'1985'

PERMACULTURE DESIGN COURSE

HANDBOOK

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SECTION 1. INTRODUCTORY

Permaculture Ethics:

"Care of the Earth" -- includes all living and non-living things, such as animals, plants, land, water, and air.

"Care of People" -- to promote self-reliance and community responsibility.

"Give Away Surplus" -- to pass on anything surplus to our needs (labour, money, information) for the above aims.

Implicit in the above is the "Life Ethic": all living organisms are not only means but ends. In addition to their instrumental value to humans and other living organisms, they have an intrinsic worth.

Permaculture is an ethical system, stressing positivism and cooperation.

SECTION 2. PRINCIPLES OF NATURAL SYSTEMS AND DESIGN

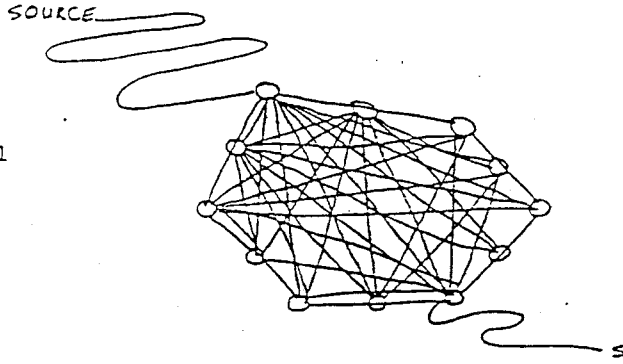
Guiding principles of permaculture design:
- Everything is connected to everything else
- Every function is supported by many elements
- Every element should serve many functions

What is design? It is composed of two elements: aesthetics and function. Permaculture design concentrates on function.

Functional design is:
(1) Sustainable — it provides for its own needs
(2) Has good product yield, or even surplus yield
For this to occur, elements must :
- have no product unused by other elements, and
- have their own needs supplied by other elements in the system

If these criteria are not met, then pollution and work result. Pollution is a product not used by something else; it is an over-abundance of a resource. Work results when there is a deficiency of resources, when an element in the system does not aid another element. Any system will become chaotic if it receives more resources than it can productively use (e.g. too much fertilizer can result in pollution).

A resource is any energy storage which assists yield. The work of the permaculture designer is to maximise useful energy storages in any system on which they are working, be it house, urban property, rural lands, or gardens. A successful design contains enough useful storages to serve the needs of people.



Diversity is related to stability. It is not, however, the number of diverse elements you can pack into a system, but rather the useful connections you can make between them.

- diversity increases
- energy stores increase
- organizational complexity increases

The Chaos or Disorder Principle: If resources are added beyond the capacity of the system to productively use them, then that system becomes disordered (goes into chaos) Odum.

Chaos or disorder is the opposite of harmony, as competition is the opposite of cooperation. In disorder, much useful energy is cancelled out by the use of opposing energy, thus creating entropy or bound energy.

Society, gardens, whole systems and human lives are wasted in disorder and opposition. The aim of the designer is therefore two-fold:

- To use only that amount of energy that can be productively absorbed by the system
- To build harmony, as cooperation, into the functional organization of the system

Methodologies of design

Permaculture design emphasizes patterning of landscape, function, and species assemblies. It asks the question, "Where does this (element) go? How is it placed for maximum benefit in the system?"

Permaculture is made up of techniques and strategies:

- Techniques: concerned with how to do things (one-dimensional) e.g. organic gardening
- Strategies: concerned with how and when (two-dimensional) e.g. Fukuoka system
- Design : concerned with patterning (multi-dimensional) e.g. permaculture

Approaches to Design:

- (1) Maps ("Where is everything?")
- (2) Analysis of elements ("How do these things connect?")
- (3) Sector planning ("Where do we put things?")
- (4) Observational
- (5) Experiential

(1) Maps (be careful; the "map is not the territory")

Sequence of maps valuable to see clearly where to place many elements. Clear overlays to plan:

- Access
- Water
- Buildings
- Topology

(2) Analysis of Elements

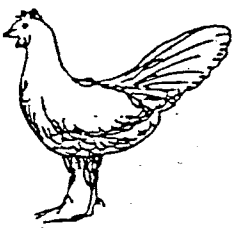
An analytic approach: list the needs, products, and the intrinsic characteristics of each element. This is done on paper. Lists are made to try to supply (by some other element in the system) the needs of any particular element.

Example would be that of the chicken:

eeds are:

food
shelter
dust
air
other chickens

- water
- protection
- grit
- control



Products are:

- manure
- heat
- meat
- eggs
- gas
- feathers

Intrinsic factors: breed characteristics (colour, ranging habits)
unique factors

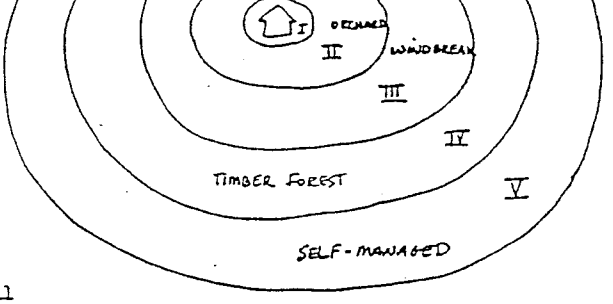
xperiment, on paper, connecting and combining the elements (buildings, plants, animals, etc) to chieve no pollution (excess of product), and minimum work. Try to have one element fulfil the eeds of another element.

) Sector Planning

ctor planning includes (a) zones (b) sector (c) slope, and (d) orientation

) ZONES. It is useful to consider the site as a series of zones, which can be concententric rings, a single pathway through the system, starting with the home centre and working out. The placement of elements in each zone depends on importance, priorities, and number of visits needed for each element, e.g. a chciken house is visited every day, so it needs to be close (but not necessarily next to the house). A herb garden would be close to the kitchen.

. mostly structures
. very intensive
. start at backsteps



Zone II:

. intensive cultivated
. heavy mulched orchard
. well-maintained
. mainly grafted and selected species
. dense planting
. use stacking, storeys
. some animals: chickens, ducks, pigeon, quail
. multi-pupose walks: collect eggs, milk, distribute greens & scraps.

Zone III:

. connect to Zone I and II for easy access
. may add goats, geese and sheep, bees
. plant hardy trees and bush species
. ungrafted for later selection, later grafting
. animal forage
. self-forage system: poultry forest, etc.
. windbreaks, firebreaks
. spot mulching, rough mulching
. trees protected with cages, strip-fencing
. nut tree forests

Zone IV:

. long term development
. timber for building
. timber for firewood
. watering minimal
. feeding minimal
. some introduced animals: cattle, deer, pigs

Zone V:

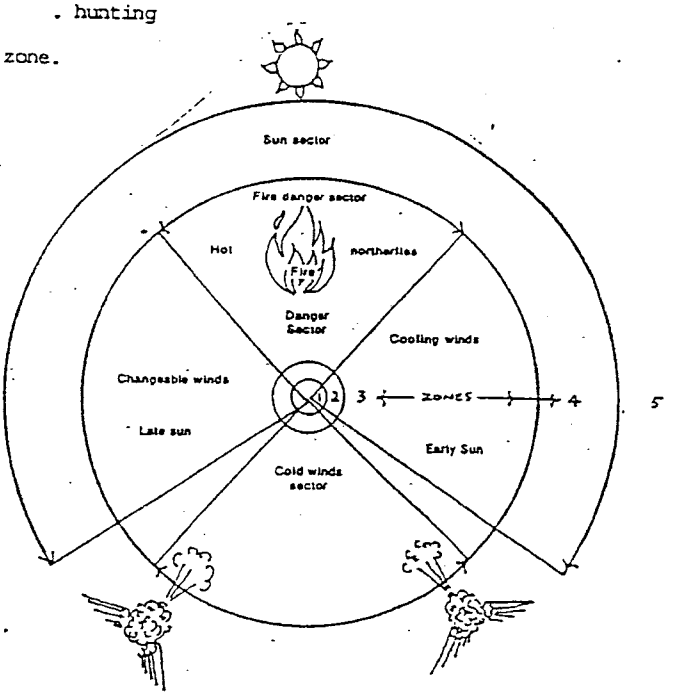
. uncultivated bush
. regrowth
. timber
. hunting

Species, elements, and strategies change in each zone.

(b) SECTORS

The aim of sector planning is to channel external energies (wind, sun, fire) into or away from the system.

The zone and sector factors together regulate the placement of particular plant species and structures.



(c) SLOPE

Placement of an element on slope so that gravity is used to maximum capacity:

. water storages
. mulch and other materials (kick-down)
. cold air fall; warm air rise

(d) ORIENTATION

Placement of an element so that it faces sun-side or shade-side, depending on its function and needs.

(4) Observational

Free thinking or thematic thinking (e.g. on blackberry or bracken)

(a) Note phenomenon
(b) Infer (make guesses)
(c) Investigate (research)
(d) Devise a strategy

(5) Experiential

Become conscious—of yourself, feelings, environment. Can be free-conscious or thematically-conscious. Zazen—walking without thinking, unreflective.

PUTTING IT TOGETHER: Use all the methodologies of design.
Select elements - pattern assembly
Place elements - pattern relationship

SECTION 3. PATTERN IN DESIGN

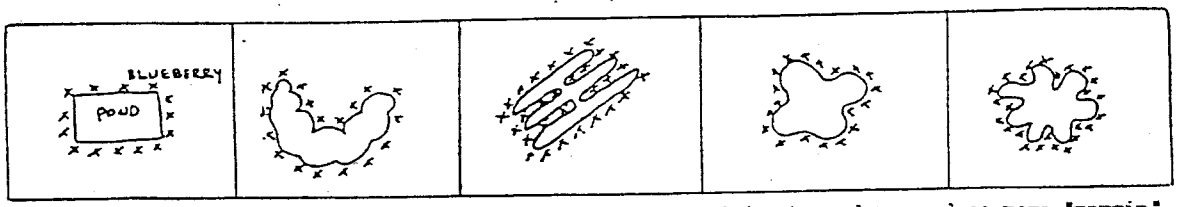
The world is a sequence of events within a pattern. All things spiral through the pattern. In pattern application, there are two aspects: the perception of the patterns that already exist (and how these function), and the imposition of pattern on sites in order to achieve specific needs.

Zone and sector planning are examples of pattern application.

(A) Edge effects and harmonics

Edge effect: the interface between two ecosystems represents a third, more complex system which combines both. The interface, or edge, receives more light, nutrients and so is more productive.

