Permaculture in Refugee Situations

A Handbook for Sustainable Land Management

Produced by the UNHCR Engineering and Environmental Services Section in conjunction with the Southern Alliance for Indigenous Resources (SAFIRE)

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A Refugee Permaculture Handbook

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About SAFIRE

The Southern Alliance for Indigenous Resources (SAFIRE) was established in 1994 to assist rural communities in the development of self sufficiency through the improved management of their natural resource base. SAFIRE is a collaborative initiative, deriving its membership from a number of local and international non governmental organizations (NGOs), grassroot development agencies, government instittutions, international organizations and individuals.

Today, SAFIRE's vision is: *To be a regional leader and service provider of first choice in benefit driven sustainable natural resources management by rural communities, and its mission is: To facilitate the development and application of innovative approaches to diversify and improve rural livelihoods, based on the utilization, commercialization and sustainable management of natural resources.*

Operational in Zimbabwe, SAFIRE also provides support and training to community based natural resourcess management programmes throughout Southern Africa emphasizing the use of participatory development methodologies. In addition, SAFIE contributes technical assistance on environmental issues in refugee situations in Africa. Up to now, SAFIRE has contributed technical assistance to environmental programmes for refugees in Malawi, Tanzania, Namibia, Botswana, Mozambique, Swaziland and Guinea.

SAFIRE's Refugee and Environmental Management Unit (REMU) is currently facilitating the implementation of permaculture projects in refugee and refugee hosting communities in Zimabwe. The projects are funded by EESS, UNHCR, Geneva. SAFIRE and the refugees are grateful for this assistance.

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Introduction

The word 'permaculture' is probably new to most people working with refugees. It describes an environmentally friendly design system for settlements that emerged from the world of ecology rather than relief work. The idea nevertheless has clear potential for refugee situations, where there may be a great number of people in relation to the resources available and a need to find ways of managing the environment more carefully. Permaculture is one such way.

This handbook aims to give somebody unfamiliar with permaculture a better idea of what it entails and how it can contribute to the sustainability of camps and settlements where refugees live. It is intended to be concise, readable and simply presented. For readers who want to know more about permaculture, references are provided at the back of the handbook for detailed sources of information in the literature and on the internet.

The aim of the handbook is not to turn anyone into a permaculturist overnight. It is hoped instead that it might show managers and non-technical staff in refugee assistance organisations how permaculture can bring social and environmental benefits in places that host refugees. Convinced of its merits, they might be encouraged to give greater support to permaculture activities in the camps or settlements where they work, and the concepts of permaculture can be gradually more integrated in refugee programmes.

What is Permaculture?

The term 'permaculture' was coined in the 1970s and comes from the words 'permanent' and 'agriculture'. So it is a type of sustainable farming. More than that, it is a land use design system for creating sustainable human environments.

Permaculture is really about living in an environmentally sound way. There are other movements that promote this idea as well, but permaculture distinguishes itself by stressing the *relationships between landscape elements* and *deliberate spatial design*. While it deals with soil, plants, animals, water, buildings and infrastructure at one level, it is really about the relationships that can be created between these elements by the specific ways in which they are placed in the landscape. Refugee camps tend to be designed as an assemblage of isolated elements like roads, schools, hospitals and water supply systems, whereas permaculture would integrate all of these elements carefully from the start.

Although it is consciously designed, a permaculture system is still expected to have the diversity, stability and resilience of a natural ecosystem, and is able to provide people with their food, energy, shelter and other needs in a sustainable way. So it is a serious production system that can support livelihoods, not an experimental type of settlement planning.

Land Design

The core of permaculture is design. Design is a connection between things. It is not about a tap-stand, a refugee garden and a tree, but how the tap, the garden and the tree are connected in ways that benefit each other. Within a permaculture system, different elements are appropriate for different places in the landscape according to their interrelationships.

An approach that permaculturists often use in the land design process is to develop four or five concentric 'zones' focussed on particular centres of activity in the landscape. In a refugee situation these centres might be homes, distribution centres or water points. Close to each centre of activity are located elements that need a lot of attention or water, such as vegetable gardens or huts for small animals like rabbits. Further away are elements that need to be tended less often or require less water, such as fruit orchards or fields of cereal crops. In this way the system can be managed with minimum effort. Within each zone, and between zones, the relationships between elements are carefully planned. The handbook will give some examples of these relationships and how they determine the best positions for all the different elements that might exist.

The landscape is also designed according to 'sectors', often radiating outwards from the centre of activity. The sectors may receive different amounts of sunshine or wind or may slope in different ways, so the elements suitable for placement in each sector will be different.

The handbook explains the idea of zones and sectors in more detail and how different landscape components may be suited to different positions within the permaculture system. The main point is that pre-planning and design are fundamental to permaculture, which in the refugee setting means that early action in the emergency phase will be much more effective than redesigning an existing camp or settlement along permaculture lines after it has been set up.

More than Organic Farming

Permaculture might at first be confused with organic farming. Both systems aim to produce food in an environmentally friendly way. But while organic farming does not use chemically-produced pesticides and fertilisers, it still faces some of the same problems that are found in conventional agriculture. Monoculture is permitted, for example, which can lead to the buildup of pests and diseases and the depletion of soil nutrients. Organic agriculture prescribes rotations, natural sprays, liquid manures and compost to combat these problems. Permaculture, in contrast, does not just replace synthetic inputs with organic inputs , but relies on the systems' plants and animals themselves, and their relationships in the landscape, to discourage pests and diseases from even appearing and to maintain soil fertility before it declines. So potential problems are eliminated through deliberate design measures in the spirit of 'prevention before cure'.

Permaculture farms also tend to be more complicated, diverse and visually confused than purely organic farms, with a minimal amount of bare soil and often no clear pattern of planting. Weeds may be tolerated and plants allowed to go to seed as a deliberate part of planning. Organic farming tends to maintain more regimented organisation of space along the lines of traditional agriculture.

In spite of the differences, anyone who has some knowledge of organic farming will be in a good position to start learning about permaculture, as many of the same practical techniques are found in both approaches.

Global Applicability

Permaculture design is site specific and culture specific. This is partly because it incorporates land management practices directly from local people. In fact indigenous knowledge is often the starting point for designing a permaculture system, as this handbook will explain. This makes it flexible and suited to almost every part of the world.

Many of the permaculture practices shown in this handbook were derived from SAFIRE's project with refugees and local communities in Zimbabwe. In other places with different resources, climatic conditions and social traditions the practices that are suitable could be quite different. The plants that perform particular functions in the design system are especially likely to vary according to the ecology and climate of the area. So not all of the handbook's suggestions are to be taken literally, but should be seen as working examples from which to adapt models for other places. In a dry area in tropical Africa, for example, it might be wise to grow sorghum and pigeon peas together to produce food while maintaining soil fertility, whereas in a wetter place in south-east Asia perhaps okra, tomato, ginger and mung bean would be a more appropriate combination. In both cases the end result is production of food and protection and improvement of the soil.

It is always advisable to seek advice from trained permaculturists on plant and animals varieties that can serve the desired purposes in a particular ecological setting.

Suitability of Permaculture to Refugee Situations

Permaculture has several components that make it a livelihood support system well-suited to refugee situations:

Deliberate spatial design

Permaculture systems are explicitly designed to maximise the benefits of placing certain landscape elements in particular positions. Refugee camps and settlements are also usually designed in an organised manner. The two approaches are compatible as they both follow a pre-planned approach to the layout of living space.

Small-scale and intensive production systems

Each component in a permaculture system performs many functions and space is used to its maximum potential. As refugee families often have access to limited areas for habitation and resource use, it is desirable for them to be able to make optimal use of small amounts of land.

Minimal inputs and efficient energy use

The pre-planning of permaculture systems is intended to ensure that effort is minimised, outputs are maximised, wastage is eliminated and materials are recycled on site. External energy inputs are kept to a minimum. This suits the refugee context, where funds and material resources are often limited in relation to population.

Polycultural (as opposed to monocultural) production

Permaculture promotes biological diversity through mixed species techniques such as agroforestry and intercropping. This is desirable in a high density living environment such as a refugee camp, where human, animal and plant diseases would be encouraged to spread under systems of monoculture.

Relatively high labour input

Permaculture is fairly labour intensive. In a refugee situation labour is often abundant so this may be a benefit rather than a constraint.

Production of tangible outputs

Permaculture can produce tangible outputs by improving water supplies, providing food, producing firewood, fodder, building materials, herbs and other resources, generating income and improving quality of life. It is not an experimental system. This can make it attractive to refugees who have few resources of their own, as it gives them practical ways to increase their self-sufficiency and reduce dependency on handouts.

Optimal use of water

Refugees are very often placed on inferior land within the host country, typically in areas with lower than average rainfall. In extreme cases refugees may be placed in areas of desert and semi-desert. Permaculture places great emphasis on a variety of techniques that capture, store and utilise rainwater and surface water in the most economical ways. Many of these techniques are specifically designed to minimise water loss and maximise retention in dry areas. For dryland refugee settings where water needs to be conserved and used optimally, permaculture is therefore one of the most effective land management systems available.

Permaculture is therefore clearly compatible with refugee camps and settlements. This has already been shown in projects with refugees implemented by Concern Universal in Malawi, CARE International in Macedonia (where permaculture is being used in camp site rehabilitation with the local community) and the Southern Alliance for Indigenous Resources (SAFIRE) in Zimbabwe - whose project formed the basis for this handbook.

Limitations of Permaculture

Permaculture is not the panacea to environmental problems. It is important to be realistic about its limitations in refugee situations.

High labour input is required

As already stated, permaculture needs a lot of work. It relies on human labour more than mechanical power and refugees need to be convinced of its benefits before they will invest sufficient time to appreciate its full potential.

Time is needed to produce results

Permaculture takes a certain amount of time to generate results. Where refugees are uncertain of their status or the length of time that they will be in the host country, they may not be motivated to commit labour and other resources. In order to increase the attractiveness of permaculture for such refugees, it is necessary to look for practices that can yield short-term benefits, the production of green vegetables, for example. Using this as the basis for capturing people's interest and energy, more intensive processes can be introduced that will yield further successes in the longer-term

Refugees may lack concern for the host environment

For permaculture to work to its full potential, people should feel a commitment to the land. Refugees may lack commitment to managing the resources of a host country, or may not have the authority to do so. For this reason it may be better to concentrate permaculture activities on refugees' living plots around their homes, as they will be more interested in investing time and effort in that space than in areas further afield that do not come under their control. This requires a modification of true permaculture to bring a heavier focus on the design of the innermost zones.

Permaculture is a way of life; it can be hard to 'sample'

Many permaculturists are committed to living an environmentally sustainable, self-supporting lifestyle by taking the concept as almost a moral and social code. It is important to respect the totality of permaculture as a movement and the holistic approach that many of its practitioners consider essential. Piecemeal approaches that take a selection of useful practices will not capture the true essence of permaculture. It may also be difficult to 'post design' a permaculture system for a refugee camp that has been set up according to traditional site planning methodologies. It is nevertheless possible in refugee work to benefit from the practical application of permaculture ideas without subscribing to its holistic spatial and chronological approach.

Layout of this Handbook

Permaculture should be introduced to a refugee community in a number of stages. This handbook is arranged according to one set of suggested stages so that the reader can understand exactly how a permaculture project can be implemented:

(a) Participatory Project Development

(b) Landscape Observation

(c) Goal Formulation

(d) Land Design

(e) Implementation of the Design

(f) Monitoring and Evaluation

At the end of the booklet there is a glossary of terms and a selection of sources of further information on permaculture. This includes a list of UNHCR publications that relate to the environment, which will be useful for readers who want to gain a broader view of UNHCR's environmental strategies and the way in which permaculture can build on past lessons and experiences in refugee situations.

Permaculture Stage One: Participatory Project Development

The first part of a permaculture project should be to identify its participants, carry out basic training and develop an implementation plan. This will probably take 2-4 months.

There are five steps involved:

(a) project awareness-raising
(b) selection of the participants
(c) assessment of existing skills and indigenous knowledge
(d) technical training in permaculture, building on existing skills
(e) definition of project objectives, activities and indicators

Project Awareness Raising

Awareness of the permaculture project first needs to be created among the refugee community. Using existing channels of communication, they should be informed of its joint goals of environmental care and self-sufficiency. An organisational workshop might be a good idea, at which plans can be shared and the foundation laid for identifying interested participants. Refugees should be informed of the basic principles of permaculture, the overall goals of the project and its anticipated lifespan.

Selection of the Participants

Once people are aware of the project in outline form, interested individuals can be sought to take part in a process of project development. Community mobilisation is important in the implementation of permaculture design. As it requires commitment of time, resources and labour before results will be forthcoming, not all refugees will see benefits from getting involved with a permaculture programme, and not all will be motivated to provide the inputs that are required. Refugees from rural farming communities typically show more interest than those originating from urban areas. Those with a background in natural sciences may grasp some of the more technical aspects more readily. So although it has many benefits for refugees and for the environment, participants should be self-selected and aware of the inputs that they will need to provide.

It is important to balance a permaculture project aimed at refugees with an offer to work with local people as well. This is not only fair and equitable, but may avoid its success being jeopardised by jealousies. Members of the local community should be involved from the outset, either within the refugee project or in a parallel programme. Other stakeholders to involve at this stage might be government officials, both for the sake of good relations and because some will be able to provide useful technical advice, especially in the areas of forestry and agriculture.

Assessment of Existing Skills and Indigenous Knowledge

Once a group of interested individuals has been identified, their existing knowledge of permaculture needs to be established. What do they know, for example, about organic farming practices? Many traditional land use practices can embrace permaculture design principles, and such practices may be readily transferable to the refugee situation.

Specialist trainers skilled in participatory appraisal methodologies may be required for this information sharing process.

Many non-governmental organisations (NGOs) have staff trained in participatory appraisal methodologies. UNHCR has its own methods of conducting 'people-oriented planning' (POP) that many of its staff will be familiar with.

Technical Training in Permaculture

Having determined who will participate in the project and what they already know about permaculture ideas, it is important to introduce technical training in permaculture to the refugees so that its distinguishing features are clearly understood. This will build on what the target group already knows about sustainable land management, but should provide a thorough grounding in the specific design aspects unique to permaculture.

Short courses may be run on themes such as sustainable agriculture, natural pest and disease management, intensive organic farming and organic tree propagation techniques, as well as the overall principles of permaculture design. Specialist training staff will be needed with a background in permaculture. Such courses will help refugees grasp the full diversity of permaculture and give them a range of ideas that can be used in the design and implementation stages.

Definition of Project Objectives, Activities and Indicators

Before moving on to actual implementation of field activities, participants from the refugee and local population should be taken through a process of defining the *objectives* of the project, along with its specific *activities* and ways in which progress in each of those activities will be assessed against certain *indicators*. If the participants play the leading role in defining the *objectives, activities* and *indicators* for the project at the outset then they will naturally be its main evaluators later on.

Some form of 'logical framework' or 'project planning matrix' is recommended to lay out the project clearly. UNHCR calls this a 'reporting and operations plan'. It is a standard planning approach to ensure that implementation can be made accountable and that the project will stick to a timetable. It will also mean that the participants will be aware of what is expected of them as the project goes ahead.

As an example of the project design process, perhaps the *overall goal* has already been defined by the implementing agency or the donor. It might be something like:

"To promote food security, environmental protection, enterprise development and social harmony in the refugee camps and surrounding areas".

To achieve this goal various *objectives* need to be developed. This is the job of the stakeholders in the project design stage. One objective could be:

"To develop, support and strengthen permaculture designs as a contribution to meeting the project's overall goal".

This objective could be achieved through many *activities*. Some of the first activities could be as follows, though the participants might come up with their own:

- Create awareness of the permaculture project and its overall goal among the refugee and local community.
- Complete a process of selection of participants, according to personal interest and commitment.
- Identify existing levels of knowledge of permaculture techniques among the project participants.
- Supplement existing knowledge with permaculture training courses and other technical courses as appropriate.

The stakeholders need to know when they have achieved their objectives. So *indicators* need to be defined. In defining these indicators, the projects' participants should be prepared to evaluate not only the performance of the project staff, but also their own inputs.

Indicators of achievement for the above activities could be:

- Awareness raising programme implemented in the camp(s) and local communities within two months.
- Refugees and local people interested in the project and willing to participate.
- 50 project participants identified by the community, 25 refugees and 25 local.
- Two participatory workshops held to ascertain existing permaculture skills, within three months of the start of the project.
- Two five-day permaculture training courses run, as well as four other skills courses according to participant's identified needs, within four months of implementation.

More activities and indicators can of course, be selected for this objective.

If the project is large then a specialist facilitator might be needed to work with the stakeholders to develop this framework of objectives, activities and indicators. At the end of the exercise the information can be summarised in a single grid.

Permaculture Stage Two: Landscape Observation

By this stage the refugees (and local people) who are working with the project should have understood the principles of permaculture and have developed a plan and timetable for the project. They will know what the objectives are, how these are to be achieved and which indicators are to be used to judge progress. They should now be ready to enter the first practical phase.

This is the crucial 'observation and analysis' stage. Existing resources need to be identified and recorded so that the permaculturists-in-training are familiar with the building blocks with which they are going to design the permaculture system. Already, each element in the landscape has to be thought of in terms of its interaction with all other elements of the landscape.

