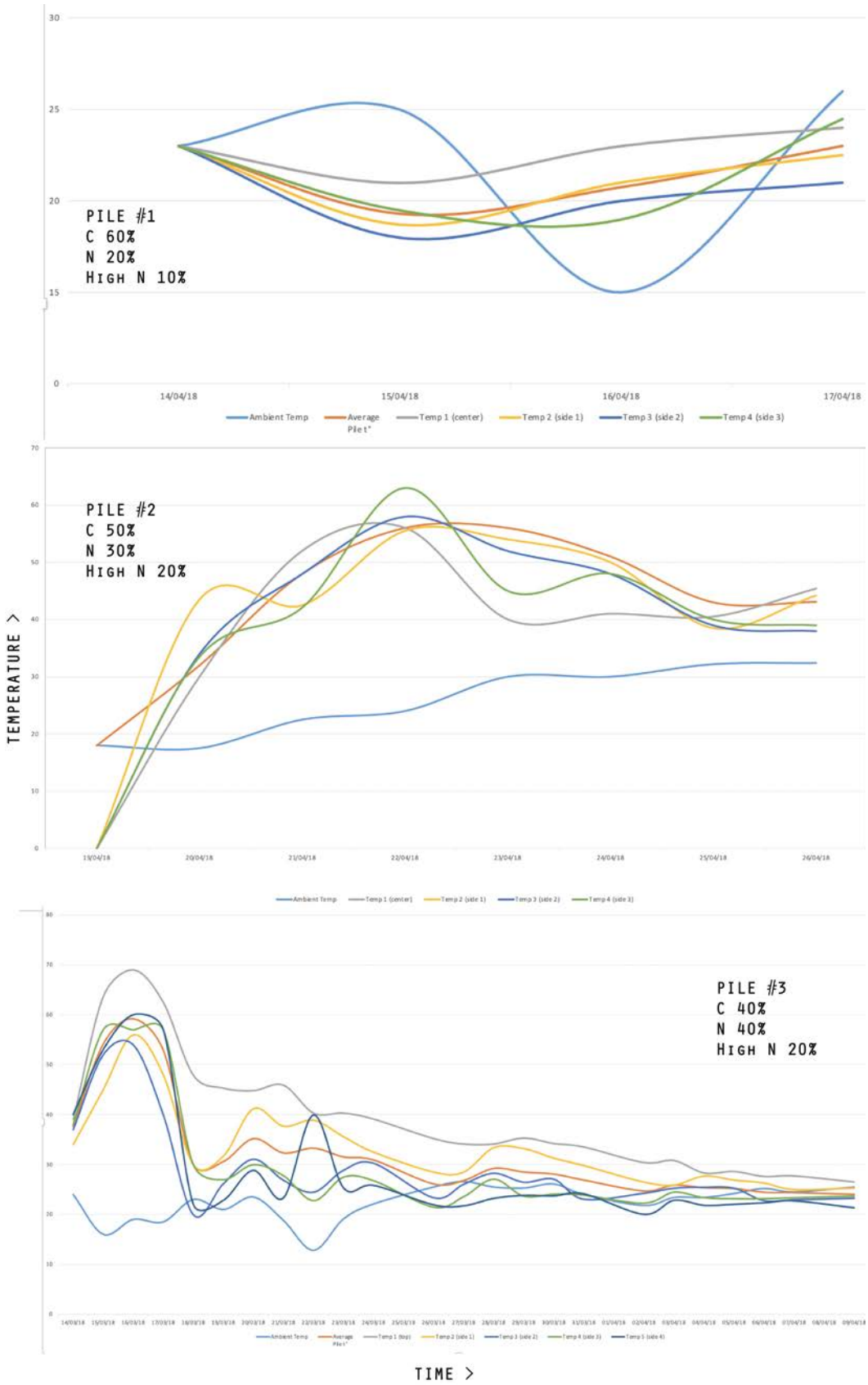
The process

The biomass is cut into smaller pieces as much as possible. It is added in layers in the pit with a bedding of sticks and hardwood at the bottom. The bedding ensures air flow the bottom and allows drainage of excess water. While adding the layers, water is sprayed onto the biomass to moisten it well. The layers of green biomass, dry biomass and cowdung are alternated to have a good even mix in the compost. Once the pit is half full, a big handful of cowdung is put in the center of the pile to act as a heating core and layers are added above as before.
Finish the pile with a layer of dry biomass and cover the pile with a wet jute cloth.

Keep checking the pile for moisture and temperature. The pile should be turned if:

1. The temperature is too high for more than 4 days.
2. The moisture is higher than 50% for more than a day.
3. The pile starts smelling.

The compost normally takes 3-4 months to be ready fo use. It cooks faster in summer than in winter. The compost is ready when most of the biomass decomposes and the temperature of the compost is close to the ambient temperature. Once ready, the compost should be used within 6 months. After that the microbial life in the compost starts decreasing.
Compost can be added to the soil while planting or when the plant starts flowering. For wider applications, autumn is the ideal season as it gives time for the microbes to settle down and create conditions for growth in spring. If applied in summer, there is risk of most of the compost leeching out during monsoon.



Temperature logs of thermal compost piles with different proportions of Carbon, Nitrogen and high Nitrogen foods, from experiments in April 2018.

How much compost is required?

Compost should be used in addition to mulching and organic matter in pathways/trenches and not as a subititute of. So, the quantity of compost that can be made will depend on the biomass available to make the compost. The amount of compost required per square meter of soil depends on the soil health and the crop being planted. Some crops like corn, cucurbits, tomatoes, potatoes etc. are heavy feeders while some other like carrot, radish, spinach are light feeders. Once completey ready to use, no amount of compost in the soil can be too much compost.

When to make?

Because most of the growth happens in summer and monsoon season, the time to prune and harvest biomass is winter. At the end of winter, there is so much biomass that it may be difficult to add it to the soil directly. Also, the mulching in spring needs to be lighter to allow the Sun to warm the cold winter soil. Therefore, the biomass from winter can be used to make good quality compost that can feed the soil throughout the year, rather than leaving the biomass to dry out in the open and lose its energy to oxidation and leaching.

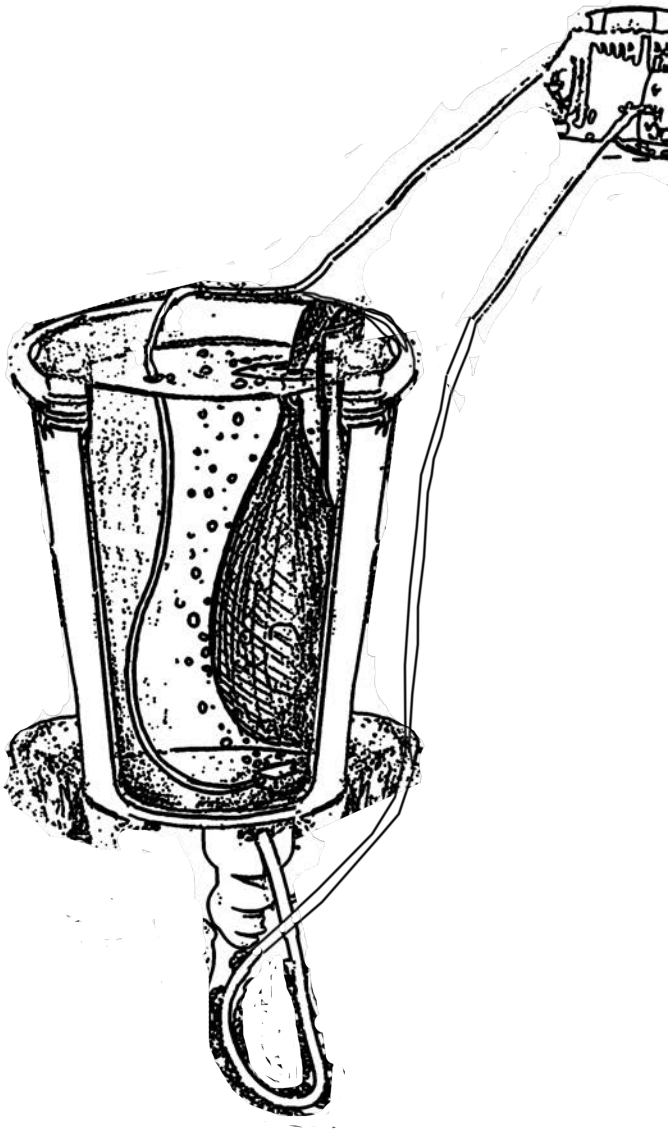
Compost extract

For wider coverage on the soil, and when there is a limited quantity of the compost available, it can made into an extract or a liquid copost by adding about a handful of the compost to a bucket of water and mixng or stiring rythmically to ensure that the microbes, the humic acids and the nutrients mix well with the water. This extract can then be sprayed onto the soil before mulching, or added by hand to each plant as desired and/or possible.

Activated compost tea

Activated compost teas can be made from a handful of compost in a bucket of water with added foods to multiply the microbial numbers. Compost teas are especially useful when there is not enough compost to broadcast on the entire land, and for foliar sprays. The important part of making good compost teas is the balance between the kind of food, the amount of food, the amount of aeration (by bubbling) and time. These variables need to be adjusted depending on the quality of the tea desired. For example, simple sugars like jaggery are good to multiply bacteria whereas complex carbohydrates like barley flour will help fungi to grow. Also, too much food could create a surge of bacterial growth and turn the tea into anaerobic if the oxygenation is not enough. Since the life cycle of each microorganism is different bacterial teas can be used after a short cycle while fungal teas need longer to be ready. Finally, the tea needs to be checked under a microscope to assess the biology before application. We recommend referring to the work of Dr. Elaine Ingham to anyone who is interested in making compost teas.

Activated compost teas give a tremendous boost to the health of the soil and the plants by introducing large numbers of microorganisms. They can be effective for accelerating decompostion, and in cases of diseases and pest infestations. We stopped using compost teas on the farm after the monsoon of 2018, as we always had enough compost and never had a serious disease problem.



Planting a tree

The act of planting a tree requires a meditative state of mind and immense care and attention. The planting decides how the tree will grow and can have benefecial or detremental effects on the future life and health of the tree. The most important thing to care for are the young roots of the sapling. Roots needs to be moist when transplanting. Dry roots could severely impact and even kill the plant.

1. Put the sapling in the location where it has to be transplanted and leave it there for a couple of days for it to get used to the sun, wind and local context. This will prepare the sapling for the transplant.
2. If the soil is too hard, dig a hole about four times the root ball (the soil holding the roots of the sapling), mix some compost with the dug out soil and fill back leaving enough space in the hole to receive the root ball. Add compost extract to the hole so that it goes deep inside. Do not overflood the hole with water as this will make the soil at the bottom even more compact.
3. If the soil is soft, dig a hole not bigger than the root ball.
4. Water the saplings well before transplanting.
5. If the sapling is a plastic bag, tear carefully the bag making sure that the root ball doesnt break and place the roots in the hole.
6. Cover the hole with the ug out soil making sure that the level of the soil is at the same level of the sapling soil.
7. Pay attention to the orientation of the plant. If the plant is facing one side more than the other, it will be helpful to face that side towards the south (towards the sun). Otherwise, the plant will have to spend energy to re-orient itself.
8. Press the soil around the sapling firmly to make sure there is good contact between the root ball and the receiving soil and that the plant is firmly in place.
9. Add compost around the plant allowing a few inches space between the stem and the ring of compost.
10. Add thick mulch (about 10-20 cm high) over the compost again make sure that it doesnt touch the stem of the plant.
11. Water well around the plant.