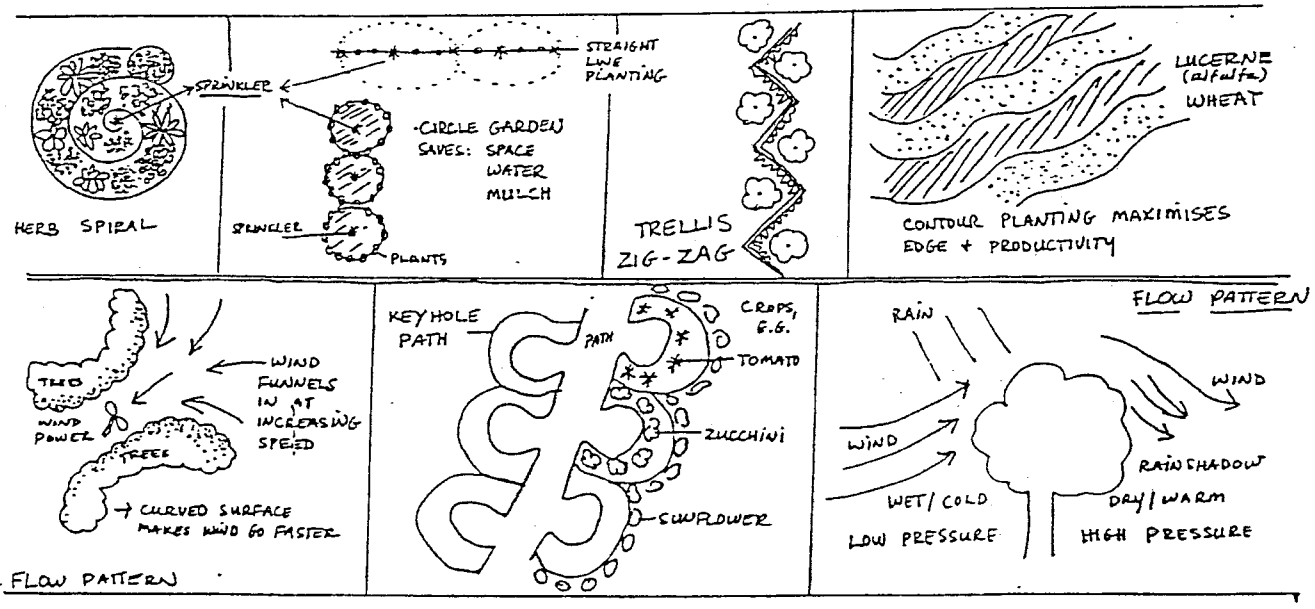
Harmonics and area: increase in linear effects while the area is constrained:



Low productivity — Higher productivity as shape of the pond is changed to produce more "margin" or edge. It may almost double the number of plants around the edge, and, as fish are mainly marginal feeders, so may be able to double the number of fish.

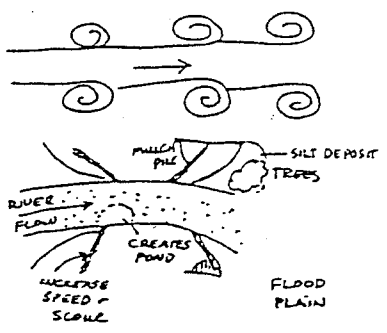
Other examples of patterning with edge include:

- Circle garden rather than linear garden - saves space and water
- Trellis in zig-zag pattern rather than straight
- Crops planted in strips and contours, with companionable crop in between strips (crops receive more light for photosynthesis and yield is high for both)
- Windbreak can be planted either to deflect wind or to funnel it into a gap for wind power.
- Gardens can make use of "keyhole" pattern to maximise space and yield.



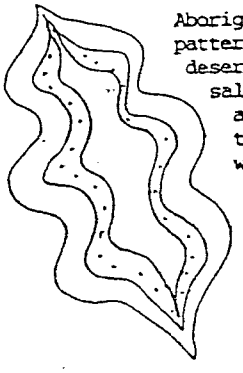
Species edge possibilities are determined by whether plants/animals are compatible, e.g. wheat planted with lucerne (alfalfa) will increase yield, while yields decrease if planted with Brassica.

(B) Flow patterns



Can use pattern in river flow to scour deep ponds, to accumulate mulch on edges, and to build up a layer of silt.

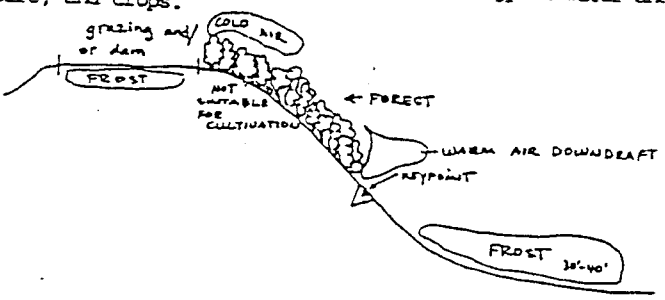
Mulch and silt accumulates during the flood phase of the river, but trees must be planted to catch this accumulation.



Aboriginal tribal song-pattern shows a map of desert, with wadis and salt-bushes. Pattern and song are used together to find one's way in a desert landscape.

The Humid Landscape

Humid landscapes (tropical or temperate) are gently rounded due to forces of water on substrate. This classical profile decides our whole strategy in water and structural placements, forests, soils, frost, fire, and crops.



High Point:

- Collection area for precipitation
- Mists and humid air
- Wide bald ridges may be grazed, but narrow ridges should be forested
- Collection of water as ridge, plateau, saddle dams

Upper Slopes:

- Instability of soils greater than 18° slope or less in fragile soils
- Forests as stabilizing mechanism
- Forests as warming systems for cold air flow
- Collection of water as plateau or contour dams, as power source

Key Point:

- Critical water control point for lower slope irrigation
- Diversion drains in to keypoint
- Irrigation canals out from keypoint to ridges
- Cultivation below keypoint
- Links from keypoint to keypoint along keyline
- Housing suited to this area or just below, with forest above
- Clean water above, soiled water below

Lower Slopes:

- Mixed cultivation area, crops
- Terracing and mini-terrace

Keyline system of water control

- Dams at saddles or skyline
  Each dam may have 2 or 3 channels in or out:
- Contour, ridge point, and plateau edge dams

Diversion channels (types and slopes; lockpipes, siphons; slope pipelines, terrace lines; head and tail channels, hardware, diversion pipes, flags, sprinklers).

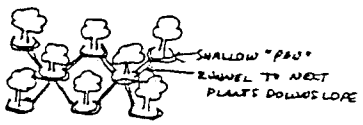
Spillways (construction and contouring)

Irrigation (types and uses; drip irrigation)

- Selection of keypoint in major landscape plan
  - laying out the keyline system: multiple dams and channels
  - Reverse siphon; siphon and obligatory points
    - diversion to keypoint
    - irrigation from keypoint
- Chisel plough or soil conditioner in keyline
  - Principle of soil reconditioning
  - Effects of conditioning on soil:
    - The soil as the main water storage system
    - air
    - temperature
    - life (worms, bacteria)
    - pH
    - minerals
    - plant growth

Treatment of Individual Slopes

1. Steep and stoney slopes: net and pan structures
2. Steep and grassy: planting shelves, houses, livestock, valley and ridge; mulch on shelves.
3. Very steep: classical intensive terrace.



NET AND PAN SYSTEM

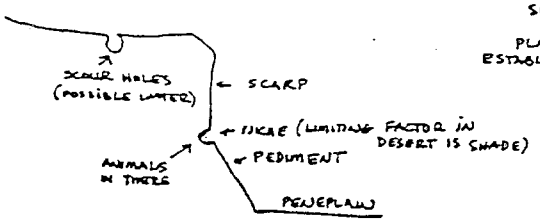
- General schematic of flow-down and kick-down systems
- Use the ideal species as slopes descend to deep soils
- Ridge top plantings in cool and hot climates
- Fire control on slopes
- Mini-catchment

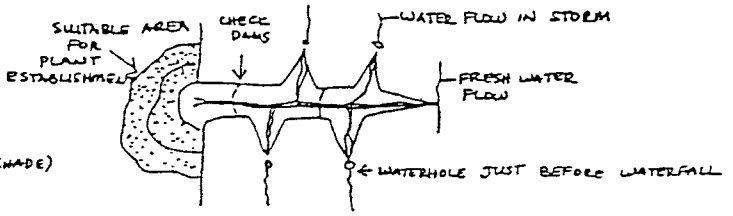
Flatlands

- Irrigation layouts and techniques
- Mulch on flat
- Swale interception of run-off (groundwater build-up), e.g. Village Homes, Davis, California. Swales in forest, especially off-garden.
- Sprial earth bank designs and use of earth banks.
- Flatland check dams. Earthbanks and earthworks.

B. The Arid Landscape

Profiles:

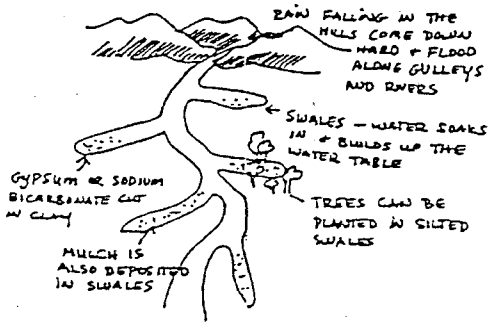


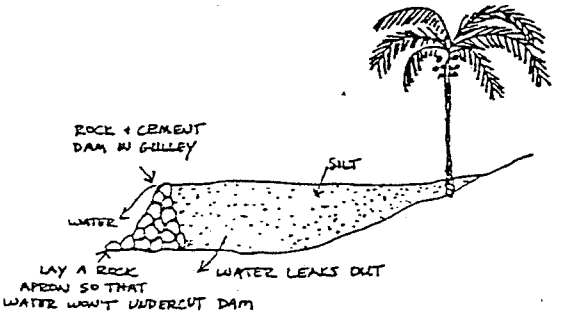


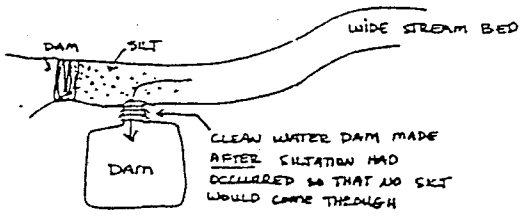
WADI

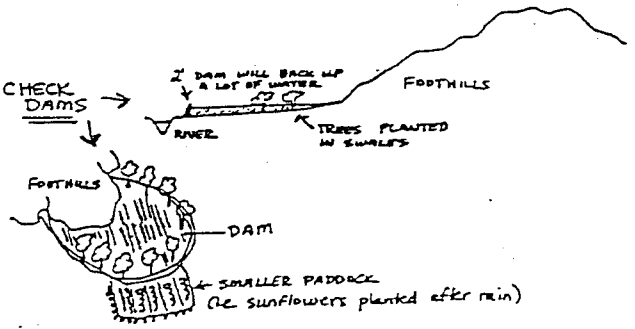
Important desert strategy is to have many little systems going, all designed to catch and store water. Water must be stored <u>in</u> ground or underground.

- Placement of human habitation, animal shelter, manurial flow
- Use of sunny cliff sites
- Checkdams; floodflow irrigation; holding banks stable
- Road run-off techniques
- Mulch-traps in desert
- Floodplain treatment in deserts (Navajo and Zuni techniques)
- Slopes and run-off catchment
- Use of basketry and woven mulch, fences
- Evaporation loss and moisture barriers
- Shade and shadehouse
- Special treatment of showers, water, run-off

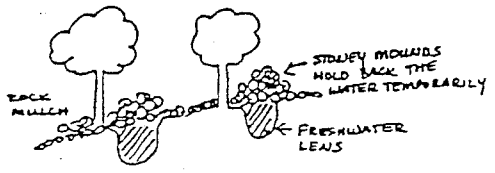


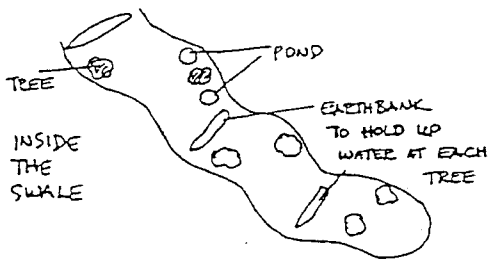






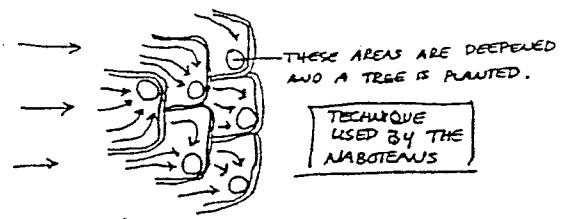
STONEY DESERT STRATEGY (SWALES)