The aim is to record and map the available resources on the piece of land to be designed and in the surrounding area. This is best done at a number of different scales:

- *Whole area:* The elements of the landscape as a whole need to be assessed. These include landforms, watercourses, prevailing wind direction, slope of the land, aspect relative to the sun at different times of day and at different seasons, flora and fauna, existing land uses, the refugee camp's location and extent (if it already exists), the nature of the surrounding communities and environment, resource ownership and management systems, and any infrastructure present. There may be additional relevant features. These should be drawn on maps. It is important that as many members of the refugee and local community as possible get involved in this process.
- *Camp and immediate surroundings:* More localised resources also need to be observed, close to where the refugees or local people are living. These might include the arrangement of roads and living plots within the camp, the positions of trees, houses, schools, clinics, distribution centres, waterpoints and waste disposal areas, the type of soil, and the main plant, animal and tree species present.
- *Household plots:* Observation is then required at the level of the individual plot and kitchen garden. There may be micro-climatic factors to consider or local issues of shade, water availability or soil variation. Again, a map or plan will help to summarise the type and location of these elements. The house itself and the area under the family's direct control should be drawn, marking the positions of each structure, plant and tree. Obviously, at this scale, the findings will differ for each participant.

As well as using direct observation on the ground and transect surveys, the required information might be obtained from maps, aerial photographs or historical records. Soil and water testing may also be needed, as well as species identification by suitably skilled individuals.

The observation of resources at the different spatial levels allows differentiation to be made between the large area and the small area. Landscapes designs can then be tailored to the resources available at these different scales.

Permaculture Stage Three: Goal Formulation

Once the available resources have been properly documented then the permaculture system can be designed. There is an intermediate step, however. The stakeholders first need to decide what they intend to get from the system. They need to prioritise their goals so that the system can be designed with these in mind.

Goal formulation can be carried out as follows:

- define all of the people, organisations and institutions connected to the piece of land
- arrange a meeting in which these individuals and organisations can participate

Find out the following from the participants:

- their personal values and current uses with respect to the land (perhaps productivity, conservation, tranquillity or education)
- what they want to produce or gain from the land
- their long-term vision for the land

Some people may want to produce large amounts of food as quickly as possible, whereas others may prioritise improving their supply of firewood or building poles. Some may prefer to leave areas untouched for recreation or education, whereas others may wish to see all available space brought under some sort of production for income generation. It is likely that the local communities' goals will differ from those of the refugees. Different design systems may therefore be appropriate for their respective areas.

Permaculture Stage Four: Land Design

Having assessed the resources available in and around the refugee camp, both human and physical, and determined what the stakeholders wish to get from the land, the layout of the landscape can now be planned. This is the design stage, the heart of permaculture.

The information gathered in the preceding stages helps in the design stage to recognise what *elements* are already present in the area and what extra elements will need to be included. An *element* is any part of the landscape that can be used in the design. It might be a road, tap-stand, fence, rock outcrop, building, orchard, nursery, rabbit hut or lake. Every element observed in the landscape should be listed.

All of the elements have *functions* - roles that can be used to benefit other elements. For example a rock outcrop may provide shade and shelter, facilitate water run-off and/or act as a source of radiant heat. All possible functions of each element should therefore be listed.

There are three rules to follow when thinking of the value of the different elements:

a) *Every element should serve many functions.* For example, a rabbit unit can function as a food source for humans, a warm place near which to grow young seedlings, and a source of manure. A tree can provide shade, windbreak, fuel, building poles, fodder and a place for birds to perch as they hunt insect pests.

b) *Every function should be served in two or more ways.* For example pest control in an orchard can be achieved by planting repellent plants around the fruit trees and also by introducing a mobile chicken unit - the chickens will eat insects on the ground (and will also produce manure for the trees).

c) *Incompatible elements should not be placed close to each other.* Chickens, for example, might scratch away mulch on a vegetable garden so they should be placed away from it otherwise the garden should be protected.

Zones

To make the design work manageable, it is advisable to break the landscape down into smaller spatial units and concentrate on each of these in turn. Here the idea of *zones* and *sectors* is useful.

The design is normally focussed around a '*Centre of Activity*'. This centre of activity is called 'Zone 0'. It is often a house, but could also be a school, hospital or other place where people congregate. There should normally be a source of water as close as possible to the centre of activity.

Spreading outwards from the centre of activity, the land is designed according to concentric zones. Elements are placed in these zones according to how much water and 'attention' they need. Attention can mean soil care, watering, pest control, shade, shelter, pruning or harvesting. Zones in a permaculture system are often numbered from 1 to 5, with 1 being the most intensively used zone needing the most water and attention and 5 being the least intensive zone, furthest away from the centre of activity.

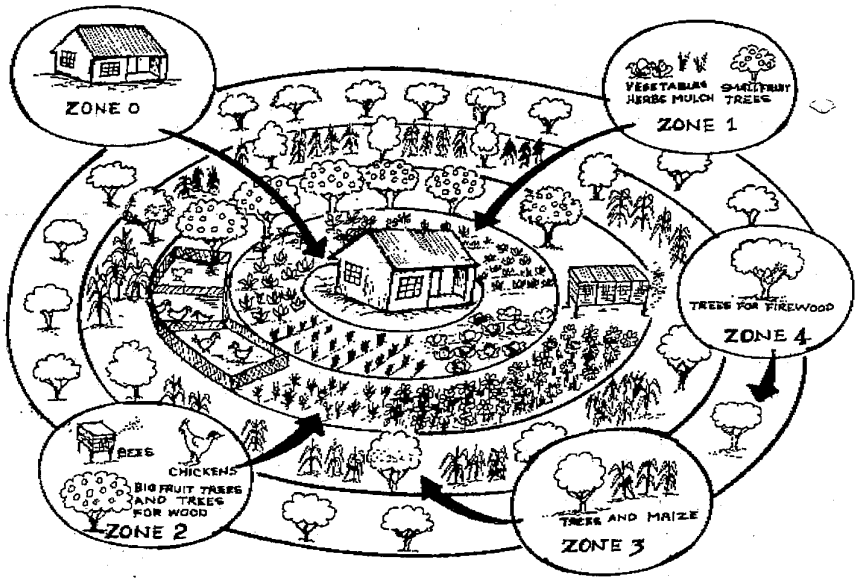


Figure 1 Stylised zone layout in permaculture design

Zone 1 might be suitable for a vegetable garden as it can be easily reached for watering and harvesting. An orchard could be placed in Zone 2, as it needs slightly less water and attention. Poultry might also be located here. The area where annual crops are grown normally relies on rain for its water supply and requires less attention than either the vegetable garden or the orchard, so it can be situated in Zone 3. Zone 4 is a less intensively used area in which fuelwood and timber trees can be planted and livestock grazed. These elements need very little attention. In some situations a fifth zone might be allowed for, which would be an almost unmanaged wild area where natural products such as firewood and water could be obtained on a sustainable basis.

Specific ideas for elements and practices that are suitable for each zone are provided later in the handbook.

Several permaculture measures in Zones 4 and 5 will need to be managed by groups or the community as these are wild and semi-wild areas where activities cannot be

implemented successfully by individuals working in isolation. This will not always be feasible in a refugee situation, depending on the degree to which host communities and the government support refugee involvement in resource management outside their immediate living space. So the outer zones will not always play a full part in a refugee permaculture system. The primary focus will be on Zones 0-3, ideally spreading outwards as the project develops.

Zone Modifiers

Zones in a permaculture system will normally not be circular and may not even come in the sequence outlined above. They are ideas or concepts but are not intended to be static boundaries on the land. Zones flow in and out of each other and are flexible, changing over time if desired. There are different types of 'zone modifiers':

- *Location of water sources:* The main water source may not be at the house itself, as may be the case in a refugee camp, and people might have to walk to a tap-stand to fetch water. In such a case, vegetables might be grown near this tap-stand, making a separate kind of 'Zone 1' at this different centre of activity. At the house, the main water supply might be waste water from cooking, washing dishes and bathing, or harvested rainwater, some of which could be diverted into a small vegetable garden or orchard. Thus the zones are modified because of the location of the different sources of water.

- *Seasonal weather variation:* There are seasonal influences on the different zones. Water might come from a rooftop in Zone 0 during rainy periods of the year so Zone 1 has excess water supply, some of which can be diverted to Zones 2 and 3 further away. At drier times of the year there may be no surplus water and Zones 2 and 3 will depend purely on water stored on the surface or underground. Zone boundaries might therefore get blurred by this kind of seasonal variation.

- *Access ways:* Some paths are travelled frequently between zones. For example a path from the house (Zone 0) to an animal shed in Zone 2 may be travelled every day. Water can be carried along this path so plants on either side can be given extra water without wasting too much energy. Fodder plants for the animals can also be grown along the path and harvested on the way to the shed. Zone 1 might therefore become elongated along a pathway.

- *Other modifiers:* Other modifiers include slope, microclimate, soils, landforms and ownership. In a refugee camp, for example, some zones will be communal (such as playing fields and roadside verges) whereas others may be considered private (such as kitchen gardens). This will affect how planning can be carried out for each of the zones. Zones 4 and 5 may even have to be excluded from a refugee permaculture system if the refugees are not permitted to exercise control over land that is not close to their homesteads.

Sectors

The land is not only designed according to zones, but also in different directions according to *sectors,* which often radiate outwards from the centre of activity. Sectors are dictated by different types of 'outside energies' which mean that the land in some directions experiences different conditions from those experienced in other directions. These outside energies can include prevailing wind direction, variations in the sun's elevation, steepness of slope, availability of water (or presence of a flood risk), frost risk or fire danger.

The external energies are probably forces over which the permaculture designer has no control, but they can either be *blocked* or *channelled* to use them to best effect. If they are not desirable then they may need to be blocked. If they are advantageous then they could be channelled to where they are most needed.

As an example, a windbreak or a live fence might block external energies like sun and wind. In hot or dry areas, this will be important to conserve moisture. Alternatively, a ditch could channel water where it is needed in a dry location or a hedge could funnel wind towards a wind pump.

Conclusion

Bearing in mind these guidelines, there are four steps in the land design process:

1. *Analysis of elements:* Look at the needs and products of each element so that they can be placed where they will benefit one another.
2. *Zone analysis:* Place elements in specific areas, often concentric rings, according to their water and attention requirements. In a refugee situation, it may be sensible to concentrate especially on Zones 0-2, given that refugees will probably have greatest control over these areas and perhaps limited authority to make decisions about land use further away.
3. *Sector analysis:* Look at what sort of external energies exist in the environment, how they are oriented, and how they can be channelled or blocked to benefit the elements.
4. *Specific placement:* Arrange species and elements in beneficial groups. Once the preliminary observations, assessments and analyses have been concluded, this final stage of specifically placing the landscape elements in the overall plan leads to actual implementation of the design.

Permaculture Stage Five: Implementation of the Design

It is assumed that the permaculture project participants have now been trained, have conducted an observation and analysis exercise of the local area, have decided upon their objectives and required outputs from the permaculture system, and have prepared a design plan accordingly that makes maximum use of existing landscape elements and minimises requirements for new materials or energy inputs.

The design can now be implemented. Obviously in a refugee setting it is highly desirable to implement the design at the emergency phase. In this way the entire camp or settlement can be laid out according to permaculture principles from the beginning, as opposed to post-constructing a permaculture system in a camp that has been planned according to traditional military engineering approaches.

This, however, would require institutional mainstreaming of permaculture as the preferred design system for all refugee settlements. This degree of policy integration is unlikely to come quickly. In most cases the permaculture design will need to be superimposed on an existing camp plan. As mentioned, it may also focus mostly on Zones 0-3 at first, given that refugees often have limited management rights over land in Zones 4 and 5. This is one reason why it was explained in the Introduction that 'true' permaculture is not easy to implement in a refugee setting, and that, in some cases, a selection of its best aspects will need to be taken rather than applying a holistic design package.

This section of the handbook outlines a few of the more promising practices that can be implemented within a refugee permaculture design system. These practices are divided by zone, but they are artificial divisions as there will be many interrelationships between different zones and different practices. As an example, the use of chickens to scratch the ground and remove weeds from an orchard might be seen as a helpful agricultural practice in Zone 3, but could equally be seen as a by-product of an egg production programme and would be categorised under poultry keeping in Zone 2 . Similarly, planting fast-growing trees along a field boundary may provide shade and a windbreak first and foremost, and is basically a forestry practice suited to any Zone from 0 to 3. The trees, however can also fix nitrogen, supply leaf mulch and provide fuelwood, and would thereby serve immediate functions in Zone 1. In this way, every element serves many functions, so the subdivisions between the zones are bound to be blurred.

For reference purposes, the following table gives ideas of different elements and practices that might be suitable for different zones within a refugee permaculture system. The list is by no means exhaustive and land users are encouraged to identify others.

Implementation of the Design

Zone	Suitable Element or Technique
0	Rainwater harvesting from roofs
0	Water harvesting from channels around the house or tap-stand
0	Use of 'grey water' from cooking and washing to irrigate kitchen gardens
0	Warm water from black piping or black tanks
0	Homemade fly and insect traps
0	Energy-saving stoves and cooking practices
0-1	Provision of shade (natural, trellises, frames, etc.)
0-2	Reuse and recycling of household waste
0-5	Maximum creation of 'edges' (non-straight walls, paths, fences, ponds, etc.)
0-5	Reuse and recycling of household waste (newspapers, food scraps, plastic, tins)
1	Kitchen door bed
1	Different types of growing beds ('keyhole', spiral, 'mandala', herb spiral, etc.)
1	'Fertility trench' beds (plants on top of pit filled with organic waste)
1	'Container gardens' in dry areas or places with poor soil
1	'Bottle watering' (upturned bottles directing water to plants)
1-2	Composting
1-5	Mulching (with stones, paper or plastic)
1-2	Liquid manure (organic matter mixed with water)
1-5	Green manure
1-2	'Double digging' (for soil aeration, etc.)
1-2	'Worm farm' to create nutrient manure with good texture
1-5	'Companion planting' (locating complementary plants next to each other)
1-5	Decoy and trap plants (to redirect pests)
1-5	Pest repellent plants (e.g. aromatic herbs)
1-5	Predator host plants (to combat pests)
1-5	Natural pest control
1-2	Tyre ponds
1-2	Seedling beds and nursery
1-5	Zero or low tillage farming
1-5	Intercropping of different plant species, especially with legumes
1-5	Crop rotations
1-3	Weed barriers between crops types
1-3	Live fencing
1-5	Windbreaks and shade trees
1-4	'Guilds' (mutually beneficial plant associations)
1-4	'Stacking' (full use of vertical space)
1-4	Tree planting and agroforestry
1-4	Animals (chickens, ducks, geese, rabbits, cows, etc.)
2-3	Half moon catchments (guiding water towards certain trees)
1-5	Swales (infiltration channels across slopes)
1-5	Infiltration pits along swales
1-5	Contour planting (thick plantings aligned horizontally across slopes)
2-5	Alley cropping hedgerows with leguminous trees
2-5	Gully erosion control (check dams, stick barriers, etc.)
3-5	Fencing or rotation of grazing areas
4-5	Wild seed collection
1-5	Harvesting system for fuelwood and building poles
4-5	Harvesting systems for other wild products
1-5	Protection of communally-utilised water resources

These ideas are now discussed in turn.

Zone 0

Optimal Use of Water

Water is likely to be the most serious limiting factor in a refugee garden but, with careful design, plenty can be made available. The incorporation of many different water-conserving strategies is one of permaculture's great strengths, and can be especially useful for refugee settings in dry areas. In Zone 0, rainwater can be harvested from roofs or trenches in the ground and 'grey' water from the house can be reused for garden crops. Watering in the early mornings or evenings is preferable to watering during the day, to minimise evaporation.

Rainwater harvesting from roofs

Rainwater can be harvested from rooftops using gutters which feed into pipes that empty into simple tanks. If prefabricated guttering is not available then gutters can be improvised using bamboo or wooden chutes lined with plastic sheeting.

Rainwater harvesting from channels

If guttering does not suit the house design or materials for making gutters are not available, then shallow trenches around the structure will also be able to collect and redirect rainwater to areas in Zone 1 where it is needed by plants.

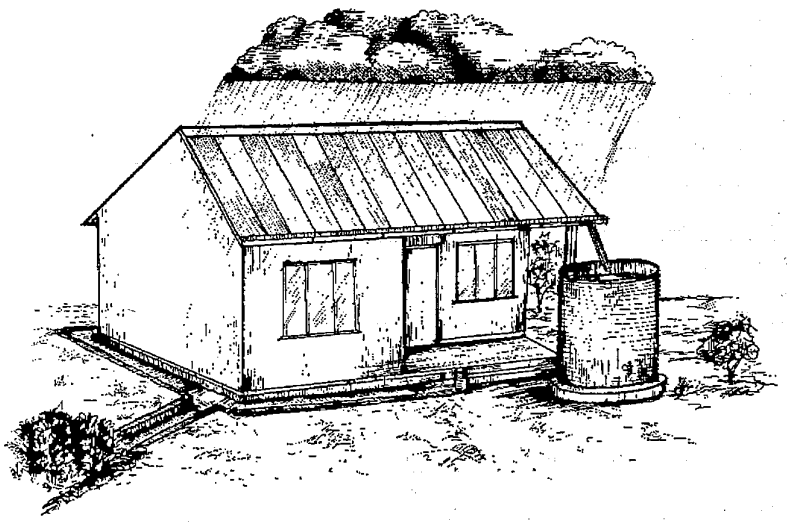


Figure 2 Rainwater harvesting from a house roof

Reuse of 'grey water'

Household waste water can be piped or channelled to fruit trees and into the vegetable growing areas of Zone 1. Bananas, pawpaws, bamboos and sugar cane can all take advantage of this waste water, and will grow well in a 'pit bed'.