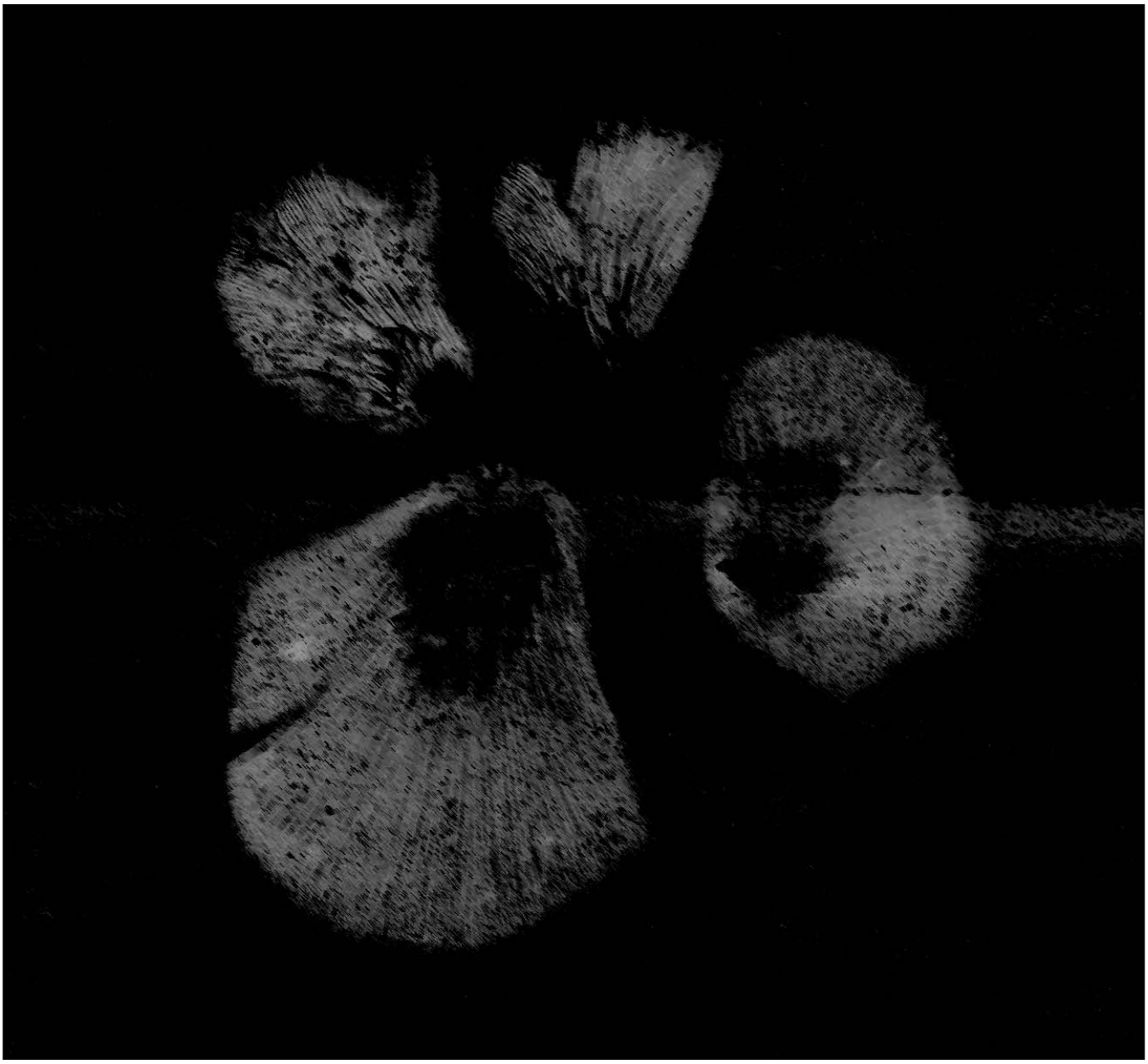
Mushrooms

From March 2017 to October 2018, we grew Oyster mushrooms on different substrates. What started off as an experiment led to really high quality mushrooms grown without any chemicals on substrate from the farm. The mushrooms were delicious, highly coveted by the people buying from the farm and brought in significant income to the farm as well. From just one room of about five square metres, we harvested about 30 kilos of fresh mushrooms every season.

Besides diversifying the income of the farm and our diet, growing mushrooms is a great way to learn about fungi and recycle farm waste like wheat straw, corn stalk, soybean husk into food.

We also tried growing our own spawn by conserving sppres in a print but were successful only to a certain extent because of the limitations of cleanliness required for culturing mushrooms from spores.

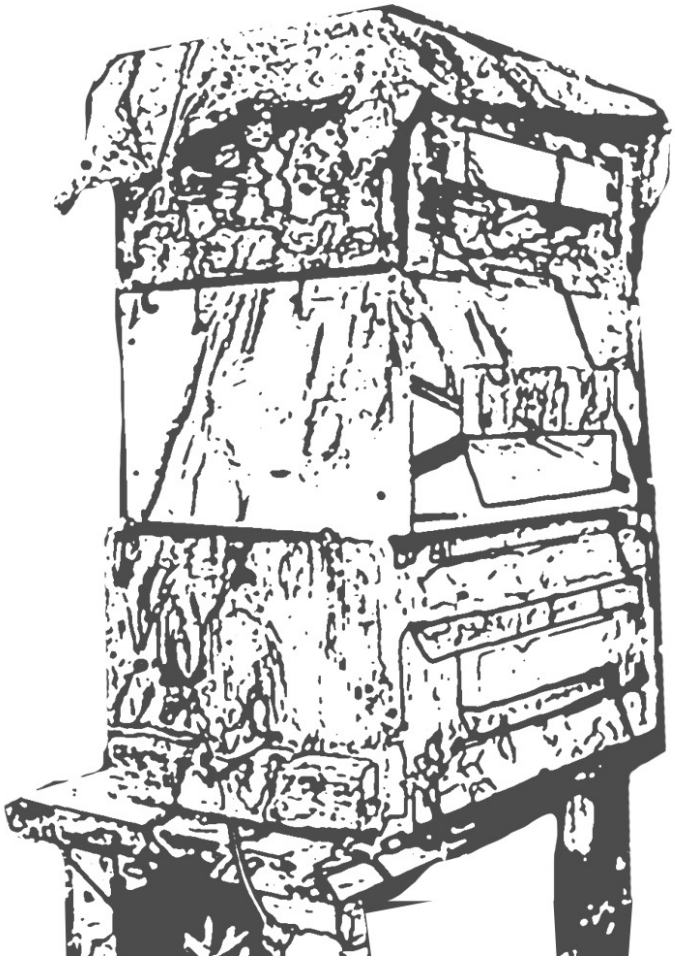
For details on fungi and the process of growing mushrooms please visit:
http://shunya.earth/mushrooms/



Spore print from Blue Oyester mushrooms taken on black paper in November 2018.

Bees

We also installed a beehive on the farm in Spring of 2018. We made a box hive inspired from the work of Abbe Warre, a french monk who designed a simple hive mimicking the natural hives of bees and where honey harvesting doesnt destroy the colonies. We were unsuccessful in progressing with this experiment due to lack of time and focus. Beekeeping is a fascinating subject and there is a lot a farmer can learn from bees. Future farmers on this land should consider reviving this experiment.



This box type beehive inspired by Warré was made on the farm from old Deodar wood.

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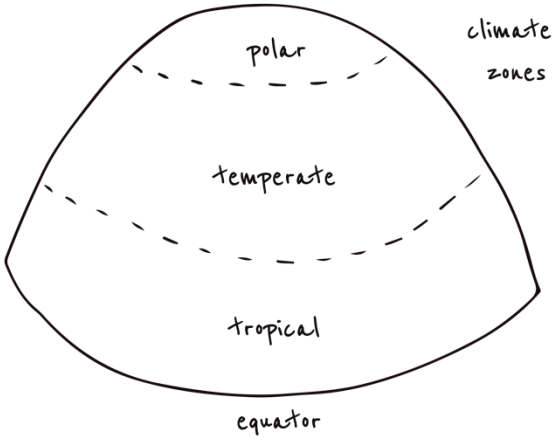
Temperate agriculture



For agriculture, temperates are both exciting and challenging. While the pronounced seasons, in some cases extreme, offer opportunities for diversity in vegetation and a seasonal cycle of creation and consolidation, they may also require different farming strategies and kinds of crops for different seasons of the year. Temperate regions, globally, are highly productive farming areas mainly because of cereal crops and have growing potential and possibilities with changing climate and land use patterns in India and the world.

The edges of the mountains superimposed on the edges of a temperate climate create a complex ecology with an immense richness of life. The topographical and thermal gradients of a mountain landscape present possibilities for development and nurturing of varied vegetation, animals and human cultures.

Following are the few strategies that are specially employed on the farm because of these conditions and are otherwise not mentioned in the document:

Raised beds

Though raised beds are not unique to temperate climates anymore, their usefulness in warming the soil faster during the day and draining off excess moisture make them ideal for cold climates especially in high precipitation areas. The beds are raised with soil from the adjacent pathways which also serve to channel water during monsoon thereby preventing water logging. The following are some of advantages of raised beds irrespective of the context.

- Clear human circulation prevents stepping on beds and compaction
- No tilling or digging required
- Beds designed for ease of working and access
- Buiding soil over the bed is easier

In India, raised beds are commonly used for vegetable cropping but they are becoming more and more popular also for tree orchards and even cereal and grains. The height of the raised beds is typically around 20-30 cm. Erosion occurs over time, reducing the height and damaging the edges of the bed and thus require some maintenance every couple of years depending on the amount of rainfall and the method of irrigation. The best time to reshape the beds is in spring and autumn. While doing this, it is important to check the slopes of the pathways to get a good flow of water in the direction desired.