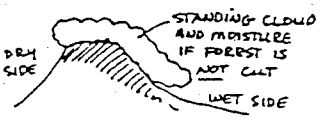


COLLECTION PANS

THIN SHEET OF WATER RUNNING ACROSS THE COUNTRY

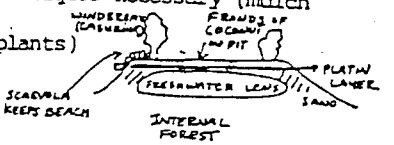


1. Volcanic Islands
   - Rich soil; range of crops almost unlimited
   - Types of lava: pahoehoe (rock lava—good only for run-off)
     u'u (pumicelike with lots of holes. Can be planted in)



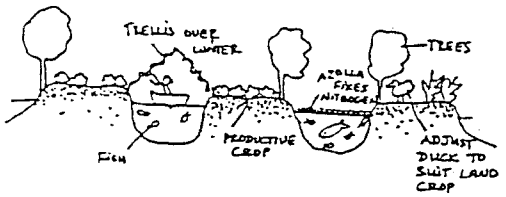
2. High Islands
   - Are either granite or basalt
   - Humid to arid aspects
   - Keyline, ridge dams, terrace
   - Rockwall and cave shelters
   - Rich flora and fauna
   - Importance of winds and rainfall
   - Lagoon catchments and shorelines
   - Special problems: cyclone and tsunami; earthquake; mudflow, lava flow, cinder flow; volcanisms

3. Low Islands
   - Are usually arid islands
   - Need essential foreshore plantings
   - Need essential windbreaks
   - Bi-modal and bi-directional winds
   - Caliche or platin-removal techniques necessary (mulch pits)
   - Gley for tanks (species of plants)
   - Atoll structures in lagoons



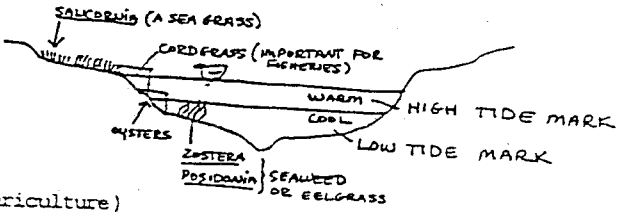
4. Coasts
   - Need frontline vegetation so that beach is not undermined
   - Salt-resistant frontline species, e.g. (casuarina, coprosma) have waxy or needle leaves.
   - Establishing plants in sand: sawdust and paper lowers pH and hold moisture; Chinese plant baskets to hold in moisture.
   - Sand-blast resistent: thick bark or very fibrous barked trees (pines and palms, casuarinas)
   - The alkaline sand needs humus; soluble sulphates and oxides offset alkalinity
   - Deficiencies in zinc, copper, iron (non-soluble in alkaline) in woven

5. Wetlands
   - Chinampa system - world's most productive agriculture, using banks next to water, maximises productive edge. Swampy or marshy land ideal for this development. System of water-land nutrient exchange in harmonic effect. (Mexico and Thailand)



   - Ducks (main livestock) cycle nutrients; return potash to water and land.
   - Fish are marginal feeders
   - Azolla is a fern which contain Anabeana (nitrogen-fixing bacteria); can be scooped up and used as a mulch on land
   - Trellis crop over water saves space; can be harvested by small boat
   - Occasionally streams are drained and nitrogen-rich mud scooped onto banks.
   - Marshes and wetlands support rich yields of wild rice (Zizania aquatica), freshwater mussels, fish, and honey-producing species (marsh marigold)

6. Estuaries
   - Rich species area (oysters, fish, sea-grass, molluscs, fowl, geese)
   - Sea-grass (Zostera) good insulation
   - Can make traps and high-tide ponds for catching or rearing fish, molluscs.
   - Spartina: mulch, catches silt from land, good fodder, returns nutrient from sea to land.



(Further information in Section 12. Aquaculture and Mariculture)

CLIMATIC DIFFERENCES

Three very basic divisions: Cold/Hot/Dry or Temperate/Tropical/Desert

Temperate: soil contains nutrients and elements, cultivation cautiously possible; natural mulch develops. Mulch (humus) either as applied on top of soil (small areas) or cut/grazed in cycles for larger areas. Amount of humus in soil determines "fertility". Smaller fields with deep rooted deciduous trees ensures nutrient cycling plus new nutrients, but best strategy for cropping is "no-tillage" cultivation.

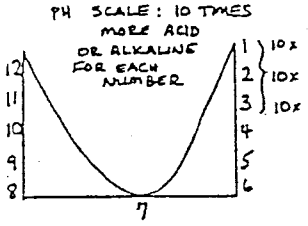
Tropical: Plants hold 80-90% of nutrients, clean cultivation in the European mode a disaster. No mulch develops under forest. Biomass is critical. Bare soil leads to development of concrete-like layer below 3 metres of soil (caliche), later erosion. Strategies: nitrogenous ground cover may be critical pre-cursor to agriculture (Desmodium, Sesbiana, Dolichos) e.g. barley/dolichos mixture is ideal, as is Desmodium under a tree crop. Problems may be summer or winter dry periods and water competition. This is solved by use of drip irrigation, selective grazing in advanced tree crops. 4-6 large trees/acre (Acacia albida, Leucaena) in crop as nutrient-recycling strategy. Essential to incorporate as much tree crop as possible; otherwise, waterculture, e.g. paddy rice, where nutrient is bound to algae and mud. Also essential to replace low-nutrition plants (lettuce) with high-nutrition tropical plants (kangkong, edible chrysanthemums, hibiscus spp. etc.)

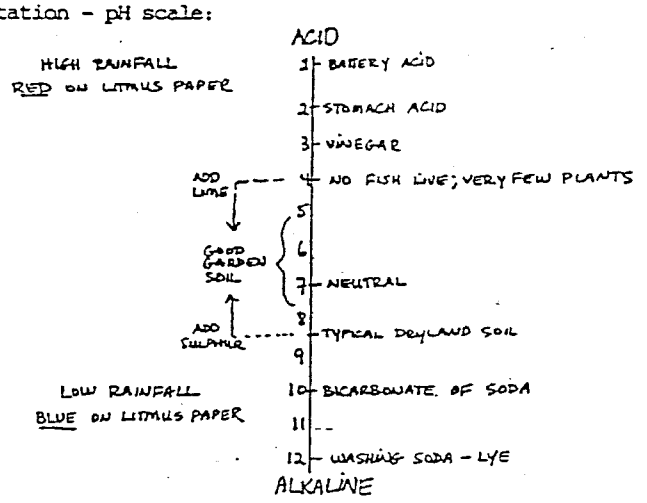
Desert: Nutrients plentiful, but need humus and water for release. Must concentrate on soil cycle, plant cycle, and water cycle in arid environments. Desert strategies are basically water-connected; great attention must be paid to "waste water" use in mulch, floodflow and runoff techniques. Deep-rooted trees need mulch plus drip irrigation in establishment. Mulch can be planted in deserts as legumes, tamarisk, casuarinas.

Of all of these, tropics and deserts most demand care and management. In temperate zones trees demand increased organic material in the soil.

SECTION 5. SOILS

A. Soil analysis and interpretation - pH scale:





B. Creation of humus in soil; can be done through addition of mulch, compost, vegetation, food scraps, manures, animal skins and bones, etc etc. May take 2-4 years to build up good garden soil. Humus solves the problems of too acid and too alkaline.

C. Difficult Soil
Alkaline areas expected in deserts, coasts and alkaline rocks. Acid areas expected in wetlands, bogs, high rainfall, uplands, siliceous rocks. Species suited to alkaline areas are mesquites, locusts, carobs, some pines. Species suited to acid areas are oaks, pines, blueberries.

Platin soil: islands--atolls and desert coasts. 18" deep a layer of calcium triphosphate, hard as concrete. Strategy: break up the platin layer, stuff with humus, and plant tree. Tree continues to break up platin and release phosphate nutrients.
Caliche : tropical equivalent of platin. Hills. Ferric silicate composition lies 1-1.5 metres below soil, often in rainforest. Best to leave forest as is.
Non-wetting: dryland areas --water rolls off. Caused by algael-fungal association which produces wax. Strategy: can be mulched (for small areas); mixed with clay or a commercial gel.
Clay : drainage problem. Mix with gypsum to help seepage (2 metres penetration); can also use gels to hold water.

SECTION 6. DESIGN FOR CATASTROPHE

Best strategy for design is to learn climatic and landform history of area and site. Use commonsense in siting houses, gardens to avoid major catastrophe, and design buildings to withstand such external energies.

A. FIRE

Criteria for fire control:

- Plant firebreaks of fire-resistant plant species
- Use plant species with little or no litter drop
- Damp mulched gardens
- Mulch pit and swales systems
- Ponds
- Use succulent ground covers, e.g. ice plant
- Use foraging animals to clean or rake up litter (e.g. "raked" soil of chickens)
- Paving of stone or tile; driveways

Criteria for plant species to assist fire control

- Species having a high ash content (least combustible material)
- Species which develop least dry litter as fuel
- Species which burn slowly and which are self-extinguishing
- Along roads and around houses are low-carpeting species
- Species which will extinguish (by competition) annual grasses that flash in fire
- Species that are easy to propagate by cuttings, divisions, runners, or offsets so that carpeting species and hedges are easy to develop
- Species which are not summer deciduous

- Summer green species, even where rootstock or fruity parts die off in winter
- Species which are heavy with large water storage; low fats, oils, or turpenes
- Species which are preferably of use as forage to bees, birds and small animals

Strategies for saving house in case of fire

- Gutters cleaned of leaves; or type of gutter that catches water, not leaves
- Pine screening on windows (in case of sparks)
- Put a tennis ball into the downpipe and fill gutters with water
- No bushes against the house
- White-painted, wooden houses best
- Have a tank or pond at house (all water pipes break during a fire)
- Rake up all leaves 100 feet around the house
- Fire comes up hill with greatest force so don't locate house on the ridge (have 2 fronts to fight)
- Keep larger, burnable trees upslope behind house

B. FLOOD, EARTH-MOVEMENTS

No cure once house is sited in wrong spot. Must make sure not to site on flood-plain (even if floods occur only once every 50 years) and don't put houses below deforested slopes (mud-slides).

C. CYCLONE, HURRICANE

- Site in sheltered place, even underground
- Use bamboo as a shelter; bends in the wind rather than breaks
- House design very important: high-pitched roof, 45° angles, cut stud into brace
- Have a back-up "famine garden" in very sheltered area

D. TSUNAMI

- Site main house and garden far enough away from tsunami area (which occurs as frequently as every 15 years), but can have "temporary" shack or smaller house near beach.

SECTION 7. BUILDINGS AND STRUCTURES

A. The temperate to sub-tropical house (Latitudes 30°-60°) Essential elements:

- Orientation of axis to sun
- Insulation and draft-proofing
- High thermal mass
- Ventilation
- Insulated ground under house
- Heat banks
- Cold banks and wall shading
- Attached greenhouse/shadehouse/water tanks
- Function and aspect of rooms (bedrooms on shade side, living and functional rooms on sun side)

B. The tropical house (Latitudes 0°-30°) Essential elements:

- Orientation to winds
- Shade on walls, valley shade, tree shade
- Reduction of mass
- Venting and air flow ducts
- Trellis and shadehouse
- Air scoops
- Tanks and cisterns
- Insect screening
- Guttering and rain catchment

C. The desert house

- Underground
- Patio structure
- Shadehouse
- Insulation
- Trellis
- Windbreaks
- Underground water tanks

D. Special houses

- Houseboat
- Bio-shelter (plant house)
- Earth houses
- Cave house
- Pond housing, reflective systems
- Flat land, earth-bermed house

E. Planting around houses

- Suntrap
- Windbreak
- Wall trellis
- Shade/heat: summer-winter use of deciduous and evergreen plants
- Roof trellis

F. Fencing types and locations

- Walls - stone and earth
- Hedges - live
- Combination ditch/hedge
- Trellis types (linear, radial, catenary)
- Electric
- Woven
- Railed

G. Integration of functions in homes

- Mud room and processing centre (saves money for individual and community)
- Commerce and light industry in home (alleviates social deprivation for many women with young children; saves money in petrol; good working conditions)

SECTION 8. APPROPRIATE ENERGY CONSERVING TECHNOLOGY

(For further information, see "Energy Paper #1" and "Energy Paper #2" by Bill Mollison, available from the Permaculture Institute (Australia).