Water can also be allowed to infiltrate directly around a washing area without channelling it away, but the site should first be gravelled to stop it becoming muddy. Around this washing area, a stick fence can be constructed on which creepers and water-loving vines (such as *chayote* or *granadilla*) can be grown. It may also be useful to add neem trees or pyrethum daisies to reduce fly and mosquito populations.

Figure 3 Using grey water to feed moisture loving plants (in this case bananas and sugar cane)

Zone 0

Warm water from black piping or black tanks

Water can be heated using a solar collector on the roof of the home. The most basic type of solar collector is a black tank or black plastic piping laid in a coil, which will absorb the sun's heat during the day and provide warm water by the evening.

Homemade fly and insect traps

Fly traps can be made from any plastic container or bottle. The top edge or spout is cut off, inverted and pushed back inside the container. Then a bait made of old food mixed with water is poured inside. The trap can be suspended next to the house and flies will enter to eat the bait and find themselves trapped. As they decompose they will create a smell, which will in turn attract more flies.

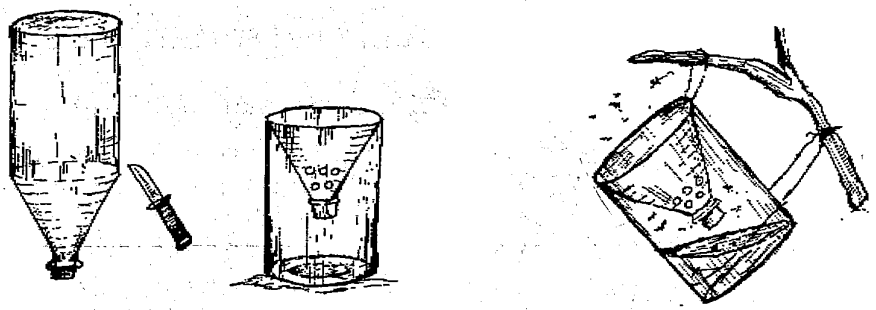


Figure 4 How to make a homemade fly trap

Energy-saving stoves and cooking practices

Demand for fuel in the home can be reduced by cooking in more efficient ways. This will save on energy from firewood, charcoal or whatever source the refugees depend upon. In many refugee situations it may be appropriate to promote simple mud-stoves that families can build for themselves using clay, sand and straw, perhaps in combination with bricks if available. Other low-cost ways to save energy include:

- cutting, splitting and drying the firewood
- shielding or enclosing the fireplace
- controlling the air supply to the fire

- sharing cooking with other people (large pots help)
- cooking fewer meals, or cook in bulk
- simmering food gently, rather than boiling it vigorously
- putting out the fire promptly (e.g. using sand)
- pre-soaking hard foods (e.g. maize)
- milling or pounding maize/wheat grain
- cutting food into small pieces (e.g. meat or hard vegetables)
- using tenderisers (e.g. bicarbonate/pawpaw juice/ water filtered through ash)
- using an appropriate pot (e.g. clay for slow-cooking, metal for fast-cooking)
- using a lid
- weighing the lid down (e.g. with a stone)
- 'double cooking' with one pot on top of another to pre-warm water
- adding water during cooking rather than all at the beginning
- keeping pots black to absorb heat, but not encrusted with soot

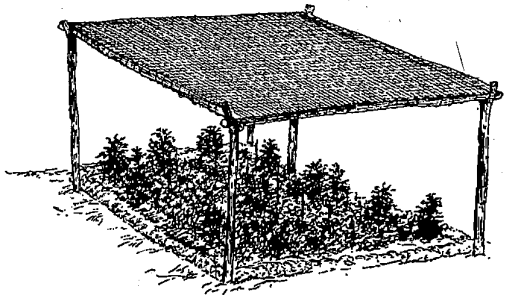
Readers should refer to UNHCR's *Domestic Energy Guidelines* for further ideas on energy conservation in the home.

Zone 0-1

Provision of shade

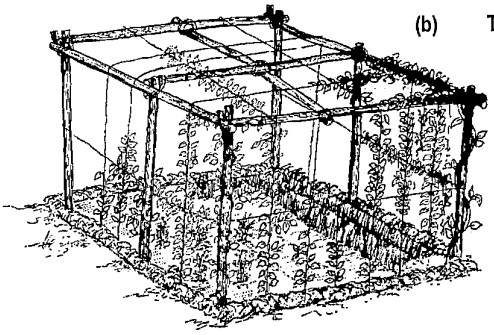
Natural shade might already be available in the garden from large trees that will protect plants from harsh sun and reduce moisture loss. If not, then shade may need to be created artificially. A trellis can be extended from a building or constructed as a stand-alone frame over which edible vine plants can be grown to provide shade and mulching material. Trellises are excellent space-saving, multiple use structures for Zones 0 and 1. Passion fruit is a suitable perennial vine for a trellis, while annual climbing plants include cucumber, melon and the squash family, as well as certain legumes like beans and peas. Tomatoes (especially the cherry types) need to be treated as a vine, and can be staked or twined around mesh and string, or allowed to climb over a trellis.

Shade can also be created by building a frame from wooden poles and covering it with leaves, grass or empty sacks.

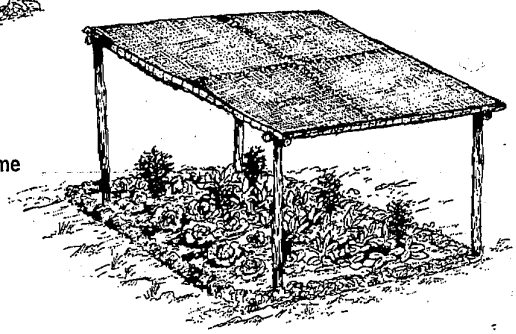


(a) Shade cloth on frame

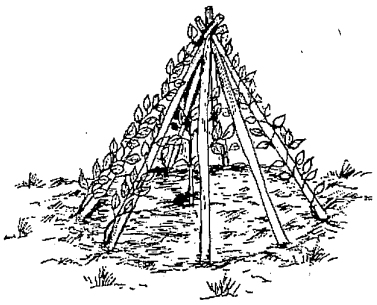
Figure 5 Different types of shade structures



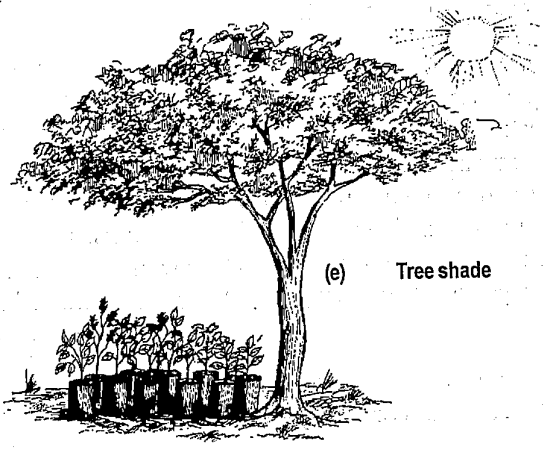
(b) Trellis



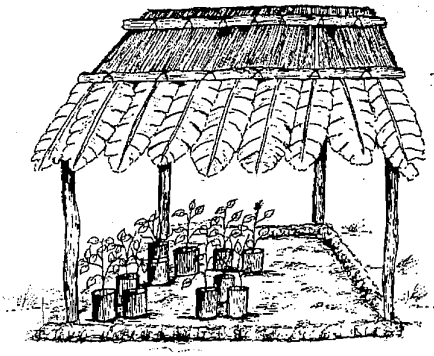
(c) Food sacks on frame



(d) Vines on frame



(e) Tree shade



(f) Grass and banana leaves shade

Zone 0-2

Recycling and reuse of household waste

Nothing need be wasted from the home. Food scraps, maize cobs, banana peels and groundnuts husks can be given to poultry. Plastic bags can be collected for growing seedlings, vegetables and herbs. Paper can be used as mulch or thrown into a compost heap. Glass bottles can be used as containers or turned upside down and filled with water to drip-irrigate individual plants.

Zone 0-3

Maximum creation of 'edges'

An edge is an interface between two mediums. Perhaps between a pond and a field, a house and a vegetable garden, or a pathway and a vegetable bed. It is normally a place of varied ecology and high productivity that draws on species from both sides of the boundary. Edges also create microclimates for various plants and animals, so are useful features that should be maximised.

One way to maximise the length of edges in a permaculture design is to avoid straight lines. Wavy lines give longer edges and maximise the opportunities for beneficial transactions and interactions across the land-use boundary. In practical terms this means

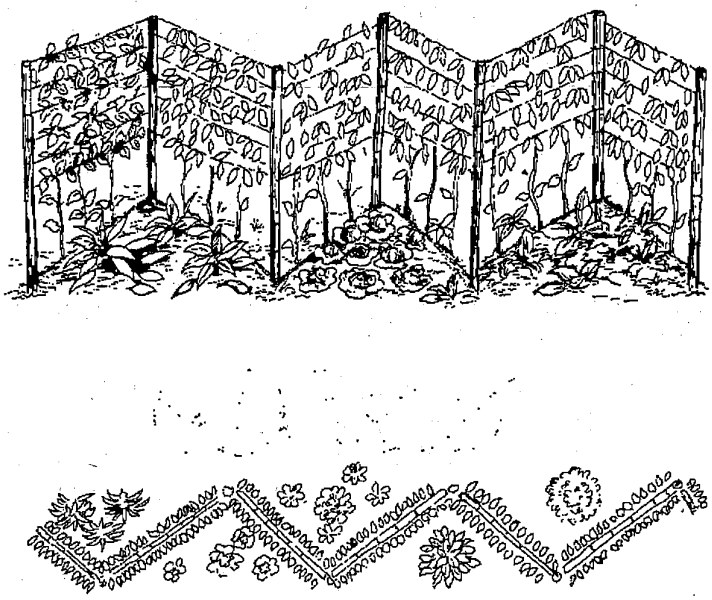


Figure 6 **Edge maximisation on trellis etc.**

that paths, hedges, trellises, pond perimeters, rows of trees and lines of crops should never be straight, but should instead be wavy and on contour. With crops this also increases the number of plants that can be fitted into a given area.

Zone 1

Zone 1 is essentially a kitchen garden. The important thing is to fill up this area with plants, according to the area available, and to totally cover it with mulch. Mulching is a vital part of conserving water and nutrients. Plants in this zone should all be edible.

It is a good idea to start with a fairly small area of about four square metres next to the house and spread outwards as resources permit. In the first year, fairly frequent watering will be needed as the first application of mulch needs to decompose and newly-planted seedlings get established. As there is no need to leave room to hoe or dig in a permaculture system, plants may be arranged very densely in mixed beds (rather than in spaced rows). By frequent and random replanting, the garden will start to assume the healthy appearance of mixed vegetation. The diversity of plants act as host for a range of predator insects, frogs, and birds and is a major factor in successful pest control. The important thing to remember is that the smaller the available space, the greater care that must be taken to minimise wastage of space and to intensify food production by using different types of growing beds and stacked or clumped plantings.

Kitchen door bed

Right next to the house, at the kitchen door if one exists, a fruit tree such as a citrus can be planted. It will provide easily accessible fruit and shade for a small growing bed where herbs like chives and parsley can also be planted.

Different types of growing beds

Growing beds in Zone 1 should be designed for the easiest possible access for watering, tending or harvesting, without treading on the soil and compacting it. Different shapes of bed serve this purpose, depending on the climate and space available:

- *Mound beds:* In wet areas, drainage might be a problem so garden beds should be mounded to shed water.
- *Pit Beds:* A pit bed is a circular raised bed around a central hollow. It is ideal in dry areas for disposing of daily kitchen waste and grey water as the hollow is used for dumping any available scraps and other waste. It becomes moister than the surrounding area and more fertile at the same time. It can be planted with bananas, pawpaw, sweet potato or other moisture-loving plants.

  The pit is normally 75 cm deep and 50-75 cm in diameter; the soil that is removed is heaped around the pit to make a growing bed. The pit should be lined with

sacking or cardboard to retain moisture and then used for disposal of kitchen scraps, paper or leaves. The last layer should be covered with dry leaves to avoid flies. After leaving the bed to decay for about six months depending on the climate (two months in the tropics), it can make a good tree planting hole.

Figure 7 Pit bed/mulch hole

- *Fertility trench bed:* This is a growing bed built on top of a pit containing organic waste - a 'fertility pit'. To make this type of bed, the pit is first dug, 30-50 cm deep, 1-1.2 m wide and 7-8 m long. The topsoil is put to one side. The hole is then one-quarter filled with manure, kitchen scraps, garden clippings, compost, paper, cardboard, old tins, bone, twigs and other available wastes, except plastic. The material should not be compressed. The topsoil is then replaced and the bed can be mulched and planted immediately. Plants will draw on the nutrients in the bottom of the pit as they grow. If there is soil left over it can be spread around fruit trees or crops, or used on paths.

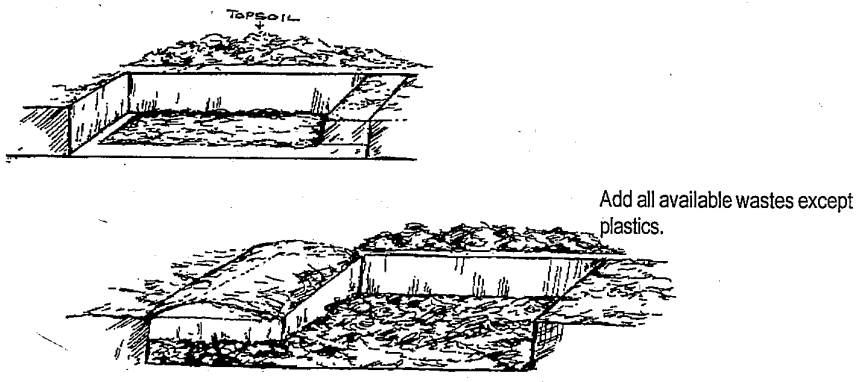


Figure 8 Fertility trench

- *Keyhole beds:* Keyhole beds are so called due to their likeness to a keyhole. A short central path with growing beds on each side gives access to a small garden around the end point, which may consist of a compost pit where heavy feeding plant such as pumpkin, squash or watermelon can grow. Keyhole beds are ideal for intercropping herbs with leafy vegetables such as cabbage, lettuce and spinach.

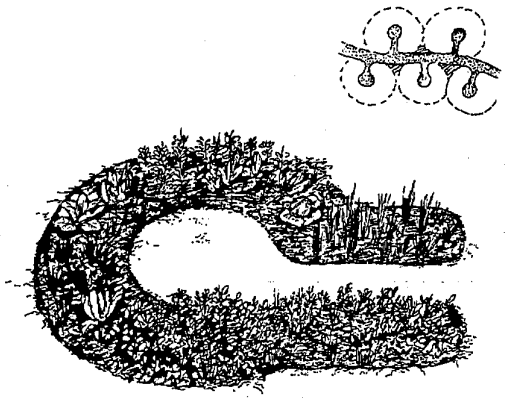


Figure 9 Keyhole bed

Keyhole beds can be arranged to protect plants from the wind by using taller and stronger varieties on the outside of the bed to protect more wind-sensitive plants on the inside. These beds are good for tomato plants as they allow easy access when the tomatoes are ripe, and also allow for protection from the wind. Depending on the space available, a number of keyhole beds can be placed just outside the kitchen area.

- *Ring Spanner beds:* A 'ring spanner' bed is really two keyhole beds joined end-to-end, with one central arm connecting two peripheral growing beds. Its shape resembles a spanner with open ends.

Figure 10 Ring spanner bed

- *Mandala beds:* Mandala beds form a circular system focussed on a central point where a pit bed may be located. The growing beds themselves are a series of arcs that form concentric circles. These circles are interrupted by pathways leading in and out of the centre of the system. The mandala takes up quite a lot of space but is still quite an efficient way to use an area of land if Zone 1 is large enough.

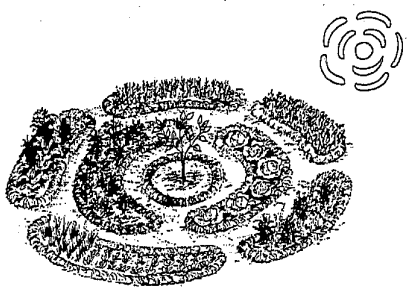


Figure 11 Mandala beds

- *Crescent beds:* On sloping land it is a good idea to curve the growing bed along the contour to catch water as it flows downhill. This is a crescent bed.

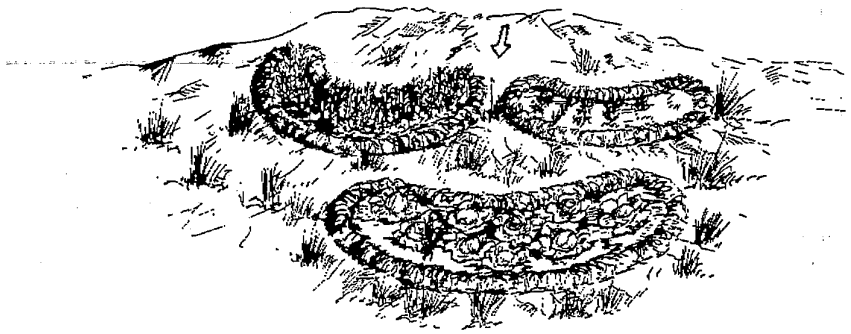


Figure 12 Crescent beds

- *Spiral beds:* A growing bed specifically designed for herbs can be constructed in a spiral shape. If the bed is made to slope upwards towards the centre of the spiral then it will end up with many aspects and niches. It is hottest on the side that most often faces the sun and shaded on the opposite side, while being damper at the bottom than the top.