The orientation of the beds is based on:

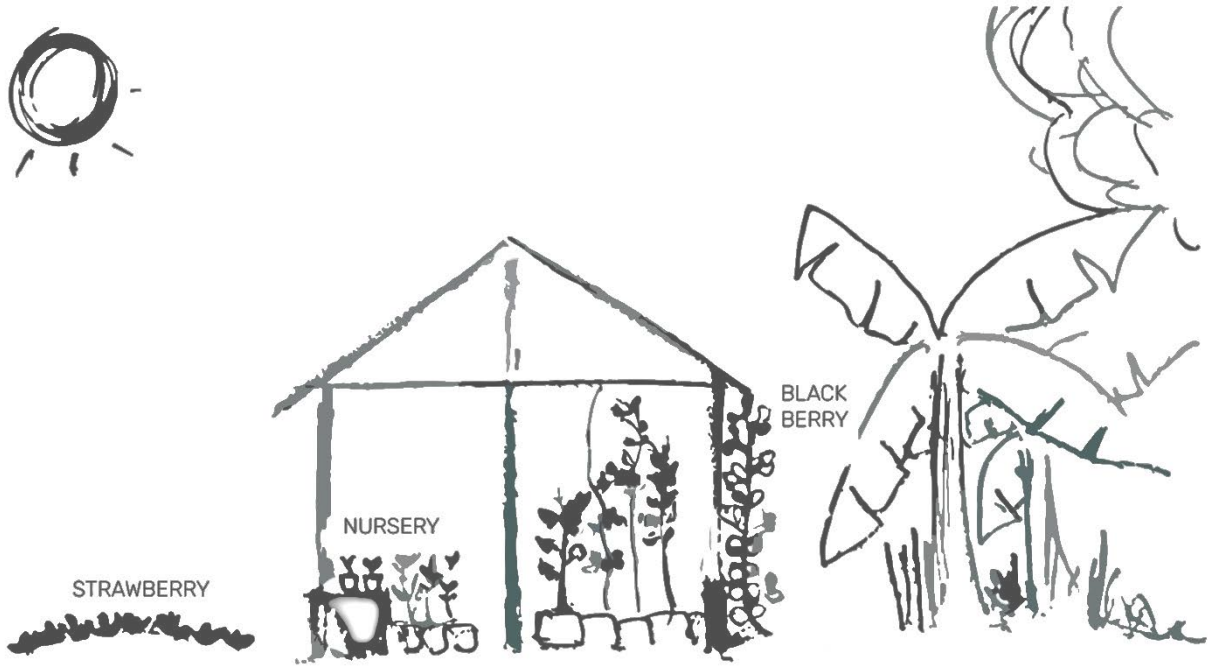
1. Sun path/shade: Orienting the beds in a way that sun exposure is optimised
2. Slope of the land: Beds made across the slope of the land hold water in the channels and facilitate infiltration.
3. Shape of the terrace (on terraced lands): Beds shaped along the terrace minimise the walking distance to access the beds.

Greenhouse

Greenhouses are being used across the world at varying scales of sizes and technology to control the growing conditions. A greenhouse is a structure made out of a transparent material like glass or plastic to retain heat inside. Greenhouses are used to create warm growing conditions in extremely cold climates and in some cases desired climatic conditions with the help of temperature and humidity control.

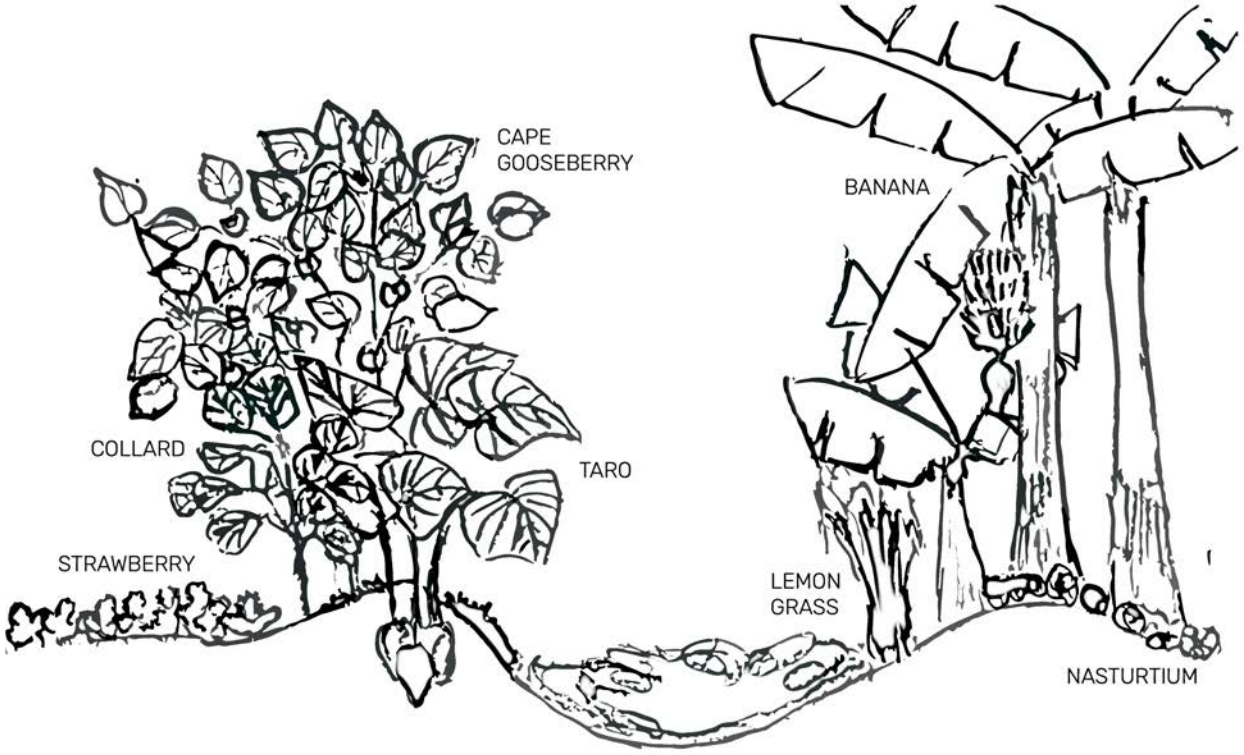
In temperate farming, greenhouses help to extend growing seasons and cultivate some specialty crops that are otherwise difficult to grow in the temperates. They also offer protection to plants from birds, hailstorms, strong winds etc. As the temperature inside the greenhouse can be really hot, it needs good ventilation and requires irrigation almost every day to maintain soil moisture. In effect a greenhouse mimics a tropical wet ecosystem climate.

The greenhouse on Shunya farm is a small structure for experiments in a controlled environment on diverse crops and their behavior with change in season and temperature. The greenhouse also helps in starting seeds before spring to obtain an early crop. This is important for a market farm as continuing harvests have to be maintained in all seasons. As inside, the greenhouse also creates a microclimate on the outside radiating the heat slowly in all directions. The area outside the greenhouse is being used to grow fruit crops like Banana and Litchi which normally require a warmer climate. The diversity within the greenhouse helps in preventing pests and diseases which is a common problem in most greenhouses. Besides the experiments with different crops, we used the green house for learning how temperature affects germination, growth and plant life cycles.



Banana circle

A banana circle is basically a pit with a raised edge which can be used for planting, and is a common method in the tropical areas for growing bananas around the pit for biomass and/or to treat greywater. This strategy can be adapted to the temperates both in dry and wet conditions. There are many mountain varieties of Banana that thrive in the cold climates. Other plants that go well in a banana circle are Cape-gooseberries, Collards and Kale, Taro, Strawberries, Lemongrass and Mint etc. The pit collects moisture from dew and rain and creates a rich habitat for worms and microbes and becomes a composting unit in itself. This feeds the plants growing on the edge. This is a great way of creating self-sustaining vermicompost pits across the farm. Also, biomass that is hard to deal with for compost or as mulch, like thorny bushes, seeded grasses etc. can be put in the pits and recycle them into bananas and other plants that give food and can later be used for compost and mulch.



Successional Agroforestry

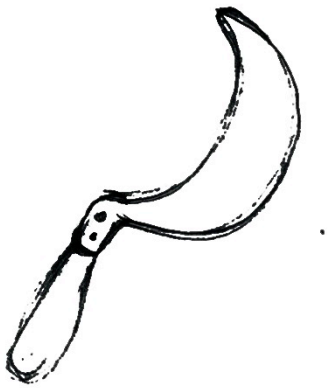
Successional Agroforestry is a process based farming mixing perennials with annual crops over time. It has three important aspects:

- Densely planting fast-growing pioneer trees to initiate the succession.
- Systematic pruning, coppicing of trees, weeding, chopping to add biomass to the soil which will add to soil carbon, cover the soil from the sun, water and wind erosion and feed the soil life.
- Selectively felling off trees to create gaps for planting late successional species, fruit trees, and other beneficial plants.

We started studying this process and experimenting with it in 2017. We created a succession plan for some parts of the farm for three years. We were still learning about different species, introducing new ones and observing their success and hence the plan has gaps and many more plants can be added to it. The template for this already exists on the farm and we should be able to see some exciting results in a few years.

This is the three year plan for successional planting for Bir, Himachal Pradesh, India: http://bit.ly/bir_biodiversity_succession

This is an interesting strategy anywhere (it was developed in Brazil) but especially for temperate areas it offers many opportunities for integrating different tree species, of different habits, and accelerates the soil succession which is otherwise slower compared to the tropics.



Community

"We do not inherit the earth from our ancestors,
we borrow it from our children."

— Native American proverb

Invisible structures

As per studies done in recent times, globally we grow food already for about 10 billion people (calorie equivalence) but over a third of this food is wasted while harvesting, storing, shipping and so forth. Interestingly, over 70% of the food that we end up eating, still comes from small-farms (25 acres or less) managed by communities and families for subsistence, and not from large mechanized monocrop systems as we are made to believe. Also small farms have been found to be 4-5 times more productive than large farms because of their intensive diverse cropping integrated with animal rearing. It is not a bold conclusion to say that hunger is not dependent on availability or lack of food. While some people grow up in scarcity, some others grow up in toxic abundance. This lopsided global food distribution is the root cause of our failing health either due to the lack of food or because of too much of it. *We do have enough food to feed the planet and almost three quarters of it comes from small farms.*

As we imagine sustainable solutions for farming, we need to think beyond organic, we need to think local. The onus of healthy farming lies as much, if not more, on the consumers, as it does on the farmers. Agriculture literally means a culture based on land and the birth place of this culture is the social unit, the community engaged in a particular philosophy and lifestyle. A community that supports agriculture by valuing the farmer, the land and the food it produces, will not only reduce the ecological costs of food and wastage, it will also be able to participate with the farmer in creating a culture of farming that is healthy for the land, the farmer and the consumer.

A natural farm, is a habitat for floral, insect, avian, microbial biodiversity, sequesters carbon in the soil more efficiently, cleans air and water, provides a space for people to reconnect with soil, plants and food besides producing nutritionally rich diversity of food. A community supporting such a farm does not only pay for the food, it supports the farm for all these ecosystem services as well. The debate of pricing organic food lower than food grown conventionally is ill founded on ignorance of these facts.
In an ideal scenario, the cost of good food must be an agreement between the farmer and the consumer based on the needs of the farmer, the value good food has for the consumer and his affordability. If each community has its farm, the cost of food will be at par with other essential commodities which means onions in a poor community (where monetary value of all products and services will be low) must not be of the same monetary value as onions in a rich community (where monetary value of all products and services will be high). Many approaches are being tried across the world on redefining the consumer-farmer relationship and working on systems based not only on the economical but also the nutritional value of food.