1. Domestic

Conservation of domestic energy may be achieved by a set of strategies applied in combination and suited to specific sites and climates. Strategy sets are:

- Behavioural: active time of day, best use of natural daylight, and choice of clothing for climate.
- House design: house must be designed for climate, utilizing energy-conserving siting, use of plants, and use of structures such as greenhouse, shadehouse, ponds, etc.
- Technological: energy generation and choice of appliances.

Categories for technological strategies are:

- Climate control: space heating
- Cooking and cook-stoves
- Hot water supplies
- Electricity and lighting
- Washing and drying clothes
- Refrigeration and cooling
- Water conservation

A. Climate control: space heating and cooling

- Radiant heat (heats solid objects; massive stoves--slow to heat and cool; burn fuel at high temperatures; use small sticks & short burning time)
- Convective heat (cast-iron stoves)
- Greenhouse; shadehouse
- Trellis; air vents
- Conducted heat (usually large under-floor systems using water pipes or electrical wires connected to waste heat)

B. Cooking and cookstoves

- Wood-fueled (with hot water supply)
- Bottled gas, kerosene
- Solar cooking
- Haybox cooking (insulated container)

C. Hot water supplies

- Hose on roof
- Solid collectors
- Solar ponds
- Flat-plate collectors
- Bread-box collector
- Cylindrical collectors
- Trough collectors

D. Electricity and lighting

- Photovoltaics
- Wind power
- Energy-conserving lights
- Hydro-electric power
- Gas and kerosene lighting

E. Washing and drying clothes

- Hand-operated pressure washers
- Coin-operated washing machines shared by community
- Drying: airy and roofed (preferably fibreglass) area
- Drying in insulated cupboard surrounding uninsulated hot water cylinder

F. Refrigeration and cooling, food drying

- Photovoltaics
- Gas and kerosene
- Sun chimneys
- Fans

G. Water conservation

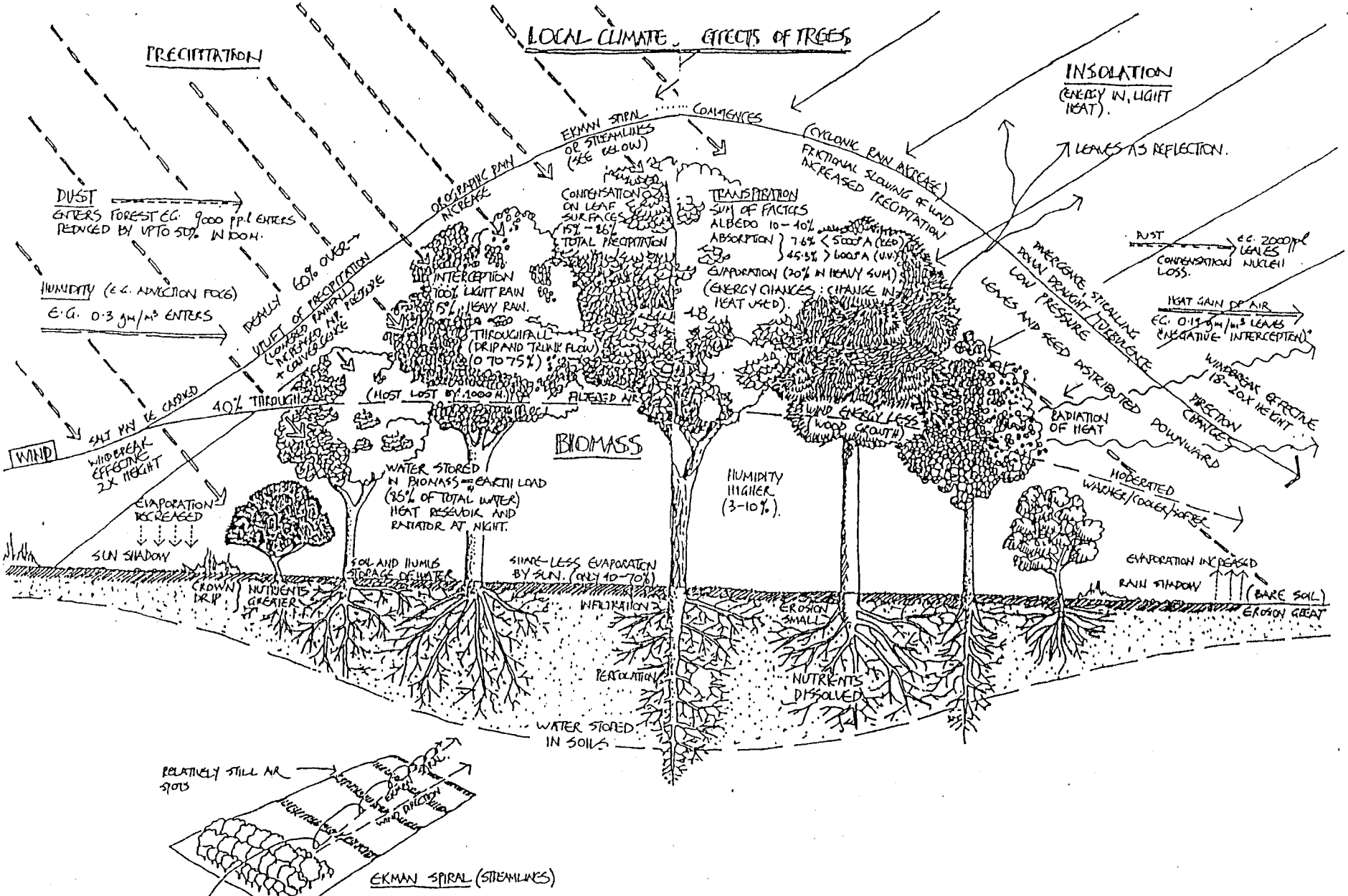
- Water tank off roof, ideally located uphill from house
- Hand-basin water to toilet
- Compost toilets
- Dual-flush toilets

2. Hydraulic Systems

- Pumps and waterlifts
- Hydraulic rams and pumps
- Water wheels
- Water turbines
- Hydro-pneumatics (air compression)
- Harnessing tide or stream flow

3. Biothermal Systems

- Woodlots
- Pyrolysis
- Compost heat (the Jean Pain system)
- Vegetable oils
- Gasification
- Biogas
- Metabolic heat


LOCAL CLIMATE. EFFECTS OF TREES
PRECIPITATION
INSOLATION
(ENERGY IN, LIGHT HEAT).
DUST
ENTERS FOREST E.G. 9000 pp.l ENTERS
REDUCED BY UPTO 50% IN 100 H.
HUMIDITY (E.G. ADVECTION FOG)
E.G. 0·3 gm/m³ ENTERS
WIND
WINDBREAK EFFECTIVE 2X HEIGHT
SALT MAY BE CARRIED
40% THROUGHFALL
60% OVER
USUALLY
OROGRAPHIC RAIN INCREASE
EKMAN SPIRAL OR STREAMLINES (SEE BELOW)
COMMENCES
(CYCLONIC RAIN INCREASE)
FRICTIONAL SLOWING OF WIND INCREASED PRECIPITATION
LEAVES AS REFLECTION.
CONDENSATION ON LEAF SURFACES 15% – 16% TOTAL PRECIPITATION
TRANSPIRATION SUM OF FACTORS
ALBEDO 10 – 40%
ABSORPTION 7·6% < 5000 Å (UV)
45·5% > 6000 Å (I.R.)
EVAPORATION (30% IN HEAVY SUM)
(ENERGY CHANGES: CHANGE IN HEAT USED).
INTERCEPTION 100% LIGHT RAIN 5% HEAVY RAIN.
THROUGHFALL (DRIP AND TRUNK FLOW) (0 TO 75%)
(MOST LOST BY 1000 H)
ALTERED AIR
BIOMASS
WIND ENERGY LESS (WOOD GROWTH)
INCREASE STEALING POWER DRAUGHT TURBULENCE
LOW PRESSURE
LEAVES AND SEED DISTRIBUTED
RADIATION OF HEAT
DIRECTION CHANGES
DOWNWARD
DUST
E.G. 2000 pl LEAVES CONDENSATION NUCLEII LOSS.
HEAT GAIN OF AIR
E.G. 0·13 gm/m³ LEAVES INTERCEPTED
WINDBREAK EFFECTIVE 15–20X HEIGHT
MODERATED WARMER/COOLER/DRIER
WATER STORED IN BIOMASS = EARTH LOAD (25% OF TOTAL WATER) HEAT RESERVOIR AND RADIATOR AT NIGHT.
HUMIDITY HIGHER (3–10%).
EVAPORATION INCREASED
SUN SHADOW
CROWN DRIP
NUTRIENTS GREATER
SOIL AND HUMUS STORAGE OF WATER
SHADE-LESS EVAPORATION BY SUN. (ONLY 10–70%)
INFILTRATION
EROSION SMALL
EVAPORATION INCREASED
RAIN SHADOW
(BARE SOIL)
EROSION GREAT
PERCOLATION
NUTRIENTS DISSOLVED
WATER STORED IN SOILS
RELATIVELY STILL AIR SPOTS
EKMAN SPIRAL (STREAMLINES)

4. Solar-Powered Devices

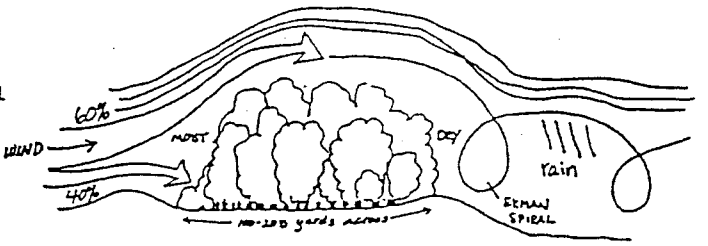
. Photovoltaic cells
. Solar ponds
. Swimming pools
. Solar chimneys

5. Wind-Powered Devices

. Fan mills
. Blade and propeller mills
. Wind kettles
. Savonious rotors

SECTION 9. FORESTS AND TREES

TREES AS ENERGY TRANSDUCERS: Wind, Sun, and Rainfall



Wind

1. 40% of incoming wind is forced through the trees, friction causes heat inside the forest (no frost). Outside trees have thicker trunks due to wind force; inner trunks are thinner.

2. Wind brings in dust and insects: at edge of forest there is fallout of these, so forest at wind edge receives more "fertilizer". Rain runoff also more plentiful at windward edge (high pressure of wind keeps the moisture in).

3. 60% of wind is forced up over the trees, forms and falls as Ekman spirals. Rain is caused by spirals if there is any moisture in the air. Trees can cause the moisture to drop because of the upward, forced spiraling of the wind. The spirals change direction depending on hemisphere (to the left in southern hemisphere).

Light

1. Light is absorbed, transmitted through, or reflected by the tree, depending on trunk colour, leaf shape and colour, and canopy (and also depending on climate).

2. Light absorption is mainly on crown for photosynthesis. A high light absorption tree is a radiator and is mainly found in low heat conditions (temperate climates).

3. Light reflection is also on the crown (in dense plantings) or all over the tree in the form of silver leaves. A reflecting tree is a light "producer" and is usually in low light conditions. In trees where bark is white, heat is reflected away from the trunk.

4. Transmitted light is red light, stimulates root growth.

Rain

1. Impact on crown causes some immediate evaporation (but in a dense planting, there is no impact on the ground, and so prevents erosion under the trees).