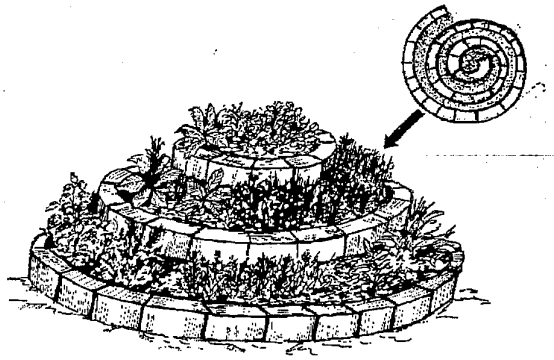


Figure 13 Spiral bed

This gives variable heat and drainage conditions within a small area, providing sunny, dry sites for oil-rich herbs such as thyme, sage, and rosemary, and moist, shaded sites for green foliage herbs such as mint, parsley, chives and coriander. Herbs have many uses in cooking and medicine, so a spiral herb bed should be located as close as possible to the kitchen or cooking area where the plants can be harvested most easily.

Container gardens

Plants can be grown inside improvised containers. This is a useful technique if space is very limited (as in a refugee camp), if the climate is particularly dry, or if the ground is unsuitable for large gardens (perhaps on account of rubble, hardpan, pure sand or clay). The soil in the container should be locally collected and composted before use, rather than being brought in from another area.

Containers to grow vegetables or seedlings can be made of almost anything: plastic bags, wastepaper bins, old baskets, half-filled sacks. Holes should be poked in them to let water escape. In cooler climates deeper containers such as old half oil drums or stacked car tyres are needed for root vegetables such as potatoes.

Figure 14 Green vegetables in a grow bag

Containers can be watered more efficiently than a long row of plants so they are good for dry areas. They also concentrate nutrients as they can be used as a dumping ground for kitchen scraps, vegetable trimmings, manures, and other added organics, forming a rich area of compost and humus right next to the plant.

Bottle watering

In dry areas, it is wasteful to water a whole garden when water is only required at certain places. One way to target the watering more efficiently is to use the 'bottle watering' method. Next to a young tree, for example, a bottle is filled with water, turned upside down and buried up to its neck in the ground. The water will seep gradually into the soil at the exact spot where it is required. The bottle can be refilled as required, probably every third or fourth day.

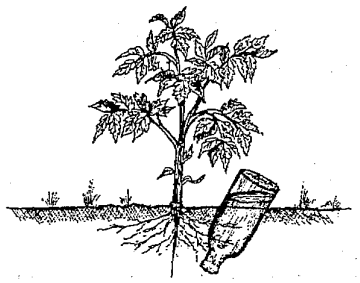


Figure 15 Bottle watering

Zone 1-2

Composting

Compost is natural fertilizer formed by decomposing plant, insect and animal residues and wastes. Compost can be made in a heap or a pit, the latter normally preferred for drier areas to conserve moisture.

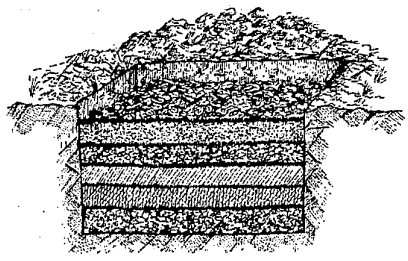


Figure 16 A compost pit

It is important to use as many different organic materials as possible to make good compost. Layers of carbon-rich materials (such as dry leaves, dry grass, cardboard and wood shavings) should be alternated with layers of nitrogen-rich materials (such as green grass, green leaves, manure, kitchen scraps and bones). If manure is used then it should ideally come from poultry, but pig or cow manure can be substituted.

The steps in compost making are as follows:

- Plan the compost site in a place that is moist and shaded.
- Collect all the material together so that the heap or pit can be made in one day
- Clear the soil surface where the heap is going to be built or dig a hole for the compost.
- Put down a layer of coarse materials such as maize husks or twigs.
- Add a thin layer of manure or some green materials (include some lime if fresh chicken manure is being used).
- Add a carbon-rich layer such as dry leaves.
- Alternate nitrogen-rich layers with carbon-rich layers - using a minimum of $1m^3$ of material.
- Water each layer.
- The last layer should be a dry layer to keep away flies.
- Check on the heap (or pit) from time to time to make sure it is not too dry. It should get quite hot after about a week.
- Once the heap/pit starts to cool down it is time to turn it over; the more often it is turned, the more effective the compost will be. Every two weeks should be sufficient.
- When the compost is ready it should be dark and crumbly, with no pieces of leaf, twig or grass remaining.
- Note: if compost is needed quickly, we can leave it to stand for the first four days and turn it every other day for 14 days, giving a ready compost in 18 days (Berkely method).

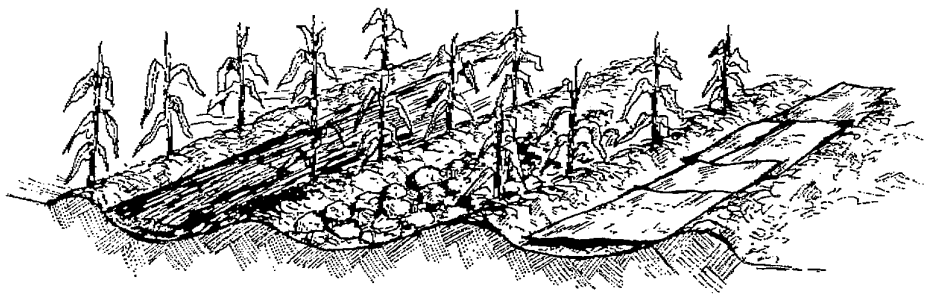


Figure 17 **Mulching with many different materials such as grass, stones or plastic sheets.**

Mulching

The use of mulch is a key strategy for taking good care of the soil. Mulching conserves soil moisture, builds up humus, adds nutrients, suppresses weeds, reduces erosion and balances extremes of soil temperature. Suitable mulch materials include cardboard, newspaper, leaves, well-rotted manure, old cotton or wool clothing, sheets of plastic, woodchips, and old carpet or felt.

In drier areas, even stones can be used for mulching, especially around trees. Leaves and twigs that may have accumulated in runoff gullies during flash floods are also good mulching materials. Mulch can also be cut from a variety of hedging plants, shrubs and ground cover. Species such as tobacco, wild ginger, comfrey, *Sesbania*, lemon grass, bamboo (leaves), *Vigna spp.*, and vetiver grass provide constant mulch, as does crop waste from maize.

When the soil has been mulched it should be covered with a layer of manure, kitchen scraps or compost, then watered well. A second layer of mulch followed by a second layer of compost or manure is advisable, followed by a layer of dry grass and further watering. After 4-6 weeks, vegetables can be planted by pushing through the mulch with a stick to make seed holes.

Also, note that mulching can be done without all the layers, just using an initial layer of vegetable scraps and manure, then sheet mulch of paper, cardboard, banana leaves etc. then a deep mulch of high carbon material such as straw or dry leaves. This can be planted immediately by making holes in the mulch and filling them with compost, potting mix, or good topsoil and planting into the holes. This should be watered well once before planting and then watered as required to maintain moisture around the plants.

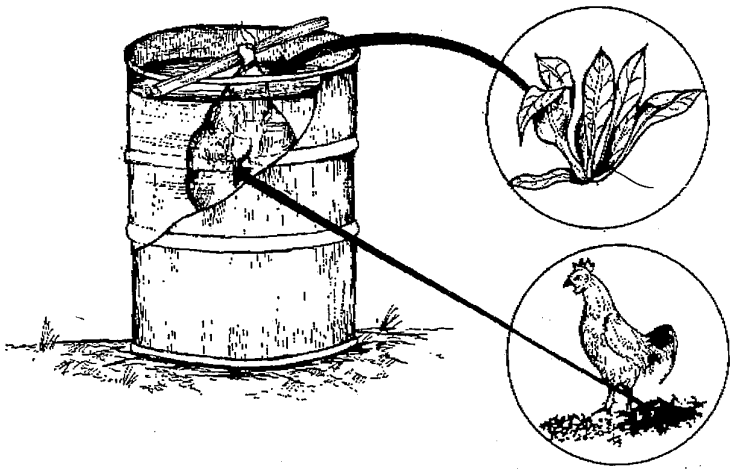


Figure 18 **Making liquid manure using a suspended sack in an oil drum**

Liquid manure

Liquid manure is a dilute alternative to pure animal manure, which can at times burn crops and may also be slow to break down and enter the soil. Liquid manure is easily made by mixing water with fleshy leaves such as comfrey, elder flower, stinging nettle, leucaena, *Gliricidia sepium* or even weeds. The quality will be higher if chicken manure is also used, ideally suspending the mixture of manure and leaves in a sack inside a container of water. An amount of 30-50 kg of weeds, leaves and dung is suitable for hanging in a 200 litre drum of water. After being left for three weeks it can be diluted with four parts water to one part liquid manure, and applied directly to the soil.

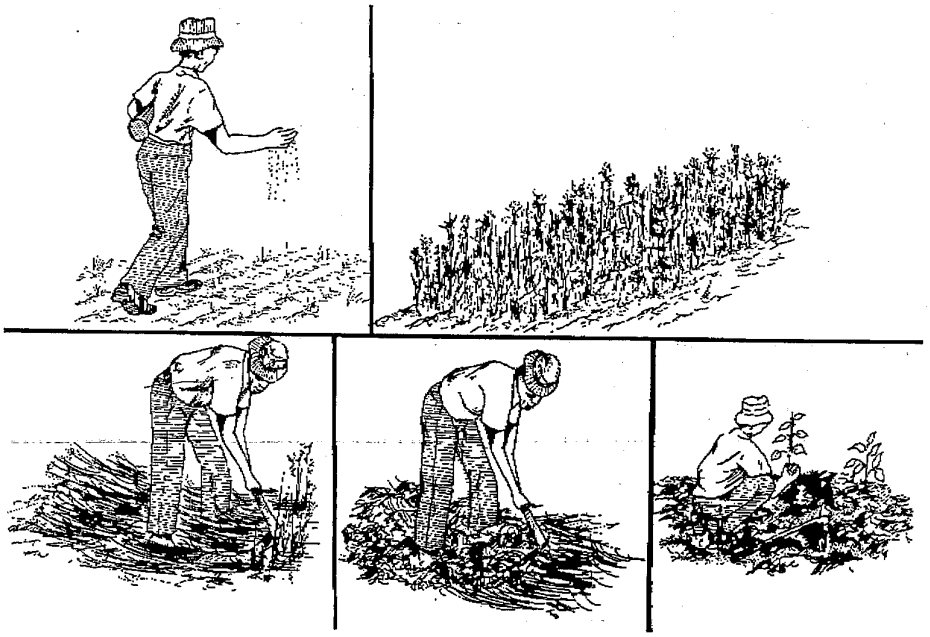


Figure 19 **Green manure establishment and use**

Green manure

Green manure crops are planted on the land, allowed to grow for 2-3 months and then ploughed in, cut as mulch or used for composting. These crops are an important ingredient in any regenerative soil conserving strategy. An ideal green manure crop will be nitrogen-fixing during its lifetime. Using green manures adds organic matter to the soil, assists in dissolving insoluble nutrients, brings up nutrients from the subsoil and improves the soil's water holding capacity. Good green manure plants include sugar bean, sunn hemp, pigeon pea, lablab bean, *Desmodium*, *Crotolaria* or *Cymbopogon*.

Double digging

In cold climates, growing beds can be prepared by digging them over twice and adding compost and manure. This assures the soil of aeration and fertility, as long as a mulch layer is maintained. It is not necessary to dig again as long as roots, insect life and surface mulch are present to maintain the soil in good condition. Leguminous crops in particular will improve soil fertility and organic matter content.

Wormfarm

A worm farm is a way to produce good quality compost. To proceed, line an old metal drum with 2-3 cm of gravel and pierce the base for good drainage. Then fill the drum with manure and waste materials along with earthworms. In a refugee camp, waste paper can be cleared up and used in the mixture. Mulch the top to keep the mixture moist. After three months (longer in cold climate), fine dark compost develops, which is particularly good for growing seedlings in a nursery.

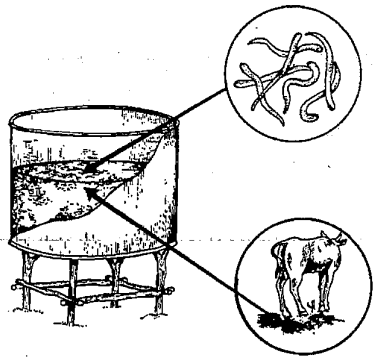


Figure 20 **Worm farm**

Companion planting

Many plants will show increased yields when placed together. This may be because of mutually beneficial properties such as pest control or soil improvement ability, or because of the enhanced 'edge effect' whereby crops generally fare better towards the edge of a planted block than in the centre. The width of each crop row should be governed by the extent of this edge effect. Assuming, for example, that the edge effect penetrates up to one metre inside a stand for a particular species, inter-cropping rows would be two metres wide.

Tomatoes and cabbages grow well together because the tomatoes keep butterflies away from the cabbage. Cowpeas and maize are good companion plants because the cowpea minimises stalk borer attack in the maize and the maize obstructs the American boll worm from getting to the cowpea. Comfrey has a deep rooting system so it grows well with almost anything that has shallow roots.

The following vegetables also make good companions in Zone 1:

- beetroot and onions
- carrots and peas, lettuce, onion or tomatoes
- onions with beetroots, strawberries, tomatoes or cucumbers
- eggplant with beans
- cabbage with potatoes, beetroots or onions
- lettuce with carrots, radishes, strawberries or cucumbers
- sunflower with cucumbers
- beans with potatoes, carrots or cabbage.

While some plants grow well together, there are other combinations that should be avoided. They may compete for the same nutrients, be susceptible to similar pests and diseases, or one may produce chemicals that have a detrimental effect on the other. The following should not be mixed:

- beans and onions (onions are better with tomatoes)
- tomato and cabbage (cabbage is better with celery)
- potato and cucumber (cucumber is better with maize)
- tomato or eggplant with green pepper (they share similar pests)

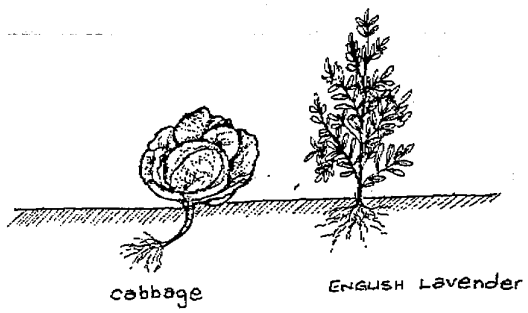


Figure 21 **Companion planting**

Decoy and trap plants

Decoy and trap plants attract pests away from valuable crops, concentrating them in one place for ease of control. Milkweed, sow thistle and black nightshade, for example, all attract aphids. Finger millet traps army worms and sunnhemp attracts nematodes and

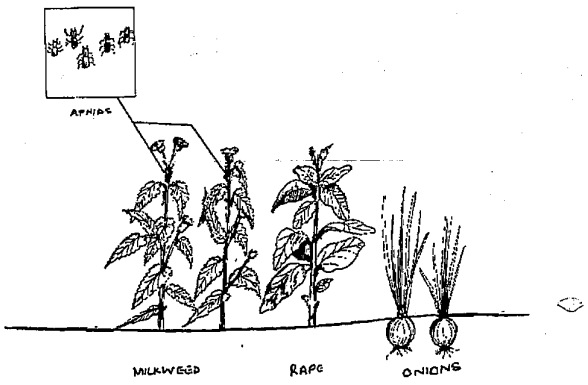


Figure 22 **Trap plant**

disrupts their breeding. Once they have served their purpose, infested decoy plants can be removed and composted, fed to livestock or chopped up and left on the soil as mulch. If very heavily infested then they may need to be burned.

Pest repellent plants

Certain plants, especially aromatic herbs, repel insect pests. Dill or coriander can be grown with tomatoes to repel spider mite, and creeping thyme can be grown with many plants to repel ants. Onion, garlic, lavender and marigold reduce insect attack if they are planted next to cabbage, rape and lettuce. Nettles repel snakes.

The following additional plants are strong smelling and good for inter-planting to repel pests:

- Sage
- Rue
- Garlic
- Nasturtium
- Sun hemp
- Tansy
- Basil
- Mint
- *Lippia*
- *Lantana*
- Cosmos
- *Caryopteris*
- Asters
- Chrysanthemums
- Tomatoes
- Onions

Predator host plants

Some plants attract useful predators so should be encouraged as these will help get rid of garden pests. Plants such as elder flower, fennel marigold, tansy, caraway, coriander, cumin, celery and dill all attract predatory wasps, for example.

Other useful predators for which habitats can be provided include the following:

- Anthocorid bugs
- Ants
- Assassin bugs
- Bats
- Bees
- Birds
- Black-kneed capsids
- Branched wasps
- Chameleons
- Dragonflies
- Dung beetles
- Earthworms
- Frogs
- Ground beetles
- Hawk moths
- Hedgehogs
- Hoverflies
- Ichneumon flies
- Lacewings
- Ladybirds
- Lizards
- Mice
- Moles
- Nematodes
- Praying mantises
- Spiders
- Stick insects
- Toads.