The organisation of a continuously harvesting farm is even more challenging than conventional farming of planting once and harvesting once in a season. Alongwith running with the seasons, a continuously harvesting farmer needs security that every week the production will have consumers. Community Supported Agriculture (CSA) is one such approach which has become popular in the last decade. In CSA, the community pays for the expenses of the farm for the upcoming season in return for a pre-decided amount of harvest every week in that season. By doing so, the community shares the uncertainty of the season with the farmer. The weekly baskets are then given based not on choice,

but what grows well and in abundance on the farm. This makes both the farmer and the consumer responsible for valuing local, less water intensive and diverse crops.

At Shunya farm, we have been fortunate to be sorrounded by a dedicated community of about 12 people (as of 2019, varying as per season) who buy from the farm every week. Since 2017, the farm has been producing a monthly average of about 50 kg of a diversity of cereals, vegetables, fruits and herbs which get divided between the people buying from the farm. Though the current system is not CSA in the strict sense, many clients pay extra for the times that they are not present, and for the lean seasons on the farm. This extra help keeps the farm going even when there are losses due to wildlife and climate.
As more people start working on the farm, the farm income can diversify through food processing, special crops like mushrooms and education. This in turn will engage more people in the community and create value not only for the farm but the others involved.

To maintain continuous harvests on the farm, the planting is continuous as well. Thougher through our experience over the years we have created a pattern of this planting, it requires keen observation every season to plan the following planting season. A planting and harvest calendar is given in the *reference* chapter which can be used as a brod pattern with more nuanced information from intuition and experience every year.

As one of the works of the farm is to propagate edible crops, the farm also offers seeds and saplings to the local farmers and often sells it to travelers and projects around Bir. A calendar for these is also given in the *reference* chapter.

Slowly and gradually the farm is creating an ecosystem of a new way of farming, based on traditonal knowledge, scientific discoveries and plain common sense to adapt to the ecological and cultural changes. Farmers in the village have started prefering the desi seeds from the farm to the hybrid counterparts available commercially. Small gardens are seen under mulch of oak leaves and cape gooseberries are finding home in many frontyards and kitchen gardens. These are some of the humble yet tangible changes we have seen in our time at the farm. We hope that the community around the farm will continue to engage with it in ways existings and new and that the farm continues to be meaningful beyond the food production.

Education

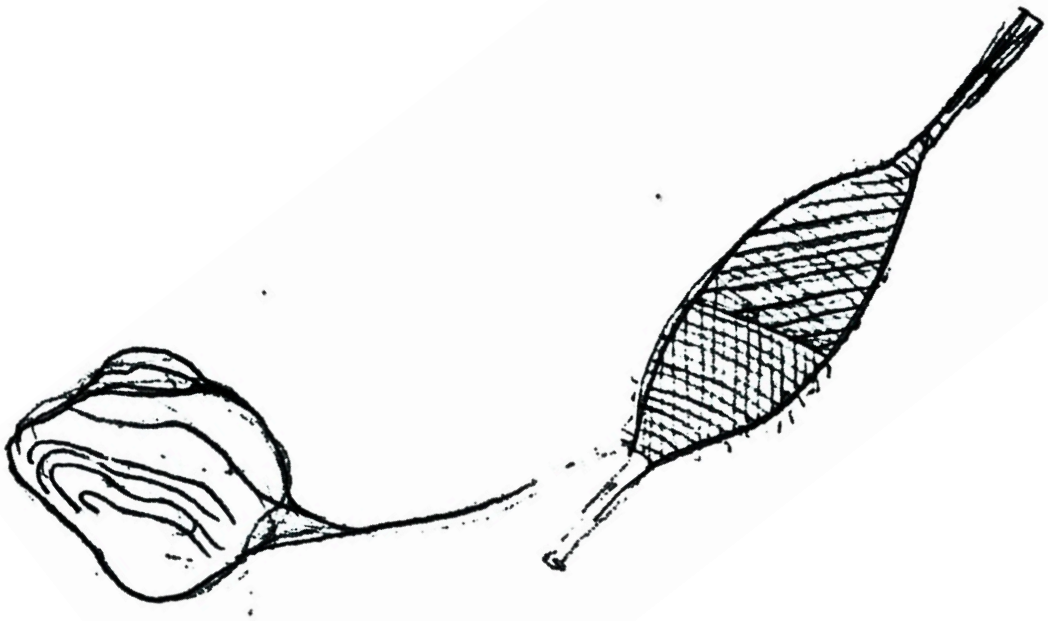
Humanity has enough information and knowledge to transition from the dominant degenerative systms to healthy cultures. What we dont have too many of are working examples of such cultures that have sustained over time. The path of transition is simple yet difficult and we are constantly discovering how to turn these philosophies of change into practices that remain holistic and meaningful over time. Any project or initiative which is attempting to do this over a long period of time is an island of change holding valuable experiences of how our future could look like.

The farm provides an opportunity for developing a sustainable farming practice for the bioregion of Bir. Many local farmers and people building their houses and guest houses in Bir are looking for simple solutions for caring for land and growing food without exploitative farming. The solutions of perennial edibles and robust desi seeds for a variety of crops could be extremely useful in the changing ecological, social and cultural landscapes of Bir.
As toruists and restaurant grow in Bir every year, the demand for exotic vegetables is also increasing. This is normally met by markets in Dharamshala, Chandigarh or Delhi. Growing some of these crops, which Shunya farm is carefully preparing seeds for, will reduce the ecological footprint of the food used in the village and give significant benefits to the local farmer.
We had also started buying from local organic producers and including their produce in our market on Fridays. This could become a regular feature as more and more farmers turn to organic and hopefully natural farming. If the farm can provide a market for this produce locally and for a better price, through its network of clients and restaurants, the local farmers can also be encouraged to participate in growing clean and healthy food.
Thus, the role of the farm in the community of Bir is that of a resource center for natural farming and a hub for integrating ideas and practices related to seeds, soil, food and health.
Of course, only the first few steps have been taken in this direction and much needs to be explored and manifested.

We have often had local children come to the farm to learn about the plants, play with the chickens, eat gooseberries and strawberries and enjoy the abundance of the farm. This farm could help show what farms and farming could look like, that they can be places of diversity and production and not sad landscapes with a bleak future.
Many tourists and travelers visit the farm as it is one of the *attractions* in the village. We have welcomed invidividuals and groups as much as we could but this is challenging specially when we are busy farming in the first place. The system of farm walks and farm tours which is happening right now could help organise the visits and generate some income for the farm from the same. The interest of tourists in organic farms also opens up opportunities for eco-tourism by creating a network of organic farms in the village where people can visit and learn.

Shorter engagements are seldom meaningful and lack the depth of observation and interaction required to understand the tenets of natural farming philosophy and practices. To explore how the farm could inspire and share the farming experiences in a structured manner, we hosted two-week long courses every season (four times in a year).
The course was designed to introduce the participants to the farm and to the village. The group was limited to nine people to offer enough space and time for each learner. About 10 courses were hosted between 2017 and 2019 and they were some of the most satisfying learning experiences as much for us as for the participants. *(http://shunya.earth/courses-reflections/)*

We see the farm as a space for learning not only for people who come from outside but also for those who work on the land. This spirit of constantly learning from nature about life and land must guide the farmer in their own journey and in the ways of how these experiences can be shared with the local and larger communities in the best way.



A farm for the future

"He travels on through waking and through sleep....
A few shall see what none yet understands;
God shall grow up while the wise men talk and sleep;
For man shall not know the coming till its hour
And belief shall be not till the work is done."

— Savitri, Sri Aurobindo

The evolution of farming

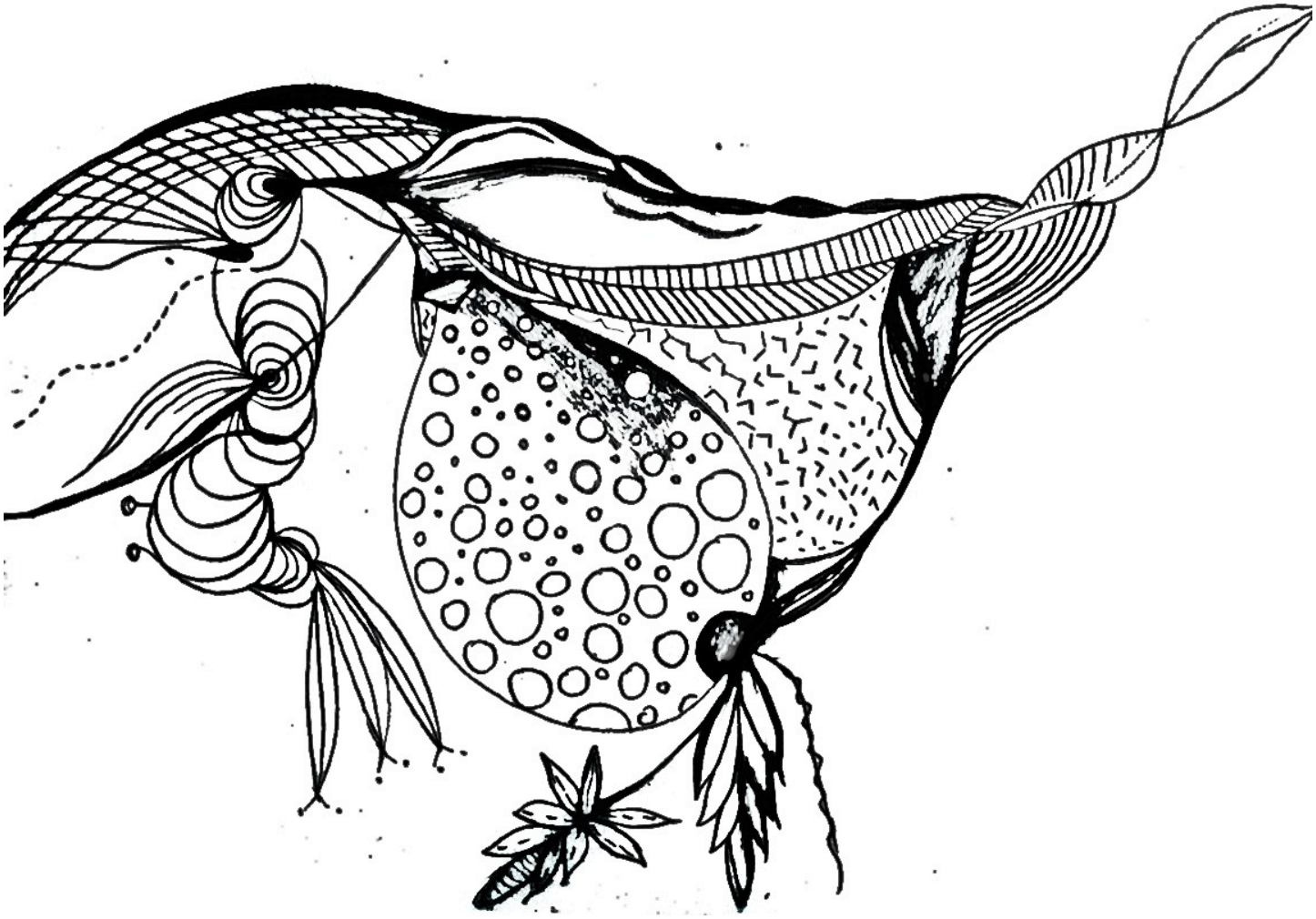
The future of agriculture stands between the traditional farmers, some of whom are tired of the ecological (climate change, wildlife, consequences of green revolution) and social (cultural and economic) pressures while only some have the resources to experiment with a different way, and the new educated aspirant with tools like Permaculture and natural farming methods trying to find yet again a balance of individual growth and collective prosperity, caught in a tight balancing act, spometimes without much guidance.