2. Each leaf is wetted; no water falls through the crown until all leaves are wet—tree intercepts rain.

3. Throughfall—water begins to drip off the leaves, towards the branches and trunk. Water now contains nutrients (dust, insects, plants nutrients).

4. Canopy drip feeds the surface roots; trunk drip feeds deeper ladder or tap root systems. Function of tap roots is mainly mining. Minerals are brought up to leaves and then washed off during rain to be used by the surface feeding roots.

5. Litter under tree impedes water absorption (3 inches of litter holds 1 inch water). Roots are then able to absorb what they need before water infiltrates the ground.

6. Infiltration--water coats all the soil crumbs (the tree roots can also soak the water up from the soil crumbs).

7. When ground reaches field capacity or saturation, water then slowly percolates to groundwater area.

Transpiration occurs when the process reverses from deep groundwaters, goes back up through the trees, and are released into the air as clouds. 60% of clouds inland (after the first rainfall of 100% moisture from the sea) are formed by trees.

The dust that rises off the trees is made up from bits of leaves and pollen, two sorts of bacteria that live on the leaves, and certain oils and waxes that exude off the leaves. At the centre of every raindrop inland (nucleus) is a dust particle off trees.

More water that comes to earth is condensation rather than rain. One tree can be as much as 20-40 acres of leaf area. Moisture is condensed at night because it is relatively cooler than the air or wind.

Trees put out negative ions (which attract positive ions, usually dust and pollution) so air around trees is healthy. Need a lot of trees in cities to counteract the positive ions in the air, which cause depression.

In forest ground water runoff is zero (100% vegetative cover). At 80% vegetative cover: 5% runoff; at 60% cover: 35% runoff; at 20% cover: 60% runoff. Severe soil loss occurs as vegetative cover is removed.

TYPES OF FOREST

. Fuel
. Food
. Forage
. Natural
. Structural
. Conservation
. Shelter; animal barrier

1. Fuel

Essentials are that least use should be made of solid fuels; barks and leaves should be returned to the soil or the system will degrade.

. Liquid fuels: Species yielding sugars for conversion to alcohol (toddy palm, carobs, fruit trees), or directly to fuel (copaiba). These are permanent trees.

. Solid fuels: Either as cones from nut pines, fallen wood, thinnings, or short-term forest for soil creation (Acacia, Leucaena)

. Gas fuels: Coppicing for conversion of biomass via composting for methane collection.

2. Food

. Orchards, usually intercrop (fruits, nuts)

. Use of food trees to support vine crop

3. Forage

. Design forage trees into Zones II, III, IV for small livestock, sheep cattle. Livestock will eat leaves, fruits, nuts off many trees (some need to be fenced off or allowed to grow large before livestock are put in). Trees include: those that drop fruit (mulberry, Coprosma, boxthorn, fig, etc.); nuts (oak, chestnut, etc.); pods (Acacia, carob, honey locust); and green leaves (pampas grass, banna grass, tagasaste)

4. Shelterbelt and animal barrier

. Windbreak around house and farm site
. Select species that provide forage, shelter, and act as a barrier hedge (e.g. pampas grass, Coprosma)

. Shelter for animals and as protection for crop (can put 20% of ground into shelter without loss of productivity)

5. Structural

Range from bamboo to black walnut, and short to long term cycles. Uses for:

. Round pole (poplar, locust)
. Sawn timber (long-term and old forests)
. Industrial use to cellulose yields
. Craft uses (rattan, bamboo)

6. Natural and conservation

Forests have an intrinsic worth: beauty, nesting sites for birds, creators of oxygen, clean water supply, rain and moisture, and soil. Prevent erosion, deflect winds, bring nutrients up from the ground.

ESTABLISHMENT OF FOREST

. Select species of use (timber forest, fuel, etc) and design for placement (crown bearers and flower bearers on outside of clump; stem and forest inside). Shrubs may last only 10 years, pioneers may last only 20.
. Pioneer species can establish essential conditions for forest (nitrogen-fixation, nutrient build-up) on poor soils.
. Important to establish trees in a clump (fed by several drippoints if necessary) as these will support one another. Individual plantings tend to get ignored, and are often droughted, wind-pruned, and smothered by grass competition.

FOREST MANAGEMENT

. Thinning
. Fire
. Coppice
. Standards
. Selection
. Nutrients

SECTION 10. WATER IN LANDSCAPE

Water as a rare mineral; it is the world's most critical resource. Fresh water is only 3% of all water (the rest is in the oceans). Of the fresh water:

Ice sheets and glaciers : 75%
*Available ground water (less than 2500' deep) : 11%
Deep groundwater & aquifers (2500' to 12,500') : 14%

* Lakes & ponds, surface : 0.3%
* Soil moisture, forests : 0.06%
Rivers : 0.03%
Atmosphere : 0.035%

* These are storages we can influence locally (as below)

Duties of WAter: The idea is to use water as many times as possible before it passes through the system.
Duty #1: To procreate life (in growing organisms)
Duty #2: To develop productive water systems (aquaculture). Yield of system increases as life increases.
Duty #3: To develop hydraulic uses for energy production (pumping water, generating electricity and mechanical take-off).

In particular we can:

- Increase surface storages
- Reduce runoff
- Decrease evaporation

The essential techniques are:

- Soil storage (rehabilitation of compressed and/or sealed soils)
- Swales (soakage to high groundwater)
- Mulch (prevention of evaporation)
- Small surface storages (dams and tanks)

A. Soil storage: rehabilitation of compressed soils mainly by Keyline methods, including chisel ploughing, for increased soil aeration.

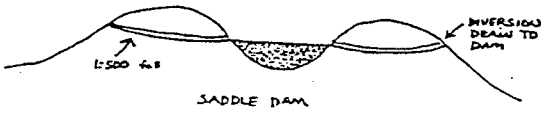
B. Swales: level grooves to hold water momentarily to keep it from running away rapidly downhill. Water soaks into the ground, and eventually ground slowly charges up with water. Trees planted either side will thrive. Village Homes, Davis, California example of diverting all surface waters into the swales (with 15" rainfall)—recharged groundwater supplies to 17 feet in 4 years.

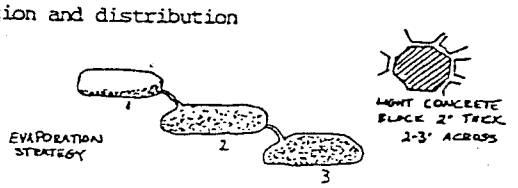
C. Mulching: imitation of forest floor--reduces evaporation, prevents erosion, and builds up soil. Easier to achieve in small areas, but can also use "mulch trees" such as Leucaena, Casuarina, pines.

D. Small surface storages: tanks at houses for freshwater supplies; small ponds in gardens, nurseries (for frogs), stock ponds, steep hillside pathends.

DAMS

- Types (saddle, valley, contour, open storage)
- Diversion and distribution
- Placements



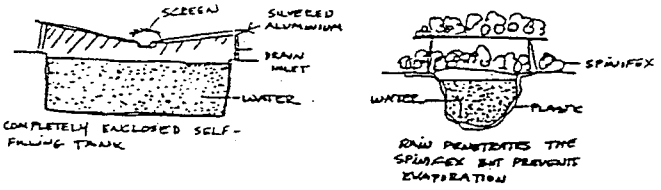


Evaporation strategy: Make 3 smaller dams (instead of one big dam), one above the other.
1. Use from dam 1 until it gets down, then pump into dam 2 and use from there. Then do the same for dam 3. This cuts the evaporation rate.

2. Float light concrete on top of dam (use polystyrene pellets instead of gravel) and paint white (which reflects the sun.

3. Pour olive oil or wax (cetyl alcohol) on water to fill the spaces in between the blocks.

Large roofed tank: used in Australian deserts



Try to catch and hold the water as high as possible. Most runoff occurs from sealed surfaces (e.g. roads and tin roof). Yeomans recommends dams should take up 15% of land area. Cater for this water by swaling and keyline ripping, then planting along swale or rip.

IRRIGATION SYSTEMS

- Drip or trickle, especially in dryland situations
- Flood irrigation (surface and sub-surface)
- Sprinklers (not efficient, build up salt in soil)
- Under canopy

Components of irrigation system

Water source: dams, bores, soaks, runoff, swales, pipelines, creeks, tanks, lake
Energy source: water at head, pressure with pump (electric, fuel, wind, hand or animal)
Distribution network: net and pan, pipes, channels, buckets
Emitter: dripline, sprinkler, bucket

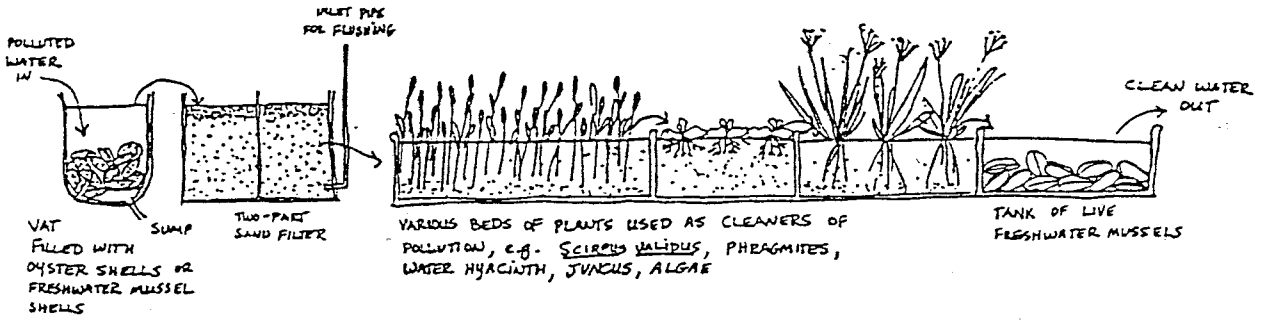
Irrigation rules (Arid regions)

Irrigate under mulch (reduces salt problems and increases irrigation efficiency
Irrigate at dusk or night if possible (put on a timer)
Give long watering every 3-5 days rather than a little bit every day (increases leaching effect, particularly for salt; and take water down—the tree's roots are bigger in the cool soil: desert strategy)
Allow for leaching

ASTE WATER

learing polluted water (Source: Max Plancke Institute, "Contributions to Revitalisation of Waters" by Seidel, Happel, Graue; Am Waldwinkel 70, D 4150 Krefeld-Hulserberg, W. Germany)

ater may contain acids, heavy metals, chlorinated hydrocarbons, radio-actives, E. coli, nitrates, salts, ilt and soap which render it unfit for human consumption. The following system is recommended for cleaning olluted water:



se of waste water

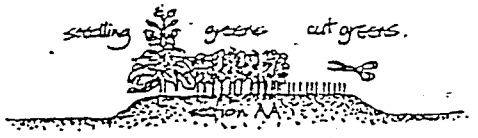
ischarged to non-food forests or nut crop, essential oils, and bamboos.
reywater: pipe to mulched gardens or by root-level drains below paths.
se in glasshouse for heat production, or methane production.

ECTION 11. THE CULTIVATED ECOLOGY

ONE 1: HOME GARDENS

one 1 needs very careful design, particularly focusing on access and schedules. Starting from kitchen teps:

. The herb spiral: 1 metre high, contains plants which are constantly used—the herbs: mints, thyme, marjoram, rosemary, sage, basil, etc.
. The lemon or lime tree: Must be close to the house as it is often used; can stay ripe on the tree a long time.
. The clipping beds for small salads: chives, parsley, mustard greens, corn salad, garden cress.
. The pathside plucking vegetables: long-bearing vegetables for salads & cooking that can be cut, or have leaves pulled for months of yield, e.g. silver beet (Swiss chard), Brussels sprouts, celery, kale, dill, capsicum (bell pepper), bunching onions, broccoli, spinach, zucchini, rhubarb.