Predators such as these can be encouraged both by providing suitable habitats and also by not destroying existing habitats. This combined strategy implies, for example, planting trees where birds can perch (e.g. mulberries, as they are attracted by the fruit), while at the same time not destroying spiders' webs, birds nests or existing trees (e.g. acacias, with their wide crowns ideal for birds). Wild birds can even be fed or provided with a bird bath to encourage them to visit the permaculture garden.

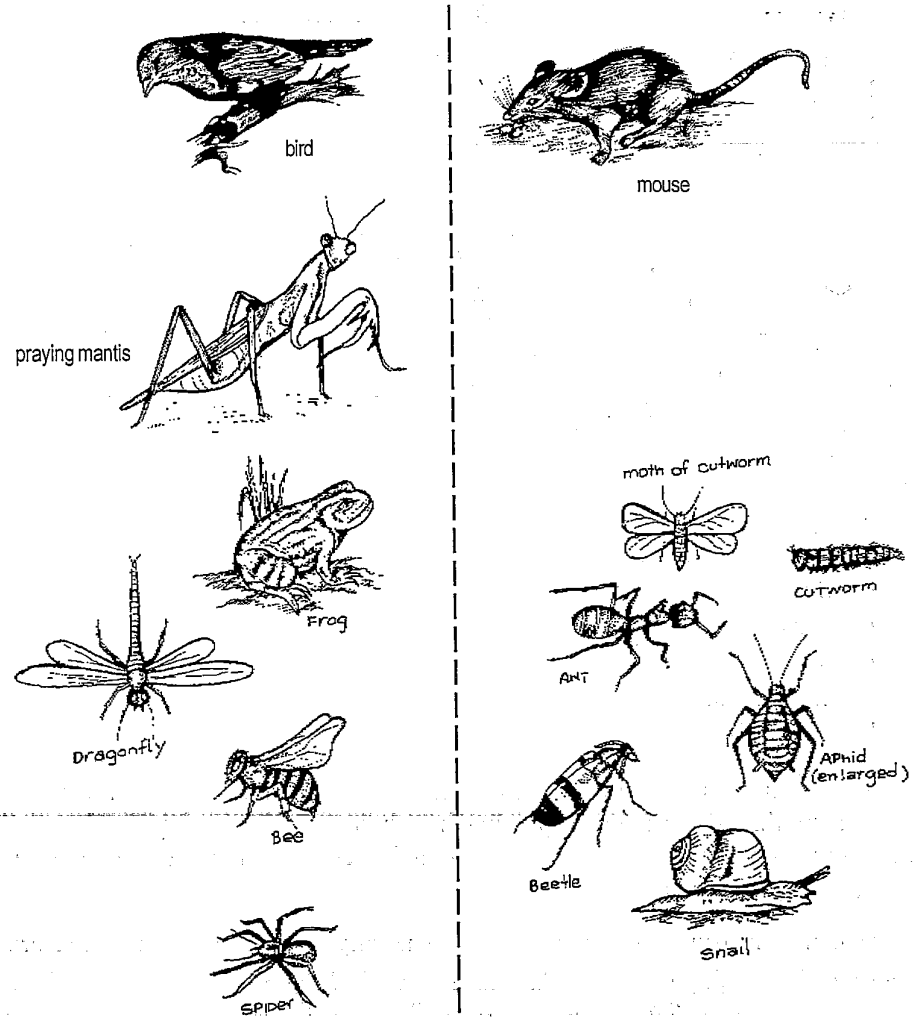


Figure 23 **Various pests (right) and predators (left)**

Natural pest control

Plant and insect extracts can be used to combat pest invasions, rather than applying commercially available pesticides. Natural pest management is a rich and diverse science, but even the inexperienced permaculturist can make use of some of its techniques. Extracts from many strong smelling plants can keep insects away. For example, the seeds and leaves of the neem tree can be mixed with water and used as a spray to combat over 200 types of insects, as well as, nematodes, fungi and bacteria.

Other plants from which insecticidal sprays can be made include:

- Onion
- Garlic
- Tea
- Chilli
- Pawpaw
- Pyrethrum
- Eucalyptus trees
- Sweet potato
- Tomato
- Sunnhemp
- *Melia azedarach* (a tree)
- Feverfew
- Sweet basil
- African marigold
- Mexican marigold
- Blackjack
- Tansy
- Rue
- Wormwood
- Tephrosia.

Certain pest insects can be countered by crushing a few specimens of the species in question, mixing with water and applying the solution to affected plants. This technique repels army worm, millipedes, saw fly, slugs and caterpillars, although it is less effective with grasshoppers and locusts.

These natural measures to combat pests are generally cheaper, safer, easier to learn and more locally appropriate than commercially available pesticides. Local advice from organic farmers will confirm exactly what can work in a particular area.

Tyre ponds

A small pond can be made fairly simply on a refugee plot using an old tyre, preferably a large one from a lorry.

To build such a pond, dig a hole about one metre deep, a little smaller than the diameter of the tyre, and line it with black plastic sheeting. The plastic should protrude over the edge of the hole, where it can be held down with large stones placed slightly back from the edge. Cut the top edge of the tyre and place it on top of the hole, sitting on the plastic sheet, inside the large stones. Put some sand, compost and water plants inside the hole before filling it with water, maybe from a permanent rainwater catchment. As the tyre changes the humidity and light conditions in the immediate area, the plants will start to

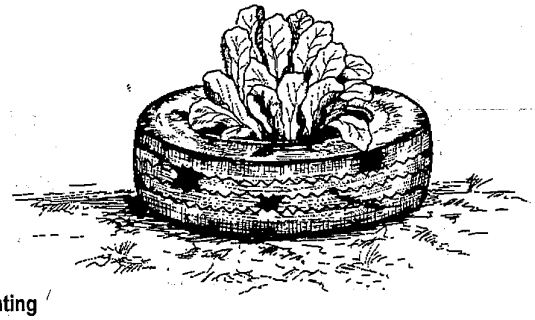


Figure 24 Tyre planting

grow inside it. Other water-loving plants or herbs can be planted in old tins or clay pots next to the tyre where they will eventually form a mass of greenery and a cooler and more moist microclimate. This climate will also attract beneficial insect predators.

Tyre ponds are susceptible to damage from children poking sticks through the plastic liner. If this proves to be a problem, small concrete and rock ponds can also be used.

Seedling beds and nursery

The garden should have a small nursery for raising trees and other plants. This will normally be placed in Zone 1 or 2 where it can be given plenty of water and attention.

The nursery site should be selected in a shady spot, ideally under a spreading tree. It should be enclosed for protection against the wind and to prevent children and grazing animals from damaging the seedlings. Nursery soil should be well drained and rich in nutrients, which may mean that soil has to brought in from elsewhere or compost will have to be mixed with what is available on the site.

The soil should be properly mixed and then used to fill seedling containers. It is not necessary to use approved polythene tubes for raising seedlings as these can be grown equally well in pots or other improvised containers such as bamboo tubes, milk packets, tins or food sacks, as long as they drain properly. Ideally the seeds for the nursery will have been collected from the wild from the surrounding area or from neighbouring farmers. This cuts costs and ensures that the plants have a good chance of surviving. Hard seeds may need 'pretreatment' to help them germinate, a process that requires boiling or soaking in water. Others can be planted directly in the containers.

Container seedlings need to be watered carefully, preferably twice per day, in the morning and evening. Once they germinate, it is important to keep the roots from growing too long and coming out into the ground. Protruding roots should be cut with a sharp knife. The seedlings will also need weeding. Watering should be reduced prior to planting and the seedlings should be moved into a sunny spot for 'hardening off'. Tree planting should take place at the start of the rainy season.

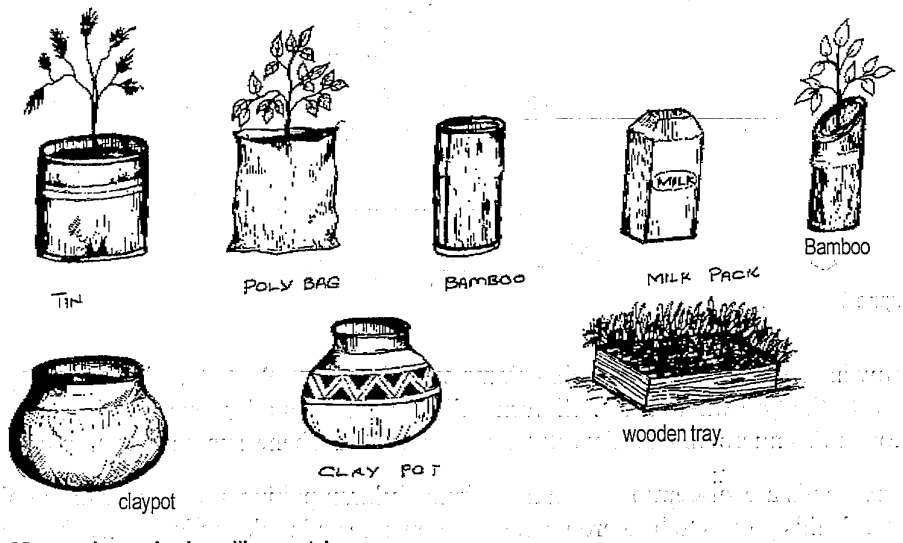


Figure 25 Improvised seedling containers

Zones 1-3

Zero or Low Tillage farming

'Zero tillage' is a system under which crops are sown and harvested with minimum disturbance to the soil. Ploughing promotes soil and water loss through evaporation, and destroys many soil organisms by exposing them to the sun. The soil may also lose its natural structure that allows water and nutrients to reach the plants, and is then more easily eroded. This leads to compaction of the subsoil and limits root growth.

Zero tillage means that the soil is not turned over during the cultivation cycle and that the roots of harvested crops are left intact. At least 30% of the crop residue is also left on the soil surface after harvesting. Planting for the next season is by broadcasting seeds onto the harvested field, or even into the standing crop prior to harvest, to reduce losses to birds. If the seed must be buried then the soil is parted only along a narrow furrow where the seeds are to be sown. In this way, the soil remains well covered throughout and is permanently planted.

The effect of these measures is to cushion the impact of raindrops and reduce surface sealing, slow down water runoff, improve infiltration, reduce evaporation, moderate any extremes of temperature, and provide extra nutrients through decomposition.

Zero tillage techniques should not, however, be introduced in isolation. Plant cover and mulch are important part of the system to prevent a hard pan from developing at the surface which could eventually bring *more* erosion, not less, if the soil is never turned.

Intercropping

Intercropping is a system of growing two or more crops side by side, or intermixed, on the same area of ground. The crops should not compete and should ideally have a positive effect on each other's growth. As well as making use of space that would not otherwise be utilised, intercropping systems can provide:

- *Increased yields:* Intercropping can reduce the nutrient losses that take place when crops are harvested, by returning biomass to the soil. In a cereal/legume system, for example, such returns include green manure (or mulch) and residues (including roots) from the nitrogen-fixing legume. The system therefore conserves nitrogen, cycles nutrients and preserves soil organic matter, all of which will lead to increased crop yields.
- *Lower risk of total crop failure:* Disease, pests or unfavourable weather conditions can wipe out a whole crop under a monoculture system. With intercropping, the risks are spread: if one crop fails at least another should yield a harvest.
- *Reduced soil erosion:* A shorter crop intercepts rainwater falling from (or between) a larger crop, so soil erosion should be reduced.
- *Reduced pest problems:* Greater plant diversity decreases the number of harmful insect species and at the same time attracts a greater number of enemies of the existing pests. One plant can protect another type of plant by obscuring the first plant's shape and odour so that the pests cannot easily find it. Plant diversity also helps to reduce the incidence of plant diseases.
- *Reduced weed problems:* Crawling or running crops can be incorporated in an intercropping system to cover the ground and suppress weeds.

Cereals and legumes are good intercropping combinations as the legumes fix nitrogen and generally have shallow root systems so do not compete with the cereals, which have high nitrogen requirements and deeper roots. Grain crops and groundcover plants also go well together as the soil is protected from rain drop impact and soil moisture is also retained.

Figure 26 **Cereal with ground cover crops**

The following are some examples of good plant combinations for intercropping in Zones 2 and 3:

- maize with groundnut, sweet potato or beans (maize gives beans protection from aphids)
- maize with ground cover (pumpkin, cowpea, watermelon, squash or velvet bean; with cowpea there is further 'companionship' as the maize can reduce the incidence of legume pod borer on the cowpea)
- maize, soybean and finger millet, under-planted with pumpkin and cowpeas
- maize, soybean and rice
- maize, sunflower, potato and mustard
- maize and beans with potatoes or tomatoes
- maize, groundnut and sugar cane
- sorghum with groundnut, pigeon pea or millet
- sorghum, millet and groundnut
- cowpea with cassava or sorghum
- cotton with cowpea, maize, sorghum, garlic, cow pea or groundnut
- cassava and beans (powdery mildew can be reduced on the cassava and the cassava protects the beans from angular leaf spot)
- cassava and maize with melons or beans
- beans with sweet potato or tomatoes
- citrus and legumes, especially cowpea (reduces nematode damage)
- okra with tomato, ginger and mung bean
- kale with tomato and tobacco
- melons and watermelons with maize, sorghum or millet
- potatoes, radish and broad beans (all grow at the same speed and are therefore suitable for planting together and harvesting together). Radish grows much faster than the others.

There are different types of intercropping:

a) *Relay intercropping:* Different crops are planted in sequence on the same field, but in the same season, e.g. pumpkins planted some time after maize. The crops grow together in the field for part of the season. Pumpkin is good for protecting the soil from rain splash.

b) *Row intercropping:* Two or more crops are planted in rows on the same field. These rows should be wavy to maximise edge effects.

c) *Strip intercropping:* Strips of different crops are planted in the same field. A strip could perhaps be 5-6 rows of one crop followed by 6-7 rows of another.

d) *Mixed intercropping:* No particular linear pattern is followed so the crops are mixed more or less randomly. This can be achieved by mixing the seeds of the different plants and broadcasting them.

e) *Crop rotations:* A rotation is a sequence of different crops grown on the same field one after the other. Crop rotations are one of the most effective tools for insect, disease and weed control, for maintaining nitrogen and moisture levels in the soil and for improving soil structure and reducing erosion.

Farmers should develop a rotation plan with both the needs of the farm *and* the needs of a sustainable system in mind. The farm will need crops that are suited to the local soils and climate, can be grown with the available tools, capital and labour, and have a market value (assuming that some crops will be sold).

Sustainability, meanwhile, demands that the crops in the rotation ensure:

- weed control
- maintenance of a nutrient balance in the soil
- insect and disease control
- improvement of soil conditions (e.g. by using deep-rooted plants).

To meet these needs it is a good idea to use legumes (mostly nitrogen-fixers) in the rotation system. Legume-based rotations and the use of green manures and cover crops are not only ideal ways to fix nitrogen, control pests and diseases and build soil organic matter, but will also improve deteriorated land, translocate minerals from the subsoil to the rooting zone of primary crops, and make most effective use of soil volume by rotating crops of different rooting and feeding characteristics. The use of these and other practices is energy efficient and makes good sense for soil and water conservation.

A good rotation system might be as follows:

Year 1:	legume
Year 2:	leaf
Year 3:	fruit
Year 4:	root

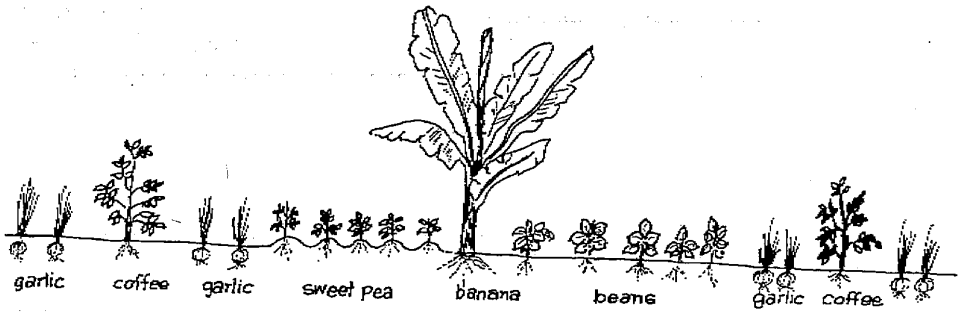


Figure 27 Intercropping

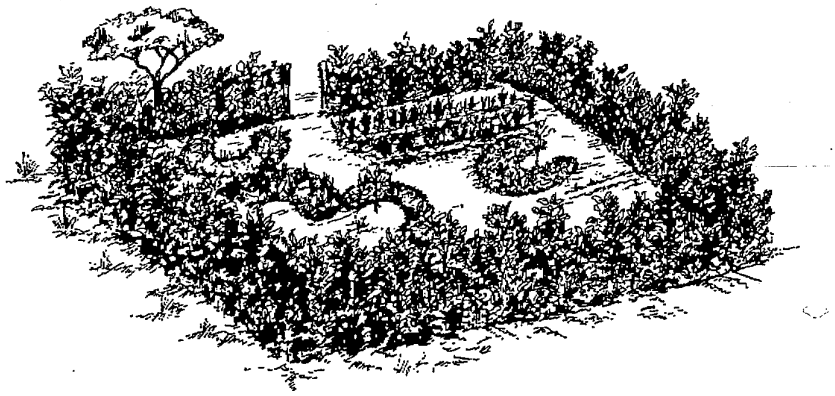


Figure 28 **Live fencing**

Weed barriers between crop types

Weeds may become a problem in cultivated areas if they are allowed to grow too quickly. A band of barrier plants can be grown around mulched garden areas to prevent weed re-invasion. A combination of the following usually works:

- a deep-rooted broad leaf (e.g. comfrey)
- a dense, perennial clump grass (e.g. lemongrass, vetiver grass)
- a carpeting plant (e.g. sweet potato, lab lab bean, velvet bean, or sun hemp, the latter is also a good green manure plant and fixes nitrogen in the soil)
- a bulb (*e.g. Canna* or onions. However, these are annuals rather than perennials. Ginger is better).