While natural farming has brought to us the realisation that farming needs to be in consort with the patterns of nature, we must also realise that *natural farming is a paradox*. Farming itself is not natural as we are constantly pulling nature back in succession, forcing to grow what we need rather than eating what continues to grow and evolve on the land. Perhaps one day, our diets will change, our behaviours and culture will change. But for now at least, that is not the case and the farming solutions cannot ignore that fact.

The agriculture of the future can also not dismiss the social without which there will be no culture. This future of agriculture demands not only a new way of farming, but a new way of social organization, of people coming together spontaneously or by design forming families and communities to support each other and to help dream and realize this task which is beyond an individual. This coming together of people for a purpose and not social obligation would require a new ethical framework beyond religion and dogma. The first condition of collaboration in farming will lead to the empowerment of the future of the farm and the farmer without which no method of sustainable farming can work.

The second important task for the future farmers will be to think of succession. A farm as an enterprise has been sustainable because children of farmers have continued farming after their parents and have passed on the skill and the responsibility to their children. With more and more opportunities for learning and expressing one self, it would be morally wrong and socially regressive to expect farmers' children, irrespective of the economic state of the farm, to take up the work of their parents. For intentional communities of today, the option of new people joining the community in future would be a solution but there must be a space for this and an integration plan that can take care of the social challenges this would present.
The situation may be more challenging for individuals, couples and families who have moved to the land for a simple life. The collective effort in this 'back to the land' and 'back to the nature' movements must go on without people having to reinvent themselves again and again which presents its own limitations and costs excessive resources. A vision for succession and a visualization of systems that can outlast human lives could be the key for supporting sustainable changes at various scales of human organization.

In this future where we grow food together to nourish our individual and collective souls, where individual and collective growth will serve each other to create a holistic invisible foundation, wisdom of working with the forces of nature and technology to enhance natural potential and accelerate evolution, will help us realize abundance and prosperity within the limits of the sacred. Such a farm will be regenerative, to say the least, not only from the point of view of the economy, but also ecology, society and the spirit. This will be the birth of an integral humanity and integral farming.



Challenges

These are some of the challenges we faced while we were actively working on the farm. In a fast changing world as ours, these challenges will evolve over time. Each challenge is an opportunity for collaboration within the community to address some foundational questions and envision a change that can make the system resilient.

1. Farming is a challenging work in Bir or anywhere else. The changing climatic patterns, uncertainty of rains, mismanagement of forests and wildlife, migration of skilled and traditional farmers to cities and for jobs, have all made it more and more difficult for sustainence of land based communities. There is a growing movement of people from cities to the agricultural lands. This movement needs to be nurtured and given the required energy to perservere and create solutions for healthy and local food systems. The challenge of documentation for practioners is a big challenge for sharing of precise knowledge in the field of new agriculture.

2. Farms of the region face challenges with attacks from wildlife that includes monkeys, mongoose, wild boars, porpcupines etc. Recently, there has also been an increase in the number of stray cattle which poses added threat to the farms. The solution to these problems can only come from a long term holistic perspective.

3. Bir is quickly becoming a tourist hub for its beauty and adventure sports. Many locals have shifted from their traditional land based livelihood to the tourism industry. The trend is overwhelming and has also influenced the priorities of the village community. Although there is some interest within a group of local farmers in going organic, the initial investment of time and energy is often seen as an impediment and there is no community support for organic farming yet.

4. The organic produce sales do well in the seasons of spring and fall, but monsoon and winter seasons see fewer residents, tourists and restaurant needs. Lack of distribution facilities and the nature of limited harvest every week make it difficult to transport this food to markets outside.

Research

1. **Edible perennials for the region**
   Finding, collecting, propagating and assessing edible perennial plants for forests/farms that do not have enough labour to mnage intensive annual cropping. Such plants can be planted once and harvested for many years with very little maintenance. Most of these plants are local traditional plants that are slowly losing relevance and cultural contact due to changing habits and lifestyles.

2. **Seeds and sapling**
   Finding most effective ways of saving seeds and growing saplings. The seeds and saplings for fruit trees and berries are also being distributed to the local farmers.

3. **Exotic crops**
   Naturalising exotic crops that can be grown with minimum resources in the region and preparing seeds and saplings for exotic naturalized vegetables that can be sold at the local restaurants so that farmers don't have to sell their produce outside. This will give more benefit to the farmers and create a local food distribution system.

4. **Documentation**
   Continuing to discover multiple ways of documenting and sharing best practices for natural farming for a small farm in this context.

References

"The best fertilisers for the land is its farmer's footsteps."

— Confucious

Cycles

PREPARING THE BED

1. Cut the previous crop at the base of the stem to leave the root inside. This root will feed the microorganisms in the soil as it decomposes.
2. Remove weeds from the bed and dry them on the pathway or channels. Once dried they can be used to mulch the beds. The best way to remove the weeds is to cut them at the base so that the soil doesnt have to be dug to remove the roots. This preserves soil structure and allows the weed roots to feed the soil. The downside of this is that the weeds grow back faster and the roots go deeper. Where this is not desirable, weeds must be removed from the soil with their roots with care without digging or turning the soil too much.
3. Use a tool to make furrows or channels (size depending on the size of the seed) on the bed for planting.
4. Add compost or compost extract in the furrows

PLANTING

1. Plant the seed. The depth of planting the seed depends on the seed size. Typically, the seed should be as much below the soil as its own size, i.e. a 0.5 cm seed could be planted at 0.5 cm depth from the soil surface. Although this can be used as a rule to start with, planting depth varies from kind of seed to type of soil, season etc. and must be observed and learnt with experience.
2. Water the bed and mulch lightly. Thick mulch could weigh the young germinating shoots down.
3. Maintain moisture in the bed and observe germination
4. When the plants are 3-5 inches tall, deweed the bed, add compost or compost extract and mulch heavily. This is also a good time to introduce a companion crop if needed and not done already.

5. *For tuber crops:*
    a. Mark healthy plants and bigger roots (if possible to see) for seeds and the let the plant go to flower and seed.
    b. Harvest the rest of the crop before flowering.

6. *For leaf crops:*
    a. Mark healthy plants for seeds and dont harvest anything from these plants. Let the plant go to flower and seed.
    b. For the rest of the crop, keep picking leaves as and when they get big. Always harvest bigger leaves at the bottom allowing for the newer leaves at the top to grow. Continuously harvesting the leaves and flowers if they appear is like pruning the plant, getting it to produce more leaves and delaying its flowering and seeding.

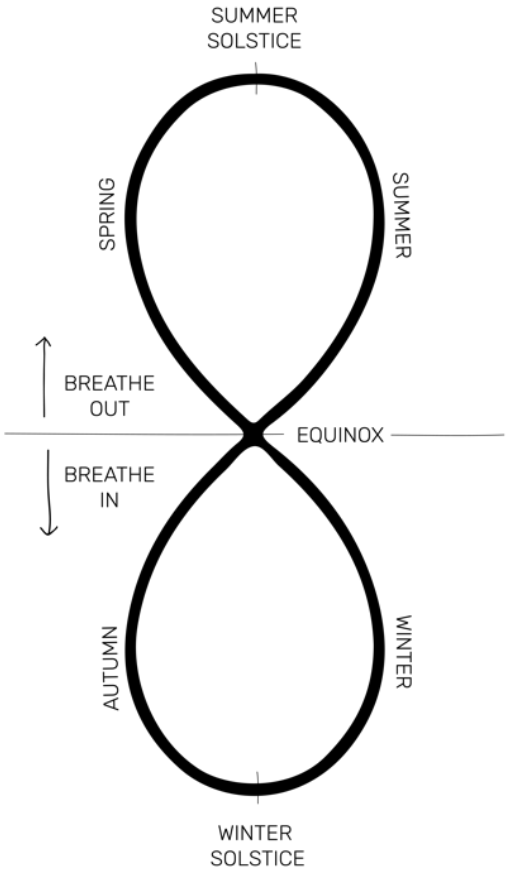
7. *For fruit/pod/seed crops:*
    a. Add compost extract when first flowers appear. Flowering plants require more energy.
    b. Mark healthy plants and desired fruits for seeds.
    c. Harvest when the crop is ready.

8. Harvest the ready seeds, dry, clean and store them carefully for next planting/season.
9. Cut the dead plant at the ground level to leave the root inside the soil.
10. Remove other weeds and prepare the bed for planting the next crop.

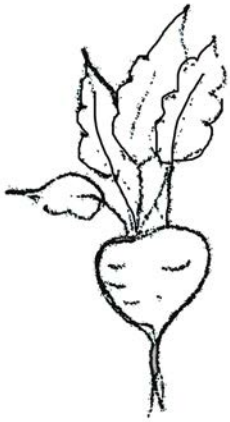
COMPOST AND MULCH

The temperate seasons mark a different rhythm of life in each season. There is growth and activity in the spring-summer time and rest and consolidation in the autumn-winter time. This pattern reflects in behaviors across vegetation, animals and humans.

	Sprıng	**Summer**	**Autumn**	**Wınter**
Mulching	Light mulch to allow spring sun to warm the winter soil	Heavy mulch to prevent evaporation and preparing soil before monsoon	Light mulch in water saturated soils. Heavy mulch to prepare for winter.	Heavy mulch to protect soils from the cold.
Compost	Apply compost	Make compost from all the biomass left after mulching	Apply compost	Make compost from all the biomass left after mulching



In the following pages, some tables are given for the reference of the people working on the farm. The information given in these tables is our experience and work in progress. This information must be updated with new observations and insights, new seeds, plants and as we learn more about food, soil and the farm.