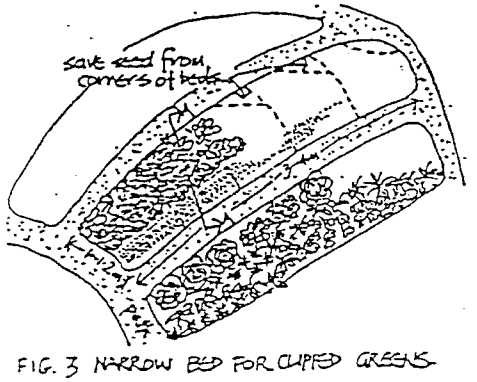
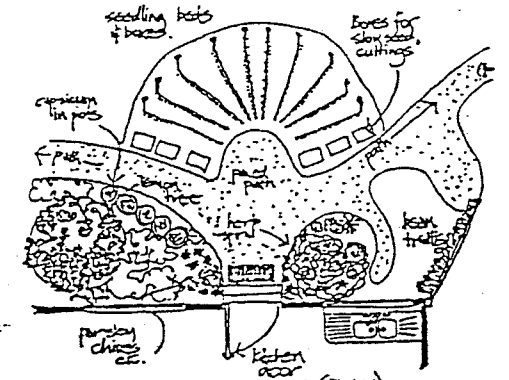


FIG. 3 NARROW BED FOR CUPPED GREENS



: AT THE KITCHEN DOOR (PLAN).

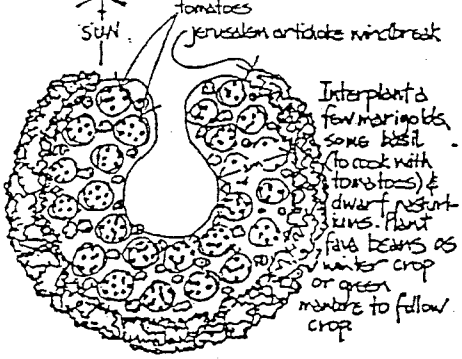
FIG 4. THE PATHSIDE VEGETABLES (FILL IN

Narrow bed plants: Must be able to move easily around the bed for easy harvest. Vegetables include asparagus, peas, beans, carrots, eggplant, lettuce, tomatoes.

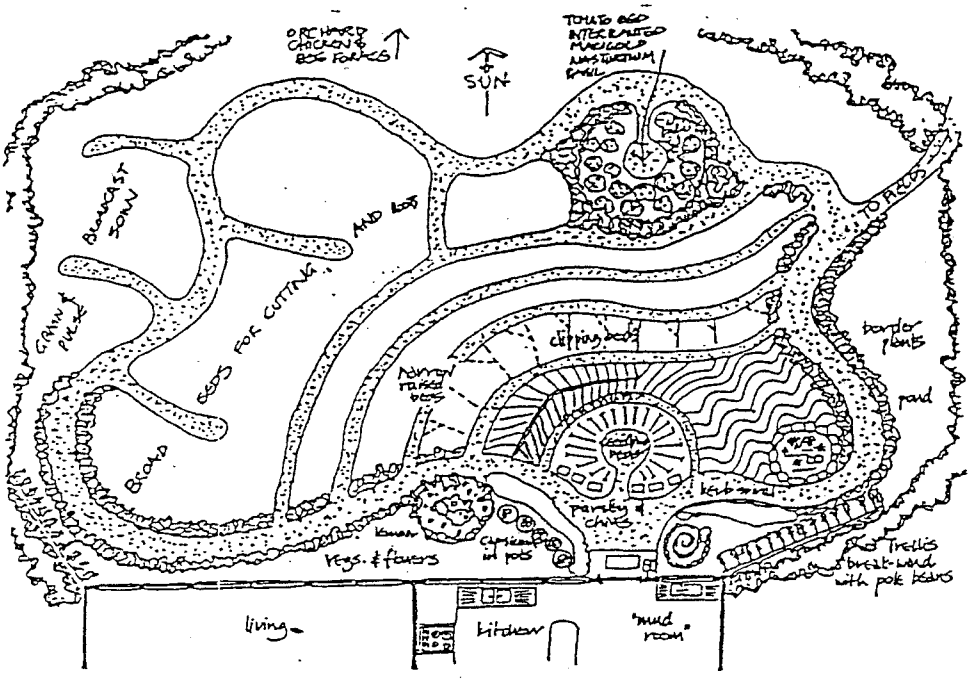
Broad beds: here are planted the basic brassicas, lettuce, root crops that are close-spaced, self-mulched, and are block-planted to be cut over a period, e.g. beets, turnips, leeks, kohl rabi, onions, melons, parsnips, cabbage, cauliflower, Chinese cabbage, pumpkin, globe artichoke, potato.

Broadcast sown grain and pulse crop, e.g. Fukuoka-style grain plots. Here can be planted successions such as rape-sweet corn-buckwheat; rice-rye-clover.

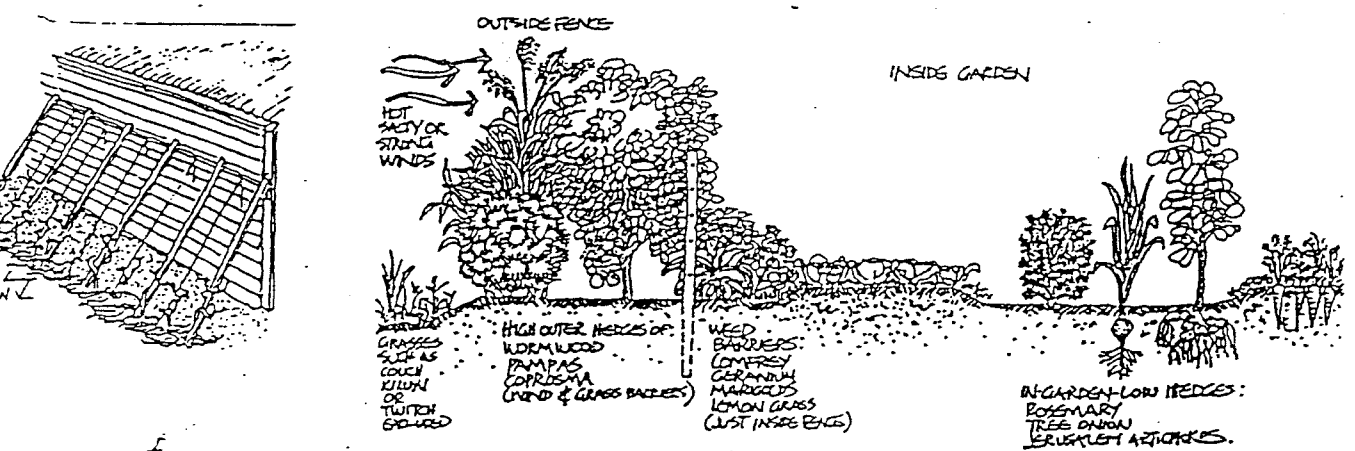
Vine and trellis crop, e.g. cucumber, pumpkin, passionfruit, jicama, peas and beans



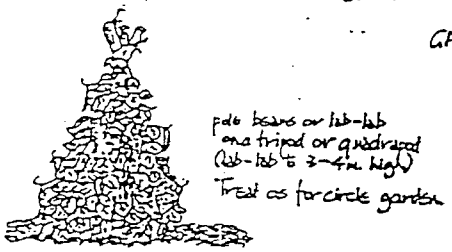
TOMATO BED.



: AN IDEAL KITCHEN GARDEN LAYOUT FOR SOUTHERN AUSTRALIA.



GARDEN WEED BARRIERS/HEDGES.



CLIMBERS & VINES

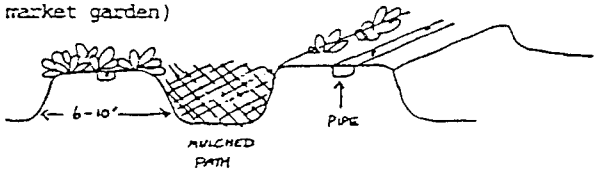
Laying down the garden

Approach 1: The instant garden

a) Sprinkle some manure, nutrients on ground (or grass) to encourage worms to come up; water well.
b) Lay down thick wet newspaper, cardboard, carpet underfelt, or carpet (not with plastic backing).
c) Cover with thick layer of mulch (straw, old compost, any seedless mulch) Water well.
d) For transplanting potted plants, uncover mulch, cut through cardboard, and fill area with a couple of handfuls of soil; transplant and water well.
e) For large seeds (broad beans, sunflowers, peas, etc.) simply plant under the mulch and water every day.
f) Small seeds: prepare area of soil, plant, water, and lay board over the area. Remove board and water daily.
g) Potatoes: simply plant under the mulch.

Approach 2: Rows, pipes, and mulch (for large area market garden)

a) Make level beds
b) Lay 3/4" pipe down the bed, and drill holes every 4 feet; wrap stocking around hole
c) Mulch entire area, even the foot-paths



Zone 1 intensive animals:

- Pigeons
- Guinea pigs
- Bees
- Quail (can be in glasshouse to control insects)
- Rabbits
- Worms

ZONE II. ORCHARDS AND SMALL LIVESTOCK

Orchard system

- Food trees mixed in with non-food trees to confuse pests and encourage pest predators.
- Nitrogen-fixing trees should also be included, e.g. leucaena, acacia.
- Combined poultry-ground cover planting for manurial resources
- Ground mulch plant species
- Barrier plants around trees to compete with grasses.
- Fire and wind protection needed (select appropriate species).

Small livestock for Zone II

- Bees
- Poultry
- Ducks
- Geese
- Pigs

Bees

- Careful placement to avoid stings, windblast
- Mid-season honey (Buddleia, brambles)
- Pollen and early honey (willow, rosemary, Echium)
- Late flows (leatherwood, forest trees)

Poultry

- Placement of poultry house and range for best advantage (manures, scratching for insects)
- Seed species
- Pod and acorn species (lucerne, Coprosma, Lycium, oak, locust, carob)
- Cover from predators (thorn and shelter)
- Choice of breed for situation (light breeds, heavy breeds, colour, behaviour differences)
- Greens (comfrey, oxalis, chicory, cleavers)
- Vines (passionfruit)
- Fruits (all fruits)
- "Medicines" (oxalis, cleavers, dandelion)
- Grit/sand/shell
- Water
- Chicken "tractor" in fallow gardens or fields to remove pests, scratch out seeds, deposit manure, help in fire control (making bare ground)

Pigs

- Forage: sunroot (J. artichoke), comfrey, lucerne
- Kitchen and market scraps
- Oak/acorns

ZONE III. EXTENSIVE FREE RANGE, WILDLIFE, BROADSCALE SYSTEMS

Broadscale systems, forage systems

Fukuoka 'no-tillage' system of sequential rotation; sustainable and soil building.
- Need to research and experiment with local crop timetables

Use of leguminous trees (Acacia, Leucaena) as pioneer species to improve soils for later orchard plantings.

Self-forage for sheep, cattle

Windbreak systems

Water systems development (large impoundments)

Fences and gates

. Annual grasses . Perennial grasses . Sugar pods (summer)
. Carbohydrates (winter) . Winter twigs and bark

Browsing animals like Coprosma, tagasaste, pampas grass, banna grass (Pennesetum purpureum), leucaena, comfrey, willows, poplars, honey locust and carob pods.

On intensive tree forage systems, stocking rate can be up to 14 animals per acre, rather than 1 per 20 acres. Watch out for compaction, especially on low country in winter.

Goats and peacocks are a "no-no" on farms; if must have goats, use Rosa rugosa, roses, blackberries, and boxthorn; also tagasaste.