Live fencing

In a permaculture system there is no point having a fence or field boundary made of wooden posts or wire. Field boundaries can be productive ecosystems in themselves. *Leucaena* and banna grass provide useful windbreaks and help reduce soil erosion. *Leucaena* fixes nitrogen and can be cut as mulch or livestock fodder, while banna grass can be used as cattle fodder, mulch, hay and silage, and can be cut every 6-8 weeks. Napier grass is equally good as live fencing and cattle fodder.

Bordering a garden, woody legumes such as horseradish tree, pigeon pea, *Calliandra*, and sunn hemp, provide mulch for the garden and fodder for domestic livestock. Behind these, a taller band of cassava, banana, pawpaw, pigeon pea and leucaena will form a stronger hedge or windbreak.

To discourage animals and provide better security, thorny or inedible hedges can be planted around the garden. Possible plants include, cactus, kei apple, hibiscus, bamboo or a double row of spiny pineapples. In dry areas *Commiphora* and *Euphorbia* are ideal. *Euphorbia tirucalli* also repels termites.

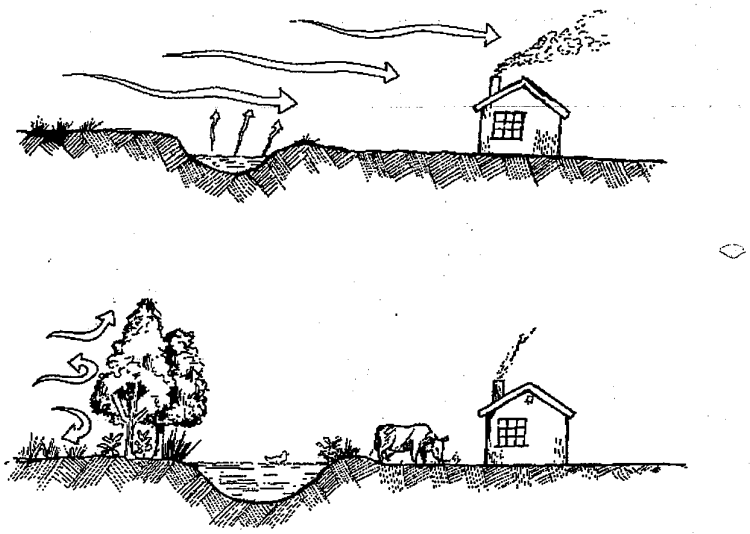


Figure 29 The value of a windbreak

Jatropha is another versatile plant that can be grown as live fencing for kitchen gardens, and for fences and hedges around the homestead. Oil from the seeds can be used for making soap, candles and for medicinal purposes. The seeds of the horseradish tree have similar properties.

Zones 1-3

Windbreaks and shade trees

Windbreaks and shade are especially important for permaculture systems in hot and dry places where moisture is easily lost through evaporation. Gardens should be protected from direct windblast and shielded from harsh sun.

If possible, the windbreak and shade can come from existing buildings and trees. The branches of spreading trees such as acacias cast a light shade over crops. If no suitable protection from the elements exists trellises or wooden fences can be built or tyres can be stacked in a protective wall.

Windbreaks can also be planted, ideally selecting species with the following characteristics:

- Self-mulching plants (i.e. those with good leaf fall such as *Faidherbia albida*)
- Nitrogen-fixing plants (the majority of legumes) such as *Leucaena*

- Plants with fibrous stems and fleshy leaves, which are likely to be fire resistant
- Hardy species with deep root systems
- Pioneer plants with fast early growth (e.g. *Terminalia sericea*).

Zones 1-4

Guilds

A guild is a combination of elements (usually plants) that work harmoniously together. They are assembled around a central element (often a tree) with which they act in a beneficial relationship, helping each other grow, providing nutrients and giving protection from pests.

Within a guild it is advisable to look for plants that perform the following functions:

a) *High value:* The central element in a guild will normally be a high value fruit tree, such as a citrus

b) *Soil improvement:* Legumes improve nutrient levels and plants with long roots help improve aeration (e.g. Japanese radish).

c) *Pest control:* Plants with strong smells (e.g. basil and lavender), can repel pests; some other plants attract predators (insects, bats, frogs, birds) or can be turned into pesticides (e.g. tephrosia or chillies).

d) *Shelter:* Fast-growing, short-lived trees can give shade to protect a high-value central element from wind, frost or excessive heat (e.g. the pigeon pea, a fast-growing, perrenial leguminous tree).

e) *Ground cover:* Plants which grow close to the ground and have dense root or shoot networks can protect the soil from erosion, conserve moisture and suppress weeds (e.g. nasturtiums in a vegetable garden; creeping legumes such as velvet beans or lablab in an orchard; large-leafed plants such as comfrey).

Figure 30 **A guild system**

f) Use of vertical space: In an efficient system it is important to use vertical as well as horizontal space; various creepers can grow over larger trees planted within the guild (e.g. chayote, pumpkins and beans).

The following are good species combinations for a guild:

Guild 1: Grapefruit (high value fruit) - hot climate
Leucaena (nitrogen fixing, shade, windbreak, firewood)
Lavender (pest repellent, pleasant aroma)
Nasturtium (weed suppressant, pest repellent, ornamental flower) - cold climate

Guild 2: Orange Tree (high value fruit)
Sesbania (nitrogen-fixing, windbreak, green manure)
Garden rue (decoy for pests)

Guild 3: Beans (put nitrogen into the soil)
Maize (climbing support for the beans)
Squash/pumpkin family. This guild is called the 'three sisters' and is the most famous guild in the world.

Stacking

Stacking means making maximum use of vertical space. Different plants require different micro-climates for optimum growth. Systems can be devised to grow plants of different heights to complement each other in a system of horizontal layers. This is really how a natural forest functions. Mature trees form the uppermost layer with a sub-layer of smaller trees that do not require much light. Vines use the trees for support. Beneath this comes a shrub layer of shade-tolerant plants, underneath which are herbs, mosses and lichens. A similar system can be used in permaculture.

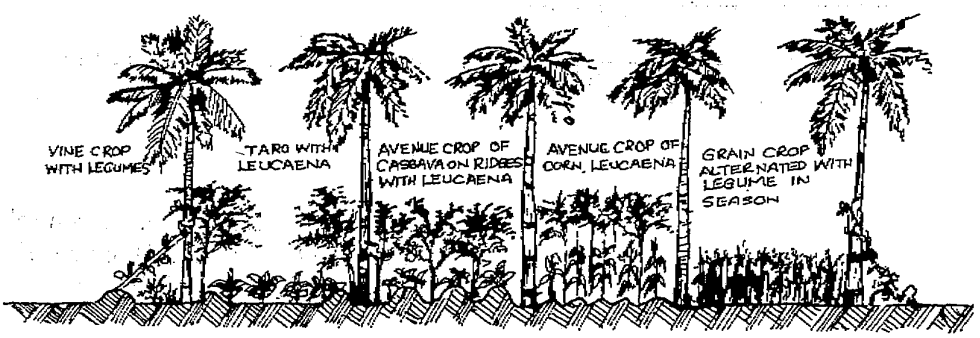


Figure 31 **Stacking sytems suitable for the tropics**

Plants needing sunlight can occupy open spaces while those requiring less light or those which are tolerant of shade (like sweet potato, dusky berries, cucurbits and members of the melon family) can be grown under trees and shrubs. Taller species for stacking systems in dry areas include pawpaw, apricot, date palm, doum palm, olive and banana.

Stacking also takes the soil into account. Competition can be minimised by growing plants that tap water and nutrients at different levels. In dry areas, deep-rooting perennials such as asparagus and globe artichoke are useful as they will not compete for water with shallow-rooted vegetables.

By planting a mixed, multistorey system, insect pest problems are minimised as habitats are created at different levels for predators such as frogs, spiders, insectivorous birds, geckoes and bats. Habitats favoured by predators should be preserved, including unused areas such as field edges or rocky outcrops.

Tree planting and agroforestry

Trees have a vital role to play in permaculture design and should be incorporated into all zones and all types of farmland within agroforestry or 'permaforestry' systems. The term 'tree garden' might also be used when referring to the combination of trees and plants in the herb and vegetable areas of Zones 1 or 2.

Trees provide multiple services as windbreaks, barriers to the spread of pests and diseases, soil erosion control, fertility improvement, provision of leaf litter, binding of earth structures (perhaps in swales or terraces), retrieval of nutrients from deep soil layers and the provision of fuelwood, poles and fodder, among other things.

Certain crop and tree combinations produce mutually beneficial outputs. *Leucaena*, for example, can be grown as a hedge or within an alley cropping system to fix nitrogen in the soil while at the same time provide livestock fodder and green mulch. If alley-cropped with maize, it has been shown to give even higher economic returns than systems that rely on artificial fertilizer to provide the nitrogen supply. Maize and sorghum yields have been shown to rise by over one-third when planted below *Acacia albida*, and the tree can be sustainably harvested for firewood.

UNHCR's *Forestry Guidelines* provide further guidance on how to incorporate tree planting within refugee camps and settlements.

Animals

In considering permaculture as a complete ecosystem, animals are essential to control vegetation and pests and to complete the basic nutrient cycle of a farm. Despite their inefficiency in protein conversion, their diverse products and multiple functions make them invaluable.

Within a refugee permaculture setting the main roles of animals are:

- to provide fibres, eggs, meat, milk and manure
- to pollinate and forage, collecting dispersed materials from the permaculture garden
- to clear and manure difficult areas prior to planting (poultry and pigs are especially efficient at soil-turning)
- to weed and manure areas already being cultivated
- to control pests, perhaps by eating the pupae and eggs of pests in fallen fruits, or in trees and shrubs
- to concentrate specific nutrients
- to act as heat sources
- to produce gas for heating and lighting

In permaculture systems, a range of animal feeds (fruits, foliage, pods, nuts, seeds and tubers) should be planted so that animals can self-forage, taking most of what they need from the vegetation and at the same time manuring and controlling the weeds and pests, and converting plants to protein.

UNHCR has published guidelines on *Livestock in Refugee Situations*, which can supplement this Handbook by providing guidance on husbandry of larger animals in refugee situations.

Animals for Zones 1 or 2

Rabbits

Rabbits supply manure for the garden and meat for the table. They are grazers and browsers and will eat grass, soft vegetation, twigs and household scraps. The Angora rabbit yields fur which has high market value. Rabbits can be penned above worm boxes so that their droppings are turned into rich compost or above a chicken house to save space, allow waste food to fall through for the chickens and to consolidate the manure from both animals in one place. Rabbits can also be put in the garden within a moveable cage to eat grass, as long as they are not left long enough to burrow into the ground. Rabbits will eat forage crops as lucerne (alfalfa), tagasaste and clover.

Pigeons and Doves

Pigeons and doves are valued for their phosphate-rich manures. They can be caged above the ground and their manure swept out from underneath. Dovecotes can also be built from local materials and the manure collected periodically. Pigeons eat seeds and grains, which can be grown and harvested from the garden (corn, sorghum, millet sunflower seeds, peas, wheat). They also provide eggs and meat.

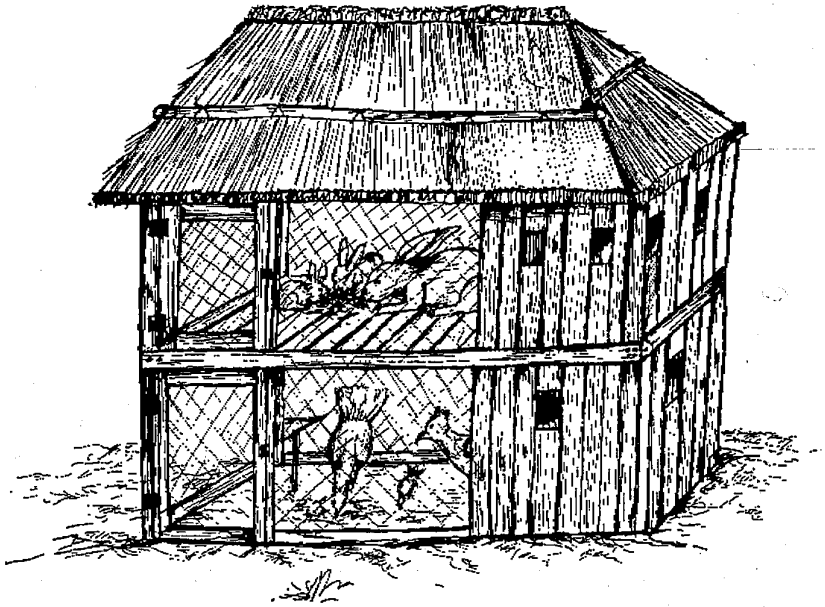


Figure 32 **Rabbits housed above chickens**

Quail

Quail provide eggs and meat and need little attention. As they are insect-eaters they do not harm garden vegetables and may be placed in movable cages to great advantage.

Guinea Pigs

Guinea pigs, an important source of protein in some South American countries, are kept very close to the house (or may live in the house), and are fed garden scraps and seeds. They are useful in weeding around small trees, usually within a mesh cage to protect them from birds of prey.

Chickens

Chickens, besides their direct products of eggs, meat, feathers and manure, also eat insects, greens, fallen fruit and all sorts of weeds. They scratch an area clean if confined in a small space and can be used to patrol a fenced boundary area to keep weed species from invading (e.g. between a garden and an orchard). Although poultry need care and maintenance, the permaculture system can be designed so that they can move around to feed and take care of themselves. In the garden, under controlled conditions, chickens can 'tractor' an area and leave it completely manured and free of weeds. Portable cages

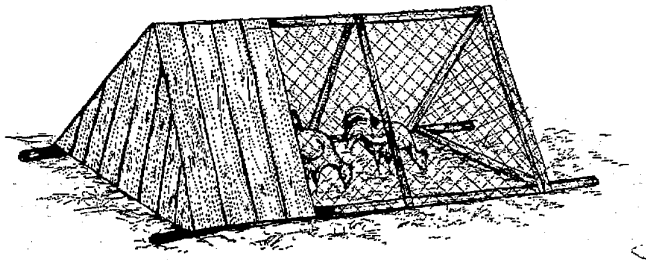


Figure 33 A mobile poultry cage sometimes known as a 'chicken tractor'

'chicken tractors' can also be used for better control, with chickens allowed onto the land between the time of harvest and before replanting. Bantam chickens are small and eat mainly insects, cutworms and slugs, leaving grown vegetation alone.

The following foods are good for chickens:

- *Seed foods: Tagasate,* sunflower, *Amaranthus*, *Acacia spp.*, black locust, honey locust, pea tree, salt bushes
- *Greens:* any young greens, including garden greens, comfrey, lucerne, buckwheat, clover, pea shrub, grass, parsley and other herbs
- *Minerals:* grit, sand, crushed egg shells, bonemeal
- *Insects:* A wide range of insects are eaten
- *Other:* all household scraps, but excluding citrus peels, coffee, tea grounds and onion skins

Ducks

Ducks provide meat and eggs, and are efficient slug removers. They require a reliable water supply, but are easy to manage and can be free-ranged without scratching at the soil in the way chickens do.

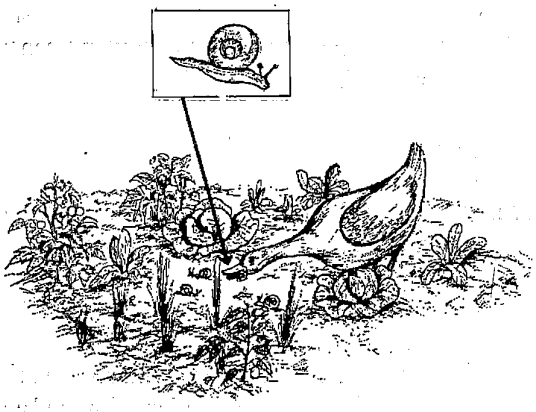


Figure 34 Ducks as slug removers

Animals for Zones 2 to 4

Goats

Besides their value in milk and meat production, goats are useful for clearing land. For a small number of goats (1-3) a pen can be developed with mesh fence surrounded by trees and shrubs. For better 'edge effect', two rows of *Tagasaste* can be included in the pen. Goats are very destructive to cultivated plants. Apart from browsing, they debark trees, so tethering is necessary before allowing them into more delicate parts of the system, for short periods. Goat husbandry in large numbers is incompatible with permaculture. Trees that can withstand limited grazing by goats are weeping willows, mulberries, tree medic, acacias, *Leucaena*, and elderberry. Goats enjoy acorns and the pods of carob, honey locust, pea tree and *Prosopis spp.*

Bees

Bees are very useful in gardens and orchards as pollinators. They produce honey, pollen and beeswax, and their needs are water and a constant source of nectar (flowers), which can be available from the surrounding woodland and bush. They cross-pollinate trees and crops, which increases yields. However, flowering and yields of nectar vary greatly from season to season and year to year, depending upon weather conditions so, at times, bees must be fed sugar water or the hives must be moved to a better nectar source. In the close living conditions of refugees, bees may not be suitable for Zones 1 and 2 and are best kept as a community-managed project in Zone 4. Reliable markets for bee products need to be carefully explored before promoting beekeeping as an income-generating activity.