CROP DETAILS

	PROPAGATION	DETAILS	PLANTING	SPACING
SPRING				
SUNFLOWER	Seeds / Saplings	Oil roasted seeds flowers edge planting biomass	Plant nursery at the end of winter	60 cm
CHERRY TOMATO	Seeds / Saplings	Need water and sun	Plant nursery in early spring	100 cm
CHILI	Seeds	Need water and sun	Plant nursery in early spring	30 cm
WHITE RADISH	Seeds	Need water	Sow directly in early Spring	30 cm
SPINACH	Seeds	Need water, can be planted in shade under a tree	Sow directly in early Spring	20 cm
KALE	Seeds / Saplings	Can be planted in shade, produces for 2-3 years. Leaves can be cooked or eaten raw.	Plant nursery early Spring and mid-monsoon	60 cm
COLLARDS	Seeds / Saplings	Can be planted in shade, produces for 2-3 years. Leaves can be cooked or eaten raw.	Plant nursery early Spring	60 cm
LETTUCE	Seeds	Need water and shade	Sow directly in early Spring	15 cm
ARUGULA	Seeds	Need water and shade	Sow directly in early Spring	15 cm
CORIANDER	Seeds / Saplings	Need water, can be planted in shade, plant in bunches	Sow directly in early Spring	20 cm
BASIL TULASI	Seeds / Saplings	Hardy, edge planting	Plant nursery in early spring	60 cm
BHABRI (LOCAL BASIL)	Seeds	Can be planted in shade	Sow directly in spring / summer	30 cm
THAI BASIL	Seeds	Can be planted in shade	Plant nursery in early spring	30 cm
ITALIAN BASIL	Saplings	Need water, can be planted in shade	Plant nursery early Spring and mid-monsoon	30 cm
CAPE GOOSEBERRY	Seeds / Saplings	Hardy, plant under trees, Fruits can be harvested within 2 years.	Plant nursery in early spring	150 cm
TREE TOMATO	Seeds / Saplings	Fast growing, living fence, medium tree, fragile, Protect from harsh sun, strong winds, Fruits can be harvested within 3 years.	Plant nursery in early spring	180 cm
MULBERRY	Seeds / Cuttings / Saplings	Fast growing, Living fence, windbreak, biomass. Fruit can be harvested within 3 years.	Plant nursery in early spring	180 cm
FLOWERS	Seeds / Saplings		Plant nursery in early spring	

	PROPAGATION	DETAILS	PLANTING	SPACING
SUMMER + AUTUMN				
AMARANTH	Seeds	Grain, tender greens, biomass, need sun, rainfed	Sow directly in early summer	30 cm
PUMPKIN	Seeds	Need care when the plants are young, water and compost, plant multiple under a tree or trellis, need sun and air for good fruit	Sow directly in early summer	200 cm
CUCUMBER	Seeds	Need care when the plants are young, water and compost, plant multiple under a tree or trellis, need sun and air for good fruit	Sow directly in early summer	100 cm
SPARROW GOURD	Seeds	Need care when the plants are young, water and compost, plant multiple under a tree or trellis, need sun and air for good fruit	Sow directly in early summer	100 cm
BOTTLE GOURD	Seeds	Need care when the plants are young, water and compost, plant multiple under a tree or trellis, need sun and air for good fruit	Sow directly in early summer	100 cm
BITTER GOURD	Seeds	Need care when the plants are young, water and compost, plant multiple under a tree or trellis, need sun and air for good fruit	Sow directly in early summer	100 cm
RIDGE GOURD	Seeds	Need care when the plants are young, water and compost, plant multiple under a tree or trellis, need sun and air for good fruit	Sow directly in early summer	100 cm
GREEN OKRA	Seeds	Harvest tender fruit for cooking	Sow directly in early summer	30 cm
RED OKRA	Seeds	Harvest tender fruit for cooking	Sow directly in early summer	45 cm
WHITE RADISH	Seeds	Need water	Sow directly before monsoon	30 cm
GREEN RADISH	Seeds	Need water	Sow directly before monsoon	30 cm
GINGER	Division	Need water and compost	Plant divisions in early summer	30 cm
TURMERIC	Division	Need water and compost	Plant divisions in early summer	45 cm

	PROPAGATION	DETAILS	PLANTING	SPACING
SUMMER + AUTUMN				
GREEN BEANS CLIMBING	Seeds	Can be planted in partial shade, tender beans can be cooked or eaten raw	Sow directly throughout summer	60 cm
BLACK RAJMA CLIMBING	Seeds	Plant in good sun, harvest seed for cooking	Sow directly throughout summer	60 cm
COLOMBIAN BEAN CLIMBING	Seeds	Plant in good sun, harvest seed for cooking	Sow directly throughout summer	60 cm
BLACK SOYBEAN	Seeds	Good for preparing soil for winter, monsoon groundcover, plant in good sun, harvest seed for cooking, milk, tofu	Sow directly throughout summer	30 cm
WHITE SOYBEAN	Seeds	Good for preparing soil for winter, monsoon groundcover, plant in good sun, harvest seed for cooking, milk, tofu	Sow directly throughout summer	30 cm
SPINACH	Seeds	Need water, can be planted in shade, under a tree	Sow directly just before monsoon	20 cm
CORIANDER	Seeds / Saplings	Need water, can be planted in shade, plant in bunches	Sow directly just before monsoon	20 cm
ITALIAN BASIL	Saplings	Need water, can be planted in shade	Plant nursery early Spring and mid-monsoon	30 cm
PERENNIAL GARLIC	Saplings	Need water, under trees, along water channels, continues to grow like grass, chives can be harvested after 1 year	Plant saplings in monsoon	30 cm
DILL		Can be planted in partial shade		
PARSLEY		Can be planted in partial shade		
MINT	Division / Saplings	Groundcover, along water channels, ponds	Plant saplings in monsoon	30 cm
CELERY	Seeds / Saplings	Under trees, edge planting	Plant nursery in monsoon, Transplant in autumn	
LEMONGRASS	Saplings	Edge planting,	Plant saplings in monsoon	60 cm
JASMINE	Saplings	Living fences, edge planting	Plant saplings in monsoon	200 cm
CANNA LILY	Division	Edge planting, ponds, water channels	Plant saplings in monsoon	100 cm
RAIN LILY	Saplings	Edge planting, gardens, pots	Plant saplings in monsoon	20 cm
ROSE	Saplings	Living fences, edge planting	Plant saplings in monsoon	100 cm
MULBERRY	Seeds / Cuttings / Saplings	Fast-growing. Fruiting in 3 years. Biomass	Plant saplings in monsoon	200 cm
STRAWBERRY	Division	Ground cover, Plant under trees in an orchard, Need water as they are shallow rooted. Good mulching required.	Plant saplings in monsoon	15 cm
BLACKBERRY	Cuttings / Saplings	Needs trellis, wall, fence, living fences, edge planting, Fruiting in 2 years	Plant saplings in monsoon	100 cm

	PROPAGATION	DETAILS	PLANTING	SPACING
AUTUMN + WINTER				
OATS	Seeds	Grain, need sun, rainfed	Sow directly in autumn	4 cm
FLAX SEEDS	Seeds	Seeds can used for oil, cooking, salads, need sun, rainfed	Sow directly in autumn	2 cm
RAI BLACK MUSTARD	Seeds	Big leaves, can be planted in partial shade	Sow directly in autumn	2 cm
SARSON YELLOW MUSTARD	Seeds	Small leaves, can be planted in partial shade	Sow directly in autumn	2 cm
FENUGREEK	Seeds	Can be planted in partial shade	Sow directly in autumn	2 cm
WHITE RADISH	Seeds	Need water	Sow directly in autumn	30 cm
ONION	Seeds	Need water and sun	Plant nursery in early autumn	15 cm
GARLIC	Cloves	Need sun	Sow directly in autumn	10 cm
TARO	Division	If planting under tree, leave 200 cm from the trunk to not disturb roots every season. Harvest root every winter, leave some root in the spot after harvest for next season.	Sow root in early winter	30 cm
SWEET PEA	Seeds	Harvest mature peas for cooking or eating raw	Sow directly in autumn through early winter	30 cm
SNOW PEA	Seeds	Edge planting, beautiful flowers, harvest tender peas for cooking or eating raw with pod	Sow directly in autumn through early winter	60 cm
BROAD BEAN	Seeds	cooking	Sow directly in autumn	40 cm
SPINACH	Seeds	Need water, can be planted in shade, under a tree	Sow directly in autumn	20 cm
BOKCHOY	Seeds	Need water, can be planted in shade, under a tree	Sow directly in autumn	20 cm
LETTUCE	Seeds	Need water and shade	Sow directly in autumn	15 cm
ARUGULA	Seeds	Need water and shade	Sow directly in autumn	15 cm
OREGANO	Saplings	Need water, can be planted in shade, under a tree		
FENNEL	Seeds / Saplings	Can grow well in partial shade, harvest tender leaves to eat raw or cooked for flavour, seeds used as mouthfreshner.	Sow directly in early Autumn, transplant in Spring	30 cm
CORIANDER	Seeds	Need water, can be planted in shade, plant in bunches	Sow directly in autumn	20 cm
KALE	Seeds / Saplings	Can be planted in shade, produces for 2-3 years. Leaves can be cooked or eaten raw.	Plant nursery early Spring and mid-monsoon	60 cm
COLLARDS	Seeds / Saplings	Can be planted in shade, produces for 2-3 years. Leaves can be cooked or eaten raw.	Plant nursery early Spring	60 cm

PLANTING CALENDAR FOR CONTINUOUS HARVESTS

 *: Direct sowing* |.  *: Transplant.* |.  *: Nursery in greenhouse.* |.  *: Nursery outdoors.* |.  *: Make cuttings.* |  *: Division*

	# WEEKS TO HARVEST	# WEEKS OF HARVEST	JAN	FEB	MAR	APR	MAY	JUNE	JUL	AUG	SEP	OCT	NOV	DEC
SPRING														
CEREAL														
BUCKWHEAT (BHRES)	24	Once												
OILSEED														
SUNFLOWER	24	Once												
FRUITS														
CHERRY TOMATO	12	8				/								
CAPSICUM	8	8				/								
BRINJAL	8	8				/								
CHILI	8	8				/								
ROOTS														
POTATO	16	Once												
CARROT	16	Once												
BEET ROOT	16	Once												
WHITE RADISH	4	Once												
LEAFY GREENS														
SPINACH	4	12												
KALE	8	Short per.												
COLLARDS	8	Short per.												