Important book, "Fertility Pastures and Cover Crops" by Newman Turner, available from Bargyla and Gylver Rateaver, Pauma Valley, California 92061. Discusses herbal pastures, particularly for dairy cows. Also "Herbal Handbook for Farm and Stable" by J. de Barclay-Levy, published by Faber & Faber, London.

RANGELAND MANAGEMENT

Well-managed rangeland is very productive, contains wildlife, fodder trees, windbreaks and shelterbelts, herbal pastures, rotated pastures, fenced appropriately. Must not be over-stocked.

URBAN PERMACULTURE
(More information on urban strategies for land access in upcoming sections on the "invisible structures of settlements")

. Take over the lawns in urban back and front yards for fruit tree and vegetable production
. Use dwarf varieties of fruit trees, or espallier prune against fences
. Put glasshouse onto sun side of house for vegetables; quail can also be kept there
. Small animals can be kept if local ordinances allow it (poultry, quail, guinea pigs, bees, rabbits)
. Reduce lead levels by screen planting of non-edibles near roads
. Plant in small areas: window-boxes, porches, near door outside, onto roof (if flat)
. Organise with like-minded people to plant in a local community garden

THEMES

RAMPANCY (Species which become troublesome by occupying large areas, or occuring in great number).

Plants: reasons for rampancy

. response to damaged or vacant niches in environment . Often species which are efficient & drought-resistant

Specific response:

. To grazing: lantana, Patterson's curse, thistle
. To fire: Erechthtites, fireweed, bracken
. To chemical changes in soil: sedges, sour-grasses.
. To exhaustion of soil: bracken, moss, pioneer species such as blackberry, thistle

Dealing with rampant species with assisted evolution

Use succession plants, e.g. groundsel—wattle—gum. Help succession by slashing/fertilizing/planting of suitable species/ spreading seeds

Interplant fruit trees and cattle grazing (extensive); goat/pig grazing (local); carpet mulch on small areas (garden), e.g. blackberry/bramble

Slash and interplant, e.g. lantana, especially shade species (pigeon pea, plantain, mango) and vines (chayote, passionfruit).

Rampant species protect and mulch soils, provide bee forage, and protect subsequent evolutions/successions.

THE FUNCTIONS OF ANIMALS IN THE SYSTEM

Are the mobile elements of the forest
As pollinators, many are specialized for species (bees, wasps, butterflies, moths, flies)
. Are nutrient sources, e.g. bat, poultry, bird guano
. Are soil aerators, e.g. worms, dung beetles
Are seed distributors (ducks: algae and sedges; emu: hard seeds; cattle, seeds of sugary pods; dogs and foxes: loquat, grape, lychee; jays: oaks)
Are regulators: Of forests (weeder species in evolution of forests)
Of other animals (predation to regulate population)

osses in establishment often greatest cost to client. Design to minimise)

Water (critical factor) needs first priority
Wind shelter may be critical in the case of citrus, avocado, etc.
Nutrients, e.g. phosphates for young pines; leguminous trees recommended
Soils: better to rehabilitate and lose a year than to persist in poor soils.

- Species choice, especially in grassland competition, e.g. tagasaste, pines, oaks more successful than cultivated fruits
- Protection needed from browsers (thorn, fence, stone, electric barriers)

CTION 12. AQUACULTURE AND MARICULTURE

ee also "Useful Plants of Wetlands" by Bill Mollison, available from Permaculture Consultancy, Australia)

QUACULTURE

Select species (plant and animals) for pond size
Set up self-forage systems for fish

nd Sizes

Mini-ponds in gardens; use for breeding frogs, water chestnut, watercress, taro, kangkong (water convolvulus).
300 + sq.metre ponds: fish, prawns, marron (need fence), eels, bait fish, Tilapia, freshwater mussels (must research habits of all--some will eat others if put in same pond)
Plants: various from edge (blueberry) to reeds (water chestnut), emergent (wild rice), marginal (Glyceria), overhanging (mulberry, willow)

lf-forage systems

Insectory plants at pond edges attract insects (many fall into the water)
Plant heavily around edges to attract nesting and feeding birds--these deposit manures onto the water, which supply detritus feeders. Ducks and fish are an excellent high-yielding combination on ponds.
Trellis crop and overhanging trees important, e.g. silkworm on mulberry trees provide manure, their own bodies, and bits of leaf for fish below.
Provide insect traps over water for fish-feeding, e.g. a yellow balloon over water will attract grasshoppers; a baited fly-trap will provide hundreds of flies; a black-light with a fan will fan insects into the water, etc.

MARICULTURE

Mangroves and estuaries

- Mangrove spp. : mulch effect will supply detritus feeders
- Plants: intertidal and sub-surface useful plants are Zostera, Spartina)

- Mangroves hold sand and start off the food chain
- Estuarine ponds: controlled for oysters, mullet, flatfish.
- Natural food trap systems (as above and use of sea organisms)

dal areas

portance of fish traps
ft cultures: rig nets for fish; rope for ssels; plants and nest sites.
Phosphates: sea platforms, roosts, nests.

- Rack and substrate cultures (mussels, oyster, algae, sponges, octopus)
- Reef cultures: tyres for fish; pipes for crayfish; pots (octopus)

sh convert algae and weeds into usable protein at high levels of efficiency compared with mammals.
lluscs, especially Unio fix nutrients in mud for land cycle, dry crop cycle, and extract calcium.

CTION 13. WASTE DISPOSAL AND RECYCLING

ter and plants as cleansers of system pollution

Fix excess nutrients: watercress, rushes (e.g. Scirpus validus), water hyacinth
Algae, e.g. Spirulina: desalinates; cleanses; removes radioactives; builds protein from nitrates and nitrites; has a high BTU value; is 68% digestible protein; and has low cellulose.

es of waste water:

wage lagoons: aeration, weeds, and waterfowl--then goes to fish and finally discharged to non-food rests, nut crop, essential oil crop, bamboos.
e also page 14 of this manual for more information.

SECTION 14. WILDLIFE MANAGEMENT AND BIOLOGICAL PEST CONTROL

WILDLIFE MANAGEMENT

Encouragement

- Species to encourage: insectiverous birds, ground birds
- Forage: extension of Zone II hardy forage systems and pioneer species, especially tagasaste, oaks, pines, locusts (honey and black)
- Provide water
- Provide shelter: hedgerow, escapement into dams, rockpiles, logs and litter, rough places
- Mowing: strip mowing for stability, mulch, seed crop. Permanent unmown strips needed.
- Corridor into Zone I

Discouragement

- Trap and cull systems for targeted noxious species
- Increase bias towards chosen species
- Provide no escapement, shelter, food, or water

PEST CONTROL

Integrated pest management

- Use of animals in pest control, e.g. frogs (pear slug, caterpillars); guinea fowl (grasshoppers and insects); ducks (snails and some slugs); lizards (slugs and caterpillars); dragonflies & dragonfly larvae (flies, mosquitoes); predatory wasps (smaller insects, egg parasitism of some species); bantam chickens (cutworms, slugs).
- Mixed planting in orchards & gardens to encourage predator species, i.e. birds, wasps, beneficial insects.
- Sound management and husbandry practiced to discourage soil and leaf pests.
- Use of plant-derived insect sprays, e.g. pyrethrum, extract from the neem tree (Azadirachta indica).
- Use plant competition to control land and aquatic weeds
- Release of biological fungus and bacteria to control pest populations, e.g. Bacillus thuringiensis
- Use of insect traps and behavioural chemicals
- Artificial feeding and attractants to induce predator species to orchard or garden site.
- Mechanical management and barriers: handpicking off insects and snails; sticky goo around trunks of fruit saplings to discourage climbing insects; diatomaceous earth around garden beds to discourage slugs/snails.

SECTION 15. SEEDS AND NURSERIES

- Seed saving - collection and exchange (Kent Whealy system)
- Perennializing annuals - how to reduce the need for seeds
- Need for specialized, permaculture nurseries for unusual plants, e.g. bamboo, palm, cacti; and for forage species, e.g. pampas grass, tagasaste, Coprosma
- Seed companies (buy from small, non-hydridized stock)
- Seed legislation (P.V.R. in U.S.; U.P.O.V. in Europe)

1. RECYCLING IN THE COMMUNITY

(For further information, see "Bioregional Organisation" by B. Mollison, and "The Fiscal Economy of a Village Community" by B. Mollison and Reny Slay, available from Permaculture Institute, Australia).

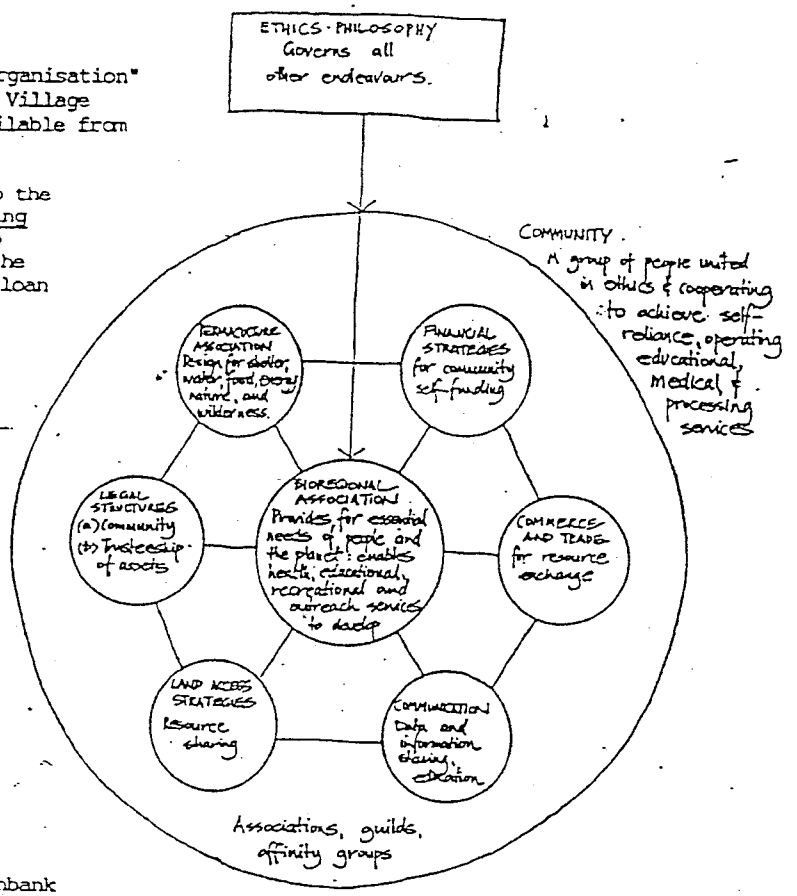
A worthwhile goal of any community is to keep the money saved and earned in the community cycling within itself. The only way to do this is to establish financial and economic systems in the community, such as a credit union, revolving loan fund, or local currency.

Community economics falls into 2 broad categories:

- The informal economy, e.g. barter
- The formal economy, subject to accounting procedures

A. THE INFORMAL ECONOMY

- Work groups cooperating to accomplish projects
- Community barter clubs operating on a system of "debits and credits" for the exchange of goods and services.
- Purely volunteer labour to the group or community.
- Informal bartering within the community



B. THE FORMAL ECONOMY

- Consumer-producer cooperatives
- Community savings and loans
- Bioregional currency systems
- Leasing systems
- Earthbank

1. Producer-consumer cooperatives

- A cooperative is a group of people acting together for the benefit of members; principles are:
  - Open membership
  - Cooperation
  - Strictly limited interest on share capital
  - Surplus/savings belongs to the members
  - Education
  - Democratic organisation
- A producer-consumer cooperative both buy from, and sells to, the community. Money is circulated within.