Zones 2-3

In Zones 2 and 3 the plants and animals in the permaculture system will need to rely on natural sources of water rather than irrigation. Various systems can be installed to maximise the collection and infiltration of rainwater.

Half moon catchments

Water can be concentrated around high value fruit trees by constructing half moon ridges on the downslope side to encourage as much water as possible to infiltrate.

Swales

A swale is a long, level excavation across a slope with an even ridge of top soil running along its lower edge. It is designed to intercept overland flow and encourage the infiltration

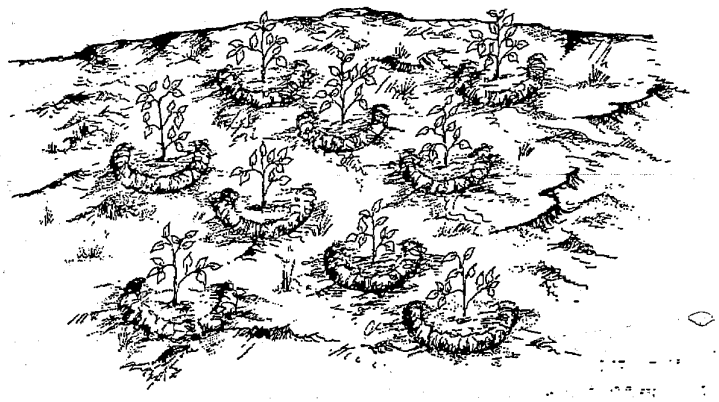


Figure 35 Half moon catchments

(rather than the runoff) of surface water. In case of exceptionally heavy rainfall, swales may need to have overflow channels and perhaps diversion banks and drains.

Swales are normally spaced at a distance of 10-20 times their width, but this really depends on the rainfall of the area. The land between the swales can be deep ripped on contour to break up the soil and increase water filtration.

The berm (soil bank) on the downslope side of a swale can be planted with a windbreak.

As swales need to be dug horizontally across a slope it is important to first identify the line of the contour. This can be done cheaply and easily using a wood or bamboo A-frame. The A-frame is constructed from two legs approximately two metres tall with a cross bar about 1.5 metres long, bound rigidly at the joints. A plumb bob on a string is hung from the apex and passes adjacent to the cross bar.

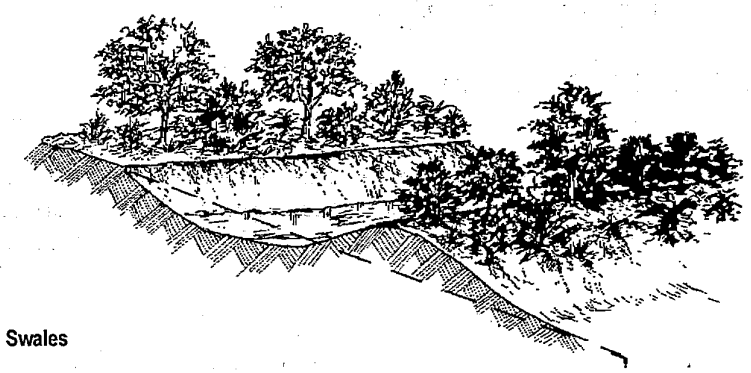


Figure 36 Swales

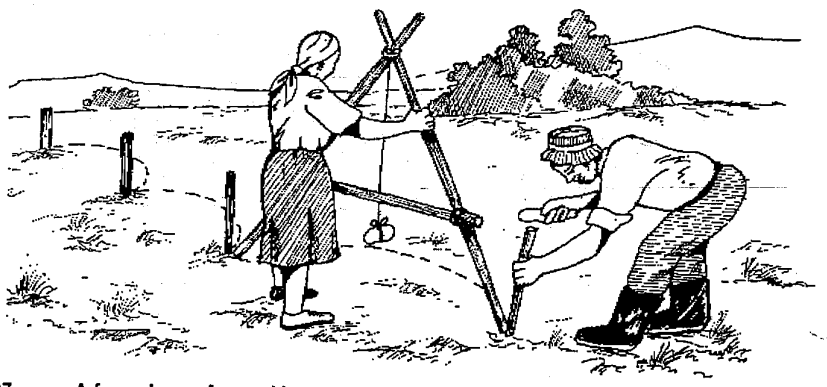


Figure 37 **A-frame in use for marking out contour lines**

The A-frame must be 'calibrated' before use. This is done by making a mark at the point where the string passes the cross bar. The frame is then turned around to rest on the same points on the ground, but facing the other way, and another mark is made on the cross bar. The central point between the two marks is the place where the plumb bob will fall when the legs are at the same horizontal level. The A-frame is now ready for use.

The steps in marking out a contour line for digging swales are as follows:

- Collect a number of stones or pegs for marking the contour
- Put leg 'A' of the frame at the starting point. Mark the place on the ground
- Let the string hang down and move leg 'B' until the string crosses the centre point on the cross bar; mark the position of leg B on the ground
- Keeping leg B firmly in position, swing leg A around until the string again hangs down at the centre point of the cross bar; mark the position of leg A
- Continue this system across the slope; the markers should form a line which is at right angles to the slope
- This line can now be dug into a shallow ditch or swale.

Infiltration pits along swales

The infiltration capacity of swales can be increased by digging pits at regular intervals along the base of the swale. Rainwater sits in these pits and soaks slowly into the ground, enhancing the swales' beneficial effects. The size of the pits depends on local rainfall and the interval between each pit. The following table is a guide for a fairly dry area with 1,000 mm of rain or less:

Distance between pits	5 m	10 m	20 m
Recommended pit dimensions (length x breadth x depth)	1 x 1 x 0.5 m	2 x 1 x 0.75 m	2 x.1 x 1 m

In wetter places the pits can be smaller and more widely spaced.

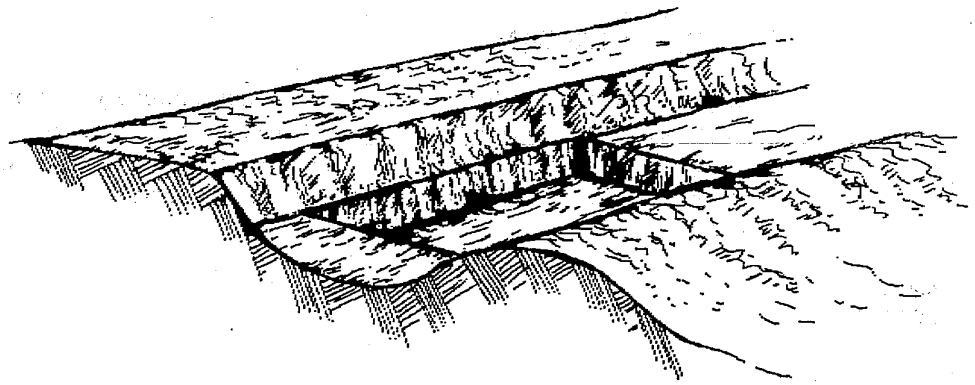


Figure 38 Infiltration pits within a swale

Contour planting

In order to stabilise the soil on sloping land it is advisable to plant horizontal rows of thick grasses or other plants. Vetiver grass is excellent for this purpose, as are fodder varieties such as napier grass and elephant grass.

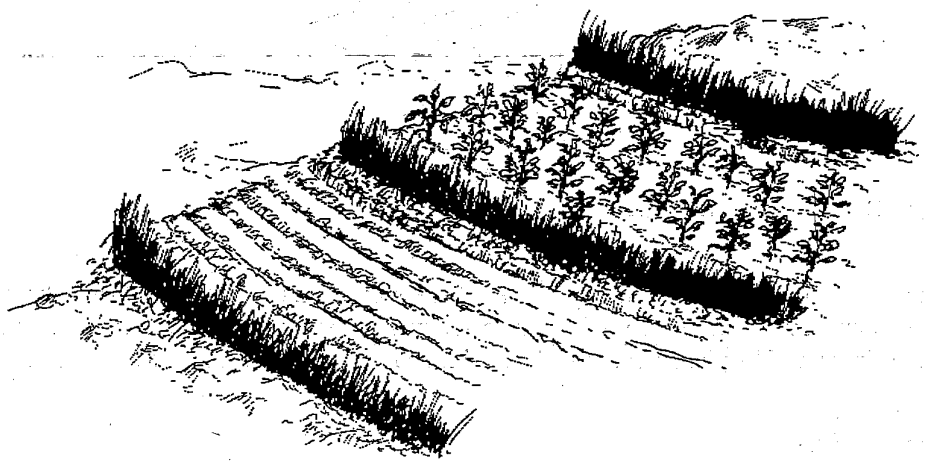


Figure 39 Contour planted vetiver grass

Zone 3

Alley cropping with leguminous trees

Growing crops in alleys between hedgerows or lines of trees can improve yields by reducing wind speeds, by providing protection from the overhead sun and by inhibiting the spread of pests. The hedges or trees may also provide direct benefits themselves, such as nitrogen-fixing or woody products. *Sesbania*, *Leucaena* and tephrosia are suitable for alley cropping systems.

Zones 3-5

Erosion control

Stone check dams or sand traps can be built across erosion gullies at a vertical interval of 0.5 - 1 metre to slow down the speed of surface runoff and allow build up of silt to repair the gully. The same effect can be achieved by using twigs woven into a short barrier.

Figure 40 **Gully erosion control measures**

These can be placed almost anywhere where water runs in streams during heavy downpours, even within crop fields. The effectiveness of any erosion control structures can be improved by planting around them with strong grass species such as vetiver grass.

Zones 4-5

Permaculture in Zones 4 and 5 is a product of the interactions between refugees and the surrounding communities. It may or may not be possible for refugees to design and implement permaculture designs for these areas, depending on how harmonious these community interactions are.

Fencing or rotation of grazing areas

Ideally, livestock can be grazed according to a system of rotation that the refugee and local community have agreed upon. For most of the year livestock will be free grazed in Zones 4 and 5, but after the harvest they can be brought into Zones 2 and 3 to feed on crop residues. At the same time they will deposit manure and contribute to an improvement in soil fertility. Manure tends to last for several seasons and is not quickly leached, brings structural and nutritional improvements to the soil and is normally locally available. It can be applied directly or made into a compost in combination with leaf litter, crop residues, ash, soil from termite mounds or other material.

Wild seed collection

Collecting local plant and tree seeds from the wild will reduce dependency on outside sources and will also ensure that the species that refugees might grow will be suitable for the area.

The selection of the parent plant is crucial for seed collection. This parent should be:

- healthy, fruiting and free of pests and diseases
- adapted to the area where it is growing
- productive and with the characteristics that are sought
- some distance away from other varieties or cultivars of the same type of plant, to avoid cross-pollination

The seeds themselves should be perfectly formed with a good shape, size and colour. They should not float in water.

Once collected, the seeds should be carefully stored to prevent rot or insect attack. They can be mixed with dry ash, roasted rice or traditional drying materials from the local area.

There are various activities for Zones 4 and 5 that can be run on a community-managed basis. The degree to which this is feasible will depend on the particular case in question and the level of cooperation between the refugees, local people and host government authorities.

Activities suitable for these zones might include:

- systems for the controlled harvesting of fuelwood and building poles
- systems for the harvesting of other wild products such as fruits, medicines or thatching material
- protection and management of communally-utilised water resources such as springs, streams, ponds and dams.

Permaculture Stage Six: Monitoring and Evaluation

Monitoring of progress and evaluation of inputs is a vital part of the permaculture development process. However, recommendations that arise from external project evaluations tend to be based on short field visits and information from secondary data sources. Such recommendations may seem irrelevant or unattainable to the people for whom they are designed and who are meant to implement them as the project continues.

It is therefore vital in a permaculture project that the participants themselves should play a leading role in monitoring and evaluating. These participants, whether refugees or local people, should have been closely involved in defining the objectives and outputs at the outset so that they will naturally be the project's main evaluators. At that stage they should have developed indicators to evaluate not only the performance of the project's staff, but also of themselves as participants.

Monitoring should be an ongoing process. If accurate records are kept by the project participants then it will be a relatively simple exercise to compile its achievements and monitor progress towards the objectives.

A formal evaluation might be needed once a year. This will be a more comprehensive assessment. It will build on the ongoing monitoring process but will also demand that further information is determined in conjunction with the participants:

- The activities that have been undertaken as a result of the project.
- The numbers and types of people who have been involved in each activity. Were all stakeholders included?
- Training courses that have been run and numbers of participants. What was achieved? Are other courses needed?
- Progress towards the project's objectives - were they achieved as expected? If not, why not?
- Lessons that have been learned.
- Impacts and benefits for the target group.
- The appropriateness of the project's activities - did they address major concerns and needs?
- Any side effects - have any unforeseen changes taken place since the inception of the project?
- Sustainability - can the community continue with the project on its own? Could the project spread on its own? If not, why not? What other inputs are needed?
- Efficiency - has progress towards the objectives been achieved in the most cost and labour effective way?

To gather this information for an annual evaluation it is likely that Participatory Rapid Appraisal (PRA) methodologies will be useful. At the end of the process, the information

that has been gathered should be presented to everyone who has been involved in the programme for questions and feedback. This can give participants a feeling of pride in their achievements and helps to promote communal spirit.

The progress of the project towards achieving its objectives can be assessed and the next phase can be designed accordingly. Hopefully as the years go by there will be progressively less need for external assistance in project monitoring and evaluation, and increasing self-reliance on the part of the participants engaged in permaculture initiatives.

Further advice on how to monitor and evaluate environmental programmes in refugee situations can be found in UNHCR's 1998 publication entitled '*Refugee Operations and Environmental Management - Selected Lessons Learned*'.

Annex 1 Common and Botanical Names of Trees and their Uses

Type of Plant	Common Name	Botanical Name	Uses	Notes
Pest Control				
	Milk Weed	Sonchus oleraceus	aphid trap crop, salad vegetable, rabbit fodder	annual herb from seed; hardy
	Tephrosia	Tephrosia Vogellii	N-fixer, hedge, shade, nurse,crop, insect spray	Perennial shrub from seed
	Fennel	Foeniculum vulgare	vegetable, seasoning, fodder, predator attractant	annual herb, from root division; do not plan with dill (species get crossed)
	Marigold	Tagates spp.	Mulch, pest repellent, dye, essential oil, roots kill nematodes	bushy annual herb, from seed; hardy
	Nasturtium T. Minus	Tropaeolum Majus,	repellent, groundcover, seasoning, vegetable	annual herb, from seed or cuttings
	Chillies	Capsicum annum	vegetable, seasoning, preserve, insect spray	perennial herb, from seed
	Garlic	Allium sativum	Flavouring, medicinal, soil pest repellent, spray	annual herb, from clove; needs sunshine
	Elder	Sambucus nigra	edible flowers and berries, hedge, fuel, predator attractant	small tree, from shoot cuttings and root division
	Lippia	Lippia javonica	tea, repellent, insecticidal spray	perennial shrub
Climbers	Seven year bean (Madagascar bean)	Phaseolus lunatus	vegetables and pulses, climbers for shade, shelter windbreaks, ground cover, smothering weeds, green manure, mulch, nitrogen fixation, erosion control	perennial climber, from seed; wide range of soils and climates; dried beans must be soaked for at least 12 hours and cooked in 3 changes of water before eating
	Choyote	Sechium edule	shade, vegetables, edible tuber, fodder	vigorous perennial climber (2-3 yrs), from sprouting fruit; mild areas; strong trellis
	Ceylon spinach	Basella alba	shade, ground cover, green manure, food dye, vegetable	perennial fleshy climber, from seed or cuttings
	Passion fruit	Passiflora spp.	fruit, juice, preserves, wine, shade, fodder, windbreak, fence cover	long-lived evergreen climber, from seed or cutting; wide range of soils
	Oysternut	Telfairia occidentalis, T. pedata	evergreen shade, nuts, goat fodder	very vigorous climber; mild/cool areas; strong trellis

Annex1 Botanical uses

Type of Plant	Common Name	Botanical Name	Uses	Notes
	Wild grape	Rhoicissus spp.	fruit, shade	Long-lived woody climber; medium to high rainfall.
	Mediterranean grape	Vitis vinifera	fruit, shade, wine, vines for weaving, oil from seeds	Long-lived woody climber
	Loofah	Luffa cylindrica	shade, vegetable, mats, sponges, pot cleaners	Vigorous, short-lived climber or creeper
Ground Covers food and fodder	Pumpkins and squash	Cucurbita maxima	ground cover, shade, vegetables, jams and pies edible seeds, oil fodder	short-lived climbers or creepers, from seed; hot dry areas on mounds
	Melon	Cucumis melo	ground cover, shade, fruit, vegetables, edible seeds, oil, fodder	short-lived creepers, from seed; hot dry areas on mounds
	Sweet potato	Ipomea batatas	edible tubers, flour, starch, syrup, glucose, alcohol, fodder, groundcover, green manure, smothers weeds, erosion control	perennial creeper, from cuttings
Ground covers soil improvement	Bambara groundnut	Vigna subterranea	pulse, green manure, groundcover	annual herb, from seed; grow on mounds; drought resistant
	Cowpea	Vigna ungulata	pulse, vegetable, fodder, green manure, groundcover	annual herb, from seed, hardy
	Chickpea	Cicer arietinum	pulse, vegetable, fodder, green manure, ground cover	annual herb, from seed; drought resistant
	Desmodium	Desmodium disturtum; D. intortum	browse, fodder, grounder cover, mulch, hay, silage, green manure, smothers weeds, N. fixer, erosion control, pioneer	annual herb, from seed; vigorous; drought resistant; good in fodder strips (most types too vigorous around fruit trees)
	Lablab bean	Lablab purpureus	pulse, vegetable, fodder, groundcover, N-fixer, erosion control, hardy, for hot dry areas, good intercrop with maize; smothers weeds	vigorous shrub, from seed or cuttings; good inter-crop for maize
	Pigeon pea	Cajanus cajan	vegetable, pulse, browse, cut fodder, hay, silage, green manure, groundcover, windbreak, hedge, erosion control	perennial shrub, from seed or cuttings; good row crop for drylands