	# WEEKS TO HARVEST	# WEEKS OF HARVEST	JAN	FEB	MAR	APR	MAY	JUNE	JUL	AUG	SEP	OCT	NOV	DEC
SALAD														
LETTUCE	8	8												
ARUGULA	8	8												
ROSELLA	6	16												
HERBS														
CORIANDER	4	8												
BHABRI (LOCAL BASIL)														
FLOWERS	/	/												
PERENNIALS														
CAPE GOOSEBERRY	/	Perennial												
TREE TOMATO	/	Perennial												
MULBERRY	/	Perennial												

	# WEEKS TO HARVEST	# WEEKS OF HARVEST	JAN	FEB	MAR	APR	MAY	JUNE	JUL	AUG	SEP	OCT	NOV	DEC
SUMMER/AUTUMN														
CEREALS														
RICE	24	Once												
CORN (DESI)	20	Once												
POP CORN	20	Once												
COLOMBIAN CORN	24	Once												
AMARANTH	24	Once												
FRUITS														
PUMPKIN	16	Once												
CUCUMBER	6	6												
GOURDS	6	6												
OKRA	8	6												
ROOTS														
POTATO	16	Once												
WHITE RADISH	4	Once												
GREEN RADISH	8	Once												
GINGER	72	Once												
TURMERIC	72	Once												
CARROT	16	Once												

	# WEEKS TO HARVEST	# WEEKS OF HARVEST	JAN	FEB	MAR	APR	MAY	JUNE	JUL	AUG	SEP	OCT	NOV	DEC
LEGUMES														
GREEN BEANS CLIMBING	8	8												
PURPLE BEANS CLIMBING	20	Once												
GUAJIRO BEAN CLIMBING	20	Once												
BLACK SOYBEAN	16	Once												
LEAFY GREENS														
SPINACH	4	12												
AMARANTH	4	12												
HERBS														
CORIANDER	4	8												
BASIL TULASI	6	12												
BASIL GENOVESE	6	12												
BASIL HIMACHALI BHABRI	6	12												
DILL	6	16												
PARSLEY	6	16												
MINT	12	Perennial												
LEMONGRASS	48	Perennial												
FENNEL	8	24												
FLOWERS														
ROSE	/	/												
JASMINE	/	/												
CANNA LILY	/	/												
RAIN LILY	/	/												

	# WEEKS TO HARVEST	# WEEKS OF HARVEST	JAN	FEB	MAR	APR	MAY	JUNE	JUL	AUG	SEP	OCT	NOV	DEC
PERENNIALS														
MULBERRY	/	Perennial												
STRAWBERRY	/	Perennial												
BLACKBERRY	/	Perennial												
WINTER														
CEREALS														
WHEAT	20	Once												
BARLEY	20	Once												
OATS	20	Once												
OIL SEEDS														
FLAX SEEDS	24	Once												
RAI BLACK MUSTARD	24	Once												
SARSON YELLOW MUSTARD	24	Once												
FENUGREEK	24	Once												
ROOTS														
POTATO	16	Once												
RADISH	4	Once												
TURNIP	6	Once												
ONION	24	Once												
GARLIC	22	Once												
CARROT	16	Once												
BEETROOT	16	Once												
TARO	16	/												

	# WEEKS TO HARVEST	# WEEKS OF HARVEST	JAN	FEB	MAR	APR	MAY	JUNE	JUL	AUG	SEP	OCT	NOV	DEC
LEGUMES														
PEAS	4	12												
BROAD BEAN	4	8												
LEAFY GREENS														
SPINACH	4	6												
BOKCHOY	3	6												
RAI BLACK MUSTARD	6	8												
SARSON YELLOW MUSTARD	8	8												
FENUGREEK	8	8												
SALAD														
LETTUCE	8	8												
ARUGULA	8	8												
HERBS														
ROSEMARY	/	Perennial												
OREGANO	/	Perennial												
LAVENDER	/	Perennial												
CORIANDER	4	8												
PERENNIALS														
KALE	8	Short per.												
COLLARDS	8	Short per.												

HARVEST CALENDAR

	Fruits	Vegetables	Root	Legumes	Greens	Salad	Herbs	Cereal	Oil seeds
Spring	-	-	Potato	Peas	Spinach	Lettuce	Fennel	-	-
			Carrot	Broad beans	Chard	Rugula	Rosemary		
			White radish			Nasturtium	Oregano		
			Green radish		Collards		Celery		
					Kale				
					Bok choy				
Summer	Strawberry	Cherry tomato	Garlic		Spinach	Lettuce	Coriander	Wheat	Flax seeds
	Apricot	Capsicum	Onion		Wild buckwheat	Rugula	Basil	Barley	Mustard
	Banana	Brinjal	Potato		Cholai/Amaranth	Rosella		Oats	Rai
	Blackberry	Chili	Beet root		Beet greens	Nasturtium			Fenugreek
	Mulberry		Carrot		Collards				
	Plum		White radish		Kale				
			Taro		Bok choy				
Monsoon	Pear	Okra	White radish	Green beans	Spinach	Rosella	Basil	-	-
	Cape gooseberry	Cucumber			Wild buckwheat	Wood sorel	Lemongrass		
		Pumpkins			Cholai/amaranth	Nasturtium	Mint		
		Gourds			Taro leaf				
		Lungdu fern							
Autumn	Walnut	-	-	Green beans	Spinach	Rugula	Coriander	Corn	Sun flower
	Banana			Hema rajma	Collards	Rosella		Amaranth	
				Col bean	Kale	Wood sorel	Mint	Buckwheat	
				Black soybean					
Winter	Mandarin	-	Ginger	Peas	Spinach	Lettuce	Coriander	-	-
			Turmeric		Chard	Rugula	Dill		
			Potato		Collards		Parsley		
			Carrot		Kale		Fennel		
			Jer. Artichoke		Bok choy				
					Mustard				
					Rai				
					Radish greens				

CALENDAR FOR STARTING SAPLINGS

	PROPAGATION	1st PLANTING	2nd PLANTING	3rd PLANTING	READY	PRODUCT
SPRING						
SUNFLOWER	Seeds / Saplings	Plant nursery at the end of Winter outside	Transplant in Spring	-	Mar-Apr	Young saplings in compost without bag
CHERRY TOMATO	Seeds / Saplings	Plant nursery early Spring in GH trays	Transplant in Spring	-	Mar-Apr	Young saplings in compost without bag
CHILI	Seeds	Plant nursery early Spring in GH trays	Transplant in Spring	-	Mar-Apr	Young saplings in compost without bag
SPINACH	Seeds	Plant nursery early Spring in GH trays	Transplant in Spring	-	Mar-Apr	Young saplings in compost without bag
KALE	Seeds / Saplings	Plant nursery early Spring in GH trays	Transplant in bags or outside in Spring or in Autumn	Put bags in the ground Autumn/Spring	Mar-May	Transplant young saplings in, bags
COLLARDS	Seeds / Saplings	Plant nursery early Spring in GH trays	Transplant in bags or outside in Spring or in Autumn	Put bags in the ground Autumn/Spring	Mar-May	Transplant young saplings in, bags
CORIANDER	Seeds / Saplings	Sow directly early Spring outside In bunches	Transplant before Summer	-	Mar-May	Young saplings in compost without bag
TULASI BASIL	Seeds / Saplings	Early Spring in GH trays	Transplant in bags in Spring/Summer	Put bags in ground before Summer	Mar-May	Young saplings in compost without bag
THAI BASIL	Seeds	Early Spring in GH trays	Transplant in bags in Spring/Summer	Put bags in ground Before Summer	Mar-May	Young saplings in compost without bag
ITALIAN BASIL	Saplings	Plant nursery early Spring in GH trays	Transplant in bags in Spring/Summer	Put bags in ground before Summer	Mar-May	Young saplings in compost without bag
CAPE GOOSEBERRY	Seeds / Saplings	Start from seeds in early Spring in GH trays	Transplant in bags in Spring/Summer	Put bags in ground in Spring	Mar-Aug	Transplant young saplings in bags
TREE TOMATO	Seeds / Saplings	Start from seeds in early Spring in GH trays	Transplant in bags in Spring/Summer	Put bags in the ground in Spring	Mar-Aug	Transplant young saplings in bags
MULBERRY	Seeds / Cuttings / Saplings	Start from seeds in early Spring in GH	Transplant young saplings in bags or outdoor nursery in late Summer	Put bags in the ground in Monsoon	Mar-Aug	Transplant young saplings in bags
FLOWERS	Seeds / Saplings	Plant nursery in early spring outside	Transplant in Summer	-	Mar -Jun	Young saplings in compost without bag

	PROPAGATION	1st PLANTING	2nd PLANTING	3rd PLANTING	READY	PRODUCT
SUMMER + AUTUMN						
SPINACH	Seeds	Plant in early monsoon in trays	Transplant or sell saplings in autumn	-	Sep-Nov	Young saplings in compost, without bag for indoor planting
CORIANDER	Seeds / Saplings	Sow directly early Monsoon outside in bunches	Transplant or sell saplings in autumn	-	Sep	Young saplings in compost without bag for indoor planting
CHERRY TOMATO	Seeds / Saplings	Plant nursery in early monsoon in GH	Transplant outside or sell in late monsoon	-	Sep-Nov	Young saplings in compost, without bag for indoor planting
ITALIAN BASIL	Saplings	Plant nursery early Spring and mid-monsoon in GH trays	Transplant or sell saplings in autumn	-	Sep-Nov	Young saplings in compost without bag for indoor planting
DILL	Seeds / Saplings					
PARSLEY	Seeds / Saplings					
MINT	Division / Saplings	Make divisions in early monsoon and transplant directly sell or put in bags	-	-	Jun-Aug	Transplant young saplings in bags. Give saplings in compost directly.
CELERY	Seeds / Saplings	Plant nursery in monsoon	Transplant or sell in Autumn	-	Oct-Nov	Young saplings in compost without bag
LEMONGRASS	Division / Saplings	Make divisions in early monsoon and transplant directly sell or put in bags	-	-	Jun-Aug	Transplant young saplings in bags. Give saplings in compost directly
JASMINE	Cuttings / Saplings	Make cuttings in Monsoon and plant in nursery	Put rooted cuttings in bags in Autumn	Put bags in the ground in Monsoon next year	Mar-Jun	Saplings in bags
CANNA LILY	Division	Make divisions in early monsoon and transplant directly sell or put in bags	-	-	Jun-Aug	Saplings with compost bags no need

	PROPAGATION	1st PLANTING	2nd PLANTING	3rd PLANTING	READY	PRODUCT
RAIN LILY	Division / Saplings	Make divisions in early monsoon and transplant directly sell or put in bags	-	-	Jun-Aug	Saplings with or without bags
ROSE	Cuttings / Saplings	Make cuttings in Monsoon and plant in nursery	Put rooted cuttings in bags in Autumn	Put bags in the ground in Spring/Summer	Apr-Aug	Saplings in bags
CAPE GOOSEBERRY	Seeds / Saplings	Start from seeds during monsoon in GH	Transplant in bags in Autumn	Put bags in the ground in Spring next year	Mar-Aug	Transplant young saplings in bags
MULBERRY	Seeds / Cuttings / Saplings	Start from seeds in mid-July Monsoon in GH	Transplant in bags in Autumn	Put bags in the ground in Monsoon next year	Jun-Aug	Saplings in bags
STRAWBERRY	Division	Make divisions in early monsoon and transplant directly sell or put in bags	Transplant in the ground early/mid Monsoon	-	Jun-Aug	Saplings with or without bags
BLACKBERRY	Cuttings / Saplings	Make cuttings in Monsoon and plant in nursery	Put rooted cuttings in bags in Autumn	Put bags in the ground in Monsoon next year	Mar-Jul	Saplings in bags
AUTUMN + WINTER						
SPINACH	Seeds	Sow directly in autumn	Transplant before Winter	-	Oct-Nov	Young saplings in compost without bag
PERENNIAL GARLIC	Saplings	Plant seeds in autumn in GH trays	Transplant saplings in bags in Spring	Put bags in the ground in Monsoon	Sep-Nov	Transplant young saplings in bags
OREGANO	Division / Saplings				Nov-Jan	
FENNEL	Seeds / Saplings	Sow directly in early Autumn	Transplant in Spring	-	Mar-May	
CORIANDER	Seeds	Sow directly early autumn outside in bunches	-	-	Oct-Nov	Young saplings in compost without bag
KALE	Seeds / Saplings	Plant nursery early Spring and mid-monsoon in GH trays	Transplant in bags or outside in Spring or in Autumn	Put bags in the ground Autumn / Spring	Oct-Nov	Saplings in bags
COLLARDS	Seeds / Saplings	Plant nursery early Spring and mid-monsoon in GH trays	Transplant in bags or outside in Spring or in Autumn	Put bags in the ground Autumn / Spring	Oct-Nov	Saplings in bags

THREE YEAR SUCCESSION PLANTING

YEAR 1

	SPRING	SUMMER	AUTUMN	WINTER
ROOTS		Radish	Radish	
		Ginger	Carrot	
		Turmeric		
		Taro		
GROUND-COVER		Soybean	Clover	
			Alfalfa	
HERBS		Lemongrass	Celery	Rosemary
		Mint		Oregano
		Basil		
		Nasturtium		
SHRUBS	Cape Gooseberry	Corn		Wheat
	Blackberry	Castor		Barley
	Elderberry	Amaranth		Oats
SHORT TREES		Banana		
		Papaya		
MEDIUM TREES		Willow		Wild Cherry
		Beul		Wild Pear
		Kachnaar		Wild Peach
		Kaphal		Wild Apricot
		Mulberry (Toot)		Wild Fig
		Black Locust		
		(Robinia)		Cluster Fig
		Poona		Guava
		Amla		
		Jamun		
		Mango		
HIGH TREES	-	-	-	-

YEAR 2

	SPRING	SUMMER	AUTUMN	WINTER
ROOTS				
				Harvest Ginger and Turmeric but leave some root in the ground. It will sprout in summer of year 3.
GROUND-COVER	Watercress	Soybean	Self-seeded clover	
		Cucurbits	Self-seeded alfalfa	
HERBS		Cleaning and propagating herbs from year 1		
SHRUBS		Propagating shrubs from year 1		
		Propagating		
SHORT TREES		Banana		
		Replacing unsuccessful trees from year 1		
MEDIUM TREES	Tree tomato			Chop and drop
HIGH TREES	Deodar			
	Tooni			
	Soapnut			
	Drek			
	Rhododendron			
	White oak			
	Khirk			

YEAR 3

	SPRING	SUMMER	AUTUMN	WINTER
ROOTS				Harvest Ginger and Turmeric. Leave some root in the ground to sprout in summer of year 4
GROUND-COVER		Strawberry	Self-seeded clover	
			Self-seeded alfalfa	
HERBS		Cleaning the herb spots to give them space to grow		
SHRUBS		Propagating shrubs from year 2		
SHORT TREES				
MEDIUM TREES		Diversifying the system based on what has worked		Chop and drop
HIGH TREES		Diversifying the system based on what has worked		

SOIL BIOLOGY ASSAY

Date Collected: 10/11/18
Date Observed: 11/11/18
Sample: Potato field, Shunya farm, Bir
Observed by: Angelica
Magnification: 400x

Standard Deviation

Reading #	1	2	3	4	5	6	7	8	9	10	Mean	StDev	Dilution	#/g	ug/ g	#/g	ug/ g
Bacteria/field	20	40	40	60	20	40	48	52	32	40	39.20	12.76	50	7,98,89,600	160	2,60,07,024	52
# in partial field	5	10	10	15	5	10	12	13	8	10							
Size/shape	Circ.	Var.	Var.	Circ.	Circ.	Circ.	Circ.	Circ.	Circ.	Circ.							
														Length (cm)	ug/ g	Length (cm)	ug/ g
Actinobacteria/field	0.4	0.5	0.3	0.5	0.55	0.35	0.3	0.4	0.35	0.4	0.41	0.09	5	3,760	6.79	793	1.43
Sum (length in cm)	0.8	1	0.6	1	1.1	0.7	0.6	0.8	0.7	0.8	0.0	0.0					
											Strands	Dev.		Length (cm)	ug/g	Length (cm)	ug/ g
Fungi/field	0	0.1	0	0	0	0.1	0	0	0	0	0.02	0.042	5	183	55	387	116
Sum (length in cm)	0	0.2	0	0	0	0.2	0	0	0	0	0.001	0.002					
Diameter	0	1	0	0	0	1.5	0	0	0	0							
Color		Brown				Brown					Avg d. (um)						
	0	0.1	0	0	0	0.15	0	0	0	0	1.3	0.00034					
														Length (cm)	ug/ g	Length (cm)	
Oomycetes/field	0.1	0	0.1	0.25	0	0	0.1	0	0.150	0	0.07	0.09	5	642	66.52	785	81
Sum (length in cm)	0.2	0	0.2	0.5	0	0	0.2	0	0.3	0	0.003	0.004					
Diameter	1	0	1	0.5	0	0	1	0	1	0							
Color	Clear		Clear	Clear			Clear		Clear		Avg d. (um)						
	0.1	0	0.1	0.125	0	0	0.1	0	0.15	0	0.8	0.00020					
														#/g		#/g	
Flagellate/field	0.25	0.3	0	0	0.25	0.25	0.15	0	0.3	0	0.15	0.14	5	30,570	**F:B**	27,595	
Amoebae/field	0	0.5	0	0.25	0	0	0.5	0	0	0	0.13	0.21	5	25,475	0.330	43,299	
Ciliates/field	0	0	0	0	1	0.1	0	0	0	0	0.11	0.31	5	22,418		64,052	
														#/g			
Nematodes/drop	0	0	0	1	0	0	0	0	1	0	1		5	100.00			
		/	/	Bacterial	/	/		/	Bacterial	/							

SOIL BIOLOGY ASSAY																	
Date Collected: 21/04/19																	
Date Observed: 22/04/19																	
Sample: Compost, Shunya farm, Bir																	
Observed by: Anshul																	
Magnification: 400x																	
																Standard Deviation	
Reading #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Mean**	**StDev**	**Dilution**	**#/g**	**ug/ g**	**#/g**	**ug/ g**
Bacteria/field	80	76	108	112	88	92	102	120	76	88	94.20	15.56	50	19,19,79,600	384	3,17,15,483	63
# in partial field	20	19	27	28	22	23	26	30	19	22							
Size/shape	Var.	Var.	Var.	Var.	Var.	Var.	Var.	Var.	Var.	Var.							
														Length (cm)	ug/ g	Length (cm)	ug/ g
Actinobacteria/field	0	0.65	0.5	0.55	0.8	0.7	0.6	0.55	0.85	0.7	0.59	0.24	5	5,411	9.77	2,159	3.90
Sum (length in cm)	0	1.3	1	1.1	1.6	1.4	1.2	1.1	1.8	1.4	0.0	0.0					
											Strands	Dev.		Length (cm)	ug/g	Length (cm)	ug/ g
Fungi/field	0.3	0.325	0.25	0.375	0.35	0.2	0.15	0.25	0.225	0.25	0.27	0.070	5	2,453	735	640	192
Sum (length in cm)	0.6	0.65	0.5	0.75	0.7	0.85	0.65	0.75	0.8	0.6	0.012	0.003					
Diameter	3.5	3.5	3	3.5	4	2.5	2	4	3	3.5							
Color	Brown	d. Brown	d. Brown	Brown	d. Brown	Brown	Pink	Brown	Purple	Brown	Avg d. (um)						
	1.05	1.1375	0.75	1.3125	1.4	0.5	0.3	1	0.675	0.875	3.4	0.00034					
														Length (cm)	ug/ g	Length (cm)	
Oomycetes/field	0.15	0.1	0.125	0.15	0.1	0.1	0.15	0.175	0.125	0.1	0.13	0.03	5	1,169	121.16	252	26
Sum (length in cm)	0.3	0.2	0.25	0.3	0.2	0.2	0.3	0.35	0.25	0.2	0.006	0.001					
Diameter	2	2	2	2	2	1.5	2	2.5	1.5	2							
Color	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Avg d. (um)						
	0.3	0.2	0.25	0.3	0.2	0.15	0.3	0.4375	0.1875	0.2	2.0	0.00020					
														#/g		#/g	
Flagellate/field	0.5	0.5	1	1	0.5	0.3	0.5	1.5	1	0.75	0.76	0.37	5	1,53,869	**F:B**	74,487	
Amoebae/field	0.2	0.2	1.5	1	1	0.4	1	0.5	0.2	0.1	0.61	0.48	5	1,24,318	1.866	97,715	
Ciliates/field	0	0	0	0	0	0.1	0	0	0	0	0.01	0.03	5	2,038		6,445	
														#/g			
Nematodes/drop	1	0	0	1	0	0	1	0	1	0	2		5	200.00			
	Fungal	/	/	Bacterial	/	/	Fungal	/	Bacterial	/							

Books

- A Pattern Language, Christopher Alexander
- Abundance for All, Shripad Dhabolkar
- Agriculture Course, Rudolf Steiner
- Ayurveda- Nature's Medicine, Fawley & Ranade
- Biodynamic Farming and Gardening, Peter Proctar
- Cosmos, Earth and Nutrition, Richard Thornton Smith
- Dirt- The Erosion of Civilisations, David R. Montgomery
- Earth Users' Guide to Permaculture, Rosemary Morrow
- Future Scenarios, David Holmgren
- Garden Cities of Tomorrow, Howard Ebenezer
- Indica- A Deep Natural History of the Indian Subcontinent, Pawan Kumar
- One Straw Revolution, Masanobu Fukuoka
- Organic Revolution: The Agricultural Transformation of Cuba since 1990- Bharat Mansata
- Pedagogy of the Oppressed, Paulo Freire
- Small is Beautiful, E.F. Schumacher
- The Agriculture Testament, Albert Howard
- The Barefoot Architect, Johan van Lengen
- The Earthworm Book, Sultan Ahmed Ismail
- The Hidden Life of Trees, Peter Wohlleben
- The Little Prince, Antoine de Saint-Exupery
- The Mother, Sri Aurobindo
- The Natural Farming Way, Masanobu Fukuoka
- The Post Carbon Reader, Heinberg & Lerch
- The Third Plate, Dan Barber
- The Transition Handbook, Rob Hopkins
- The Vision of Natural Farming, Bharat Mansata
- The Water Wizard, Victor Schauberger
- The Web of Life, Fritjof Capra
- Where Our Food Comes From, Gary Paul Nabhan