Type of Plant	Common Name	Botanical Name	Uses	Notes
	Sunnhemp	Crotolaria juncea, C. orchroleuca	ground cover, mulch green manure, N-fixer, smothers weeds, stalks used as fodder, roots repel nematodes, trap crop for pests	annual herb, from seed; fast-growing; hardy; drought resistant; good in orchards
	Velvet bean	Stizolobium aterrimum	pulse, vegetable, fodder, groundcover, N-fixer, erosion control, hardy, for high-medium rainfall areas, smothers weeds	vigorous, annual creeper; from seed; seeds may be toxic to livestock unless soaked for at least 24 hrs and boiled in 3 changes of water; good in orchards and as intercrop with maize
Soil Stabilizers (all areas)	Bana grass	Pennisetum spp.	fodder, erosion control, mulch, windbreak under storey, soil stabilisation	perennial bunch grass; from root division; drought resistant; good in fodder strips
	Lemon grass	Cymobopogon citratus	erosion control, windbreak, mulch, essential oil, flavouring, border plant, insect repellent	perennial bunch grass; from root division; hardy; good on edges of paths and ponds
	Vetiver grass	Vetiveria zizanioides	rat repellent, oil and fibre from roots, erosion, windbreak, mulch	perennial bunch grass; from root division
Soil Stabilizers (wet areas)	Bamboo	Members of the Graminaceae family	paper, furniture, roof tiles, thatch, gutters, plant pots, baskets, building material, scaffolding, bridges, rafts, edible shoots, musical instruments, implement handles, poles, garden stakes, erosion control etc.	Perennial tree-like grasses; from runners, suckers or truncheons depending upon whether the type is a running or clumping form
	Canna	Canna edulis	edible rhizomes, starch, fodder, erosion control	perennial fleshy flowering plant, from rhizome; wet site
	Comfrey	Symphytum officinale	vegetable, medicinal, fodder, weed control, compost, mulch, ground cover, soil stabilisation, windbreak, bee forage	perennial fleshy herb; from root division; good with potatoes (not generally invasive)
	Ilala palm	Hyphaene benguelensis, H. natalensis	fruit, milks, wine, timber, vegetable ivory, thatch, fibre, gully reclamation	tall tree; from seed; drought resistant

Annex1 Botanical uses

Type of Plant	Common Name	Botanical Name	Uses	Notes
	Taro	Colacasia esculenta	edible shoots and leaves, flour, starch, fodder, compost, mulch, erosion control on dams and ponds (if not harvested)	perennial herb, from corms and suckers; wet site; leaves and corms must be well-cooked
Shelter Plants	Casuarina	C. Toralosa, C. equisetifolia (coastal only) Casuarina cunninghammia	N-fixer, erosion control, pioneer, hedge, windbreak, fuel and timber, mulch	tall tree; from seed or coppice
	Erythrina	Erythrina spp	seeds for decorating, timber, bee fodder, live fence, hedge, fodder, shade	small/medium tree; from seed, truncheon or coppice; drought resistant
	Jatropha	Jatropha curcus	oil for fuel, residues for fertilizer, kills snails and fungi, yellow and blue dye, fuel wood, timber and pulp for paper	small tree/shrub; from seed, truncheon or coppice; drought resistant
	Kei apple	Dovyalis caffra	fruit, fodder, hedge, windbreak, fire resistant, bird attractant	small tree/shrub; from seed; drought resistant; very thorny
	Rubber hedge	Euphorbia tirucalli	hedge, fire retardant, fish poison, insecticide, repellent	medium-sized tree; from cuttings; toxic
	Silky oak	Grevillea robusta	windbreak, shade, timber, bee forage, mulch	large tree; from seed and cuttings
	Acacias	Acacia spp. Faidherbia albida thousands of species	food, fodder, gum, medicinal, timber, fuelwood, fencing, shade, N-fixer, windbreaks and thorny hedges, erosion control	shrubs, small and large trees; from scarified seed; hardy drought resistant tough pioneer species
	Honey locust	Gleditsia tricanthos	food, fodder, timber, fuel, shade, erosion control, hedges and windbreaks.	tall, deciduous tree; from scarified seed; drought resistant
	Leuceana	Leuceana leucocephela	food, fodder,(low quality) timber, fuel, shade, erosion control, hedges windbreaks, coffee substitute	small/medium sized tree; from scarified seed; hardy; pest potential
	Sesbania	Sesbania sesban, S. bispinosa, S. aculeata, S. grandifolia, S. formosa	food, fodder, fuel, shade, erosion control, hedges and windbreaks	small tree, may be annual; soaked or scarified seed; hardy; tough pioneer species
	Cape gooseberry	Physalis peruviana	fruit, medicinal, under storey, hedge, windbreak, nurse crop, groundcover	creeping annual bush; from seed; hardy

Type of Plant	Common Name	Botanical Name	Uses	Notes
	Cassava	Manihot esculenta	edible tubers, vegetable, flour, starch, tapioca pudding, adhesives, textile and paper making, beer, fodder, ethanol, nurse crop, pioneer, hedge and windbreak	perennial shrub; from cuttings
Large Fruit Trees	Avocado	Persea americana	shade, timber, fruit, oil	tall evergreen tree; from seed or cuttings
	Carob	Ceratona siliqua	Chocolate/coffee substitute, fodder, gum, timber, shade, erosion control	Medium to large evergreen tree; from seed or cuttings; hardy
	Cashewnut	Anacardium occidentale	nuts, oil, butter, fruit, wine, ink	medium evergreen tree; from seed; poor germination
	Macadamia	Macadamia ternifolia M. integrifolia	nuts, butter	medium to tall evergreen tree; from seed and vegetable
	Mango	Mangifera indica	fruit, juice preserve etc, shade	tall evergreen trees, from seed and budding; does not like high pH or rocky soil
	Pecan	Carya illinoensis	nuts, oil	tall trees; from seed, budding or grafting; likes abundant water, frosttolerant
Small Fruit Trees	Banana	Musa spp.	fruits, vegetable, beer, fibre dye, ink, flour, fodder, fibre, bat and bird home, leaves make plates, wrappers, thatch umbrellas, etc, windbreak, shade, erosion control, mulch	small to medium tree-like perennial herbs world's largest herb, from suckers and corms
	Lemon Grapefruit Mandarin Sweet orange Kumquats	Citrus limon C. paradisi C. reticulata C. sinensis Fortunella japonica, F. margarita	fruit, juice, preserves.	small evergreen trees
	Coffee	Coffea arabica, C. canephora	drink, understorey	evergreen shrub, from seed; should not be grown where irrigation needed; likes shade
	Feijoa	Feijoa sellowiana	fruit, jams, juice, edible flowers	evergreen shrub; from seed or leaf cutting; sunny, wind hardy

Annex1 Botanical uses

Type of Plant	Common Name	Botanical Name	Uses	Notes
	Guava	Psidium guajava	fruit, juice, dye, tanning, timber	small to medium tree; from seed, cuttings or root suckers; hardy
	Horseradish tree	Moringa oleifera	All parts edible, fodder, pickle, hedge, live fence, seasoning, medicinal	small tree; from seed or cuttings
	Mexican apple	Casimora edulis	fruit	medium evergreen tree; from seed or cuttings
	Mulberry	Morus alba, M. nigra	fruit, leaves fed to silk worms, fodder, paper making, timber, fuel, wine	large deciduous tree; from seed or cuttings; fast-growing; hardy
	Pawpaw	Carica papaya	fruit, drinks, jam, etc, meat tenderiser, vegetable, medicinal, shade, nurse crop, wind break	short-lived, fast growing tree; from seed
	Pomegranate	Punica granatum	fruit, medicinal	deciduous perennial; cuttings from suckers; drought resistant
	Stone fruits: Apricot, Peach, Plum	Prunus armeniaca, P. perseca, P. insitia, P. domestica	fruit, shade, hedge	deciduous small tree, from budding, suckers or grafting, need pruning, cross pollination
	Tamarillo	Cyphomandra betacea	fruit, shade, etc	deciduous small tree; from seed or cuttings; sheltered sunny position

Glossary

Agroforestry: The incorporation of trees in farmland.

Broadcasting: Scattering of seed over the surface with a light covering of soil or mulch. A suitable technique for random intercropping.

Companion Planting: The planting of two or more plant species adjacent to each other for mutual benefit.

Compost: Natural fertilizer formed by decomposing plant, insect and animal residues and wastes.

Coppicing: Cutting of trees or shrubs which then re-sprout via branches or root suckers. Examples of trees that will coppice are willows, eucalypts, alder and leucaena.

Cover crop: A crop that is grown to protect the soil with a dense mat of roots or foliage.

Fungicide: An element or function used to prevent the occurrence or the spread of fungal infections.

Green manure: Plants which are turned into the soil or cut and left on the surface to enhance fertility. They are mostly legumes.

Grey water: Water that has been used for washing or cooking, but not water that has sewage in it.

Guild: A species assembly of plants and animals which benefit each other, usually for pest control.

Herbicide: An element or function used to eradicate a particular plant or group of plants.

Insecticide: An element or function that controls insect problems.

Intercropping: A system of growing two or more crops side by side or intermixed on the same area of ground or the cultivation of two or more species of crop in such a way that they interact agronomically (biologically).

Legumes: Plants of the family Leguminoseae (e.g. beans, peas, clovers and tree legumes such as acacia, albizia and cassia). Most legumes (but not all e.g. honey locust and carob) fix atmospheric nitrogen in the soil through a symbiotic relationship with a bacteria within their roots. This nitrogen is available to the plant, but not necessarily to other plants unless coppiced or turned into the soil.

Microclimate: The localised climate around landscape features and buildings; important for selecting sites for specific crops or species.

Monoculture: A crop of plants of the same kind on a piece of land.

Mulch: A protective cover on top of the soil to retain moisture, suppress unwanted plants or minimise compaction by heavy rain. Can be made of organic matter such as leaves or manure, or inorganic matter such as stones or plastic.

Low tillage farming: A system under which crops are sown and harvested with minimum disturbance to the soil. The extreme form is zero tillage farming, under which no cultivation of the soil takes place and a combination of tree crop, mulch and green manure are used to build soil fertility. Weeds are controlled by slashing, mulching, browsing or flooding.

Organic matter: Plant and animal wastes.

Pesticide: Substance use to kill or reduce the number of pests. Includes insecticides, fungicides and herbicides.

Polyculture: The planting of multiple crops in the same ground or area. The opposite of monoculture.

Sector: A portion of the permaculture system that is subject to particular outside forces that are not equal across the whole system. These outside forces (or 'external energies') could include prevailing wind, winter sunshine, hillslope or water flow. They act on different parts of the system in different ways, and this dictates the alignment and size of the sectors. The sectors are often pie-shaped and radiate outwards from a 'centre of activity' (such as a house) in different directions, and they determine how landscape elements should be placed for optimum benefit.

Stacking: Arrangement of plants to take advantage of all possible space, using tall and medium-sized trees with a lower shrub and herb layer.

Swale: A long, level excavation across a slope with an even ridge of top soil running along its lower edge. Intended to intercept overland flow and encourage the infiltration (rather than the runoff) of surface water.

Trellis: A framework upon which climbing plants can be grown to provide shade and windbreak. It may be attached to a structure or may be freestanding, and is often made from bamboo or other thin poles.

Zero Tillage: see Low Tillage Farming.

Zone: An area of the permaculture system, normally forming a ring shape, that is designed according to the amount of attention and water that it requires. Most permaculture systems have 5 zones that radiate outwards in concentric bands from a 'centre of activity' (such as a homestead). The centre of activity itself is often called 'Zone 0'.

Useful UNHCR References

UNHCR has developed various guidelines and resource publications that provide useful support to this permaculture manual. They outline UNHCR's environmental policies and document various examples of good practice based on past environmental experiences in refugee work. The reader might be especially interested in the following:

- Refugee Operations and Environmental Management: Selection Lessons Learned (1998)
- Refugee Operations and Environmental Management: Key Principles for Decision-Making (1998)
- Environmental Guidelines (1996)
- Environment Guidelines: Domestic Energy in Refugee Situations (1998)
- Environmental Guidelines: Forestry in Refugee Situations (1998)
- Environmental Guidelines: Livestock in Refugee Situations (1998)
- Water Manual for Refugee Situations (1992)
- Technical Approach - Environmental Sanitation (1994)
- Shelter and Infrastructure - Camp Planning (1994)
- Vector and Pest Control in Refugee Situations (1997)

For further information or to obtain free copies of these publications, contact:

Engineering and Environmental Services Section (EESS) TS01

United Nations High Commissioner for Refugees

Case Postale 2500

CH-1211 Genève 2 Dépôt

Switzerland

Useful Books

The following books provide a much more complete outline of permaculture than this handbook and give an idea of the great variety of practical techniques that it encompasses:

Bell, G. 1992. *The Permaculture Way: Practical Ways to Create a Self-Sustaining World.* Thorsons, London.

_____, **1994.** *The Permaculture Garden.* Thorsons, London.

Fukuoka, M., 1985. *The Natural Way of Farming: The Theory and Practice of Green Philosophy.* Japan Publications, Tokyo and New York.

_____, **1992.** *One-Straw Revolution.* The Other India Press, Goa, India.

Lee, A., and P. Foreman, 1997. *Chicken Tractor: The Permaculture Guide to Happy Hens and Healthy Soil.* Chelsea Green Publishing, USA.

Lindegger, M.O. and R. Tap, 1986. *The Best of Permaculture.* Nascimanere Publishers, Nambour, Australia.

Mars, R. and J. Mars, 1995. *Getting Started in Permaculture.* Candlelight Trust, Hovea, Western Australia.

Mollison, B. and D. Holmgren, 1987. *Permaculture One: A Perennial Agriculture for Human Settlements.* 3rd ed (reprint of 1978 ed). Tagari Publications, Tyalgum, Australia.

Mollison, B. with R.M. Slay, 1991. *Introduction to Permaculture.* Tagari Publications, Tyalgum, Australia.

Mollison, B., 1979. *Permaculture Two: A Practical Design for Town and Country in Permanent Agriculture.* Tagari Publications, Tyalgum, Australia.

_____, **1988.** *Permaculture: A Designer's Manual.* Tagari Publications, Tyalgum, Australia.

_____, **1993.** *The Permaculture Book of Ferment & Human Nutrition.* Tagari Publications, Tyalgum, Australia.

Morrow, R. and R. Allsop, 1994. *Earth User's Guide to Permaculture.* Kangaroo Press, Kenthurst, NSW, Australia.

Sholto Douglas, J., and R. De J. Hart, 1985. *Forest Farming: Towards a Solution to Problems of World Hunger and Conservation.* IT Publications, UK.

Smith, J.R., 1987. *Tree Crops: A Permanent Agriculture.* Island Press, Washington, D.C.

Watkins, D, 1993. *Urban Permaculture.* Permanent Publications, UK.

Whitefield, P., 1993. *Permaculture in a Nutshell.* Permanent Publications, UK.

Yeomans, P.A., 1993. *Water for Every Farm.* Keyline Designs.

Most of these publications are available from:

Amazon address: www.amazon.com. or www.amazon.co.uk

or:

Intermediate Technology Publications address:

www.aries-bs.co.uk/cgi-win/ariesmultisite.exe/individual/itp

IT Publications can also be contacted as follows:

103-105 Southampton Row,
London WC1B 4HH, UK

Tel: +44 20 7436 9761
Fax: +44 20 7436 2013

E-mail: itpubs@itpubs.org.uk

Useful Internet Sites

The following addresses provide a rich resource of permaculture information for those with Internet access:

- Appropriate Technology Transfer for Rural Areas:
  www.attra.org/attra-pub/perma.html
- Global plant database:
  www.metalab.unc.edu/pfaf/D_search.html
- Library of Centre of Excellence for Sustainable Development:
  www.sustainable.doe.gov/
- Sustainable Architecture Building & Culture Library:
  www.west.net/~prince/index.htm
- The Permaculture Activist:
  metalab.unc.edu/pc-activist/
- Permaculture by distance learning:
  www.ozemail.com.au/~askpv
- Permaculture Drylands Journal:
  members.aol.com/pdrylands/PDIhome1.htm
- Permaculture International Journal:
  nornet.nor.com.au/environment/perma/
- Permaculture links list:
  www.permaearth.org
- Permaculture Magazine UK:
  www.gaia.org/permaculture
- Permaculture Magazine:
  www.permaculture.co.uk
- The Permaculture Research Institute:
  www.permaculture.org.au
- Restoration forestry:
  www.geocities.com/RainForest/4663/
- Seed Savers Network:
  www.seedsavers.net
- Sustainable Earth Library:
  www.envirolink.org/pubs/index.html#library_subject_areas