2. Community savings and loans

Revolving loan funds provide capital to community-based groups as well as technical assistance; they also develop networks of lenders and borrowers. Some examples:

S.H.A.R.E. PROGRAM (Self-Help Association for a Regional Economy, Great Barrington, Massachusetts)

Non-profit organisation formed to encourage small businesses that are producing necessary goods and services for the community. Works in conjunction with local bank. Members open a SHARE account (6% interest); loans are 10% interest. Borrower must show that proposed business will be a success by: (1) references of past experience & character, and (2) getting support from the community.

C.E.L.T. PROGRAM (Community Enterprise Loans Trust) New Zealand)

Charitable trust which promotes and supports cooperatives: provides advice, runs training sessions, and acts as a savings and loans organisation. The borrowing criteria is (1) must be a cooperative group, and (2) the cooperative must be willing to work closely and regularly with CELT during the loan so that it has the greatest chance to succeed.

CREDIT UNION

Credit unions must have a unifying common bond that links the membership together. They have a purposeful non-profit structure and are owned by the depositors who are shareholders and are organized for the benefit of the members, providing both the normal banking services as well as financial counseling and guidance for members.

Credit unions are harder to start, and must comply with governmental regulations by having a common bond (occupational, associational, and community) and by demonstrating the need for starting a new credit union and the support to sustain one.

2. Local currencies

Already there are many "currencies" in the form of vouchers, coupons, and tickets. These can be traded for goods and services. On a community level, these vouchers or currency can be based on a real asset of the community, e.g. wood, clean water; a community services council could print, back up, and handle the currency, which can be exchanged for most goods and services in the area. The community can then start community projects with the money. Businesses starting up can "pre-sell" their services in order to get start-up capital.

3. Earthbank

The Earthbank Society in Australia and EarthBank Association in U.S.A. exist to gather data on current alternative economic and financial strategies, and to assist in setting up ethical financial systems in the region. Local earthbank societies must be started in every bio-region. For lists of revolving loans funds, ethical investment banks and associations, and examples of community self-help systems, subscribe to Permaculture Journal, Australia (for Earthbank News) and EarthBank News, U.S.A. (Addresses in Resources section).

4. Leasing Systems

Any community, group, or individual can run a leasing service for others. A group may get together to purchase an item (i.e. vehicle, photocopier, mulch chipper) for lease to the general community (ie. by the kilometer, piece, or hour). The charge applied must pay for purchase, maintenance and replacement costs (within a period of 2-5 years, depending on the item purchased).

LAND ACCESS AND URBAN SYSTEMS

- Oxfam (land-lease) system
- City farms
- City as farm; and gleaning
- Land trusts and trusteeship
- Farm and garden clubs
- Farm-link system
- Commonworks

. Oxfam (land-lease) system

A regional office is needed to link landless people in the city with those (usually pensioners) who have a large lot or back-yard that needs tending. Regional office prepares a standard lease specifying rental (if any), goods exchange, length and type of lease, and access. Office should make a small service charge for this and many other urban services (the function of a bioregional office is to serve the community)/

. City Farms

Very popular in the U.K.--Associations lease or are given land, and a management group is appointed. On this land, the following activities are promoted:

- Demonstration gardens/allottment gardens
- Domestic animals kept; used as demonstration and breeding stock
- Recycling centre for equipment, building materials
- Family/community meetings and picnics
- Tool rental and access
- Gleaning operations (see below)
- Plant nursery
- Seed, book, plant, & general retail sales
- Seminars, demonstration, training programmes, educational outreach

. City as Farm; Gleaning

Surplus city product is collected, sorted, packaged (if necessary), and retailed. Example is of man in Melbourne who makes a living collecting and selling chestnuts from backyards. Gleaning operations can even take place in country areas near the city for distribution to community groups, the poor, the general public, etc. Another strategy is to provide a service (mowing, pest control, manuring, fire control) by ranging sheep, duck, or geese flocks in city backyards or lots.

. Farm Link

Appropriate to high-rise or rental families in an urban area. 15-20 families link to one farm in the nearby country, thus providing a farmer with income and themselves with fresh, inexpensive fruits and vegetables, wheat and meats (depending on the arrangements made with the farmer). The families should meet quarterly (or have a representative do so) with the farmer to make seasonal choices. As the "link" grows, the system can also accommodate:

- Holidays on the farm
- City (family) help on the farm at busy periods
- Educational workshops

. Farm and Garden Clubs

These suit families with some capital to invest as shares, with annual membership dues. A farm is purchased by the club or association, and a manager (if necessary) is appointed. Depending on the aims of the association, farm can be used for a variety of purposes: food growing, holiday retreat, woodlot and forest establishment, fishing, etc.

. Commonworks

A farm held by a land trust near the city arranges a series of special leases for a variety of purposes and businesses (forestry, livestock, teaching, crafts, dairy, brickworks, and other complex enterprises). Some of these are land (area) leases; others activity leases. 10% net profit is returned to the Commonwork Fund for land to be developed for further leases. One such farm in Kent, U.K. demonstrates the best model of such farm use at the highest level (send $2 for information from: Commonwork, Bore Place, Chiddingstone, Edenbridge, Kent TN8 7AR, U.K.)

. Trusteeships and land trusts

In order to acquire land (without purchasing it) for community or public purposes, must set up a public charitable or non-profit trust (more information follows in other section). Once the trust is formed, it is in a position to advertise for, and receive, gifts of land and funds.

LEGAL FORMS

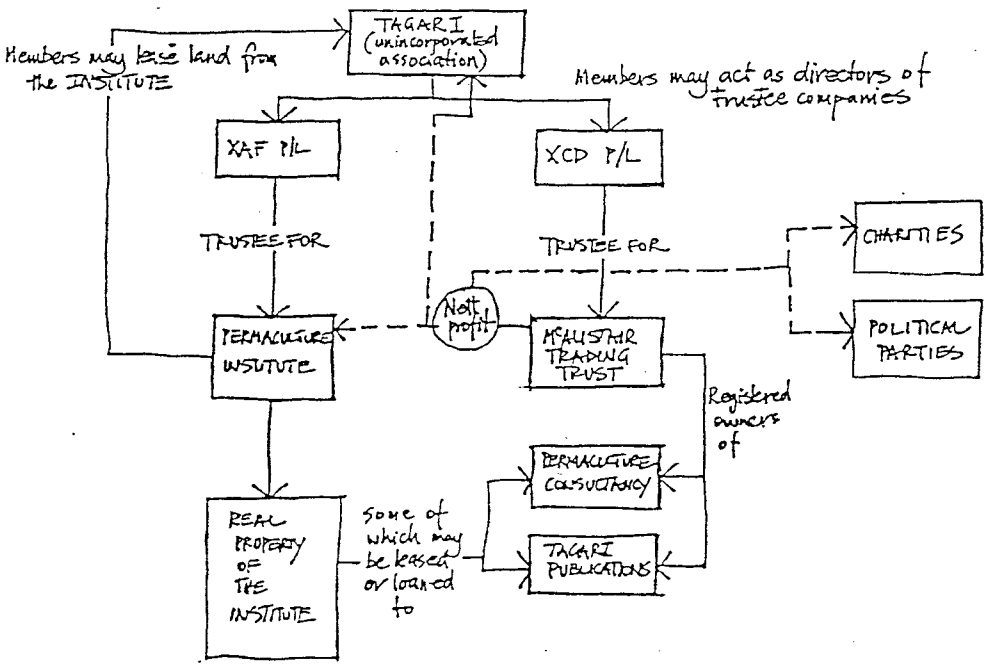
. Discretionary trusts
. Subscription trusts (investment trust)
. Charitable trusts

. Discretionary Trust

. Conducts affairs as any normal business; only difference is that it does not keep any profit but rather distributes it to beneficiaries. The company does not pay tax if it distributes its income, but the beneficiaries are liable for personal tax. Trust has a trust deed (statement of purpose), Board of Directors, Secretary, annual general meeting, and can own business names. (In the case of McAlistair Trading Trust, for example, it owns the business names "Permaculture Consultancy" and "Tagari Publications"--see below for schematic drawing)

. Non-Profit, Education, Charitable Trusts

. Set up for the public good; may accept gifts and donations (of lands and goods) from the public and other trusts (e.g. the discretionary trust described above). Directs the money towards its stated aims (as described in its trust deeds). Also has a Board of Directors and must follow the legal rules. It is immune from taxation, and may apply also for tax-deductible status (for people gifting goods and property).



Investment Trust

Groups get together to advertise for investment funds (or even donations) from the public in order to invest in ethical propositions, particularly purchase and renovation of degraded land, village developments, bioregional development, and purchase of forested areas. The emphasis would be on rehabilitation--both social and environmental.

VILLAGE DEVELOPMENT

(For further information, see "Outline for Permaculture Village Development" by B. Mollison, available from Permaculture Institute, Australia)

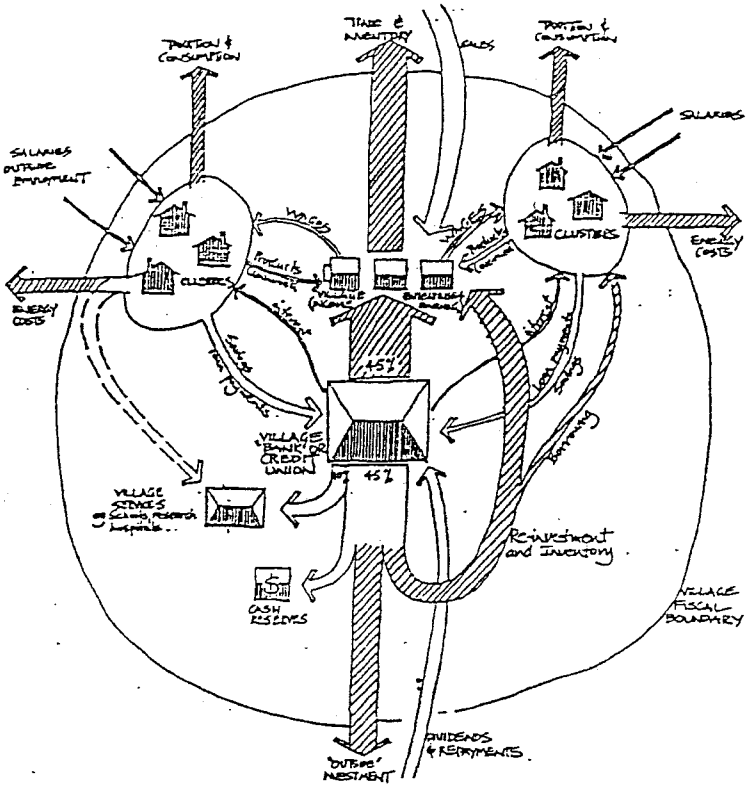
- Forming the management group
- Location of site or formation of group
- Arranging site option or purchase terms
- Obtaining agreement from local shire (may require extnesive planning and environmental reports)
- Obtain sealed permission for subdivison, cluster title, strata title from local authority
- Do careful sums (for roading, purchase, sewage, water, eletricity supply, etc.)
- Prepare a detailed and careful site plan & proposal
- for the village
- Sell to clients by advertisement (if group not formed previously)

Village Infrastructure

- Private housing
- School, seminar, and workshop rooms, craft, community area
- Food processing centre, cafe, commercial or surplus sale (open-air Sunday market)
- Retail shops; "tourist" facilities
- Dairy processing centre
- Domestic livestock housing (chickens, goats, pigs, sheep)
- Common areas for recreation, woodlot, building materials (poles)
- Domestic and commercial crop areas
- Water storages and reserves
- Wildlife and forested conservation areas
- Village revolving loans fund

Potential Enterprises & Occupations

- Food provision
- Energy provision
- Vehicle and tools
- Financial
- Medical
- Building
- Services (accounting, typing, computer)
- Repair
- Craft
- Trade (retail)



SCHEMATIC OF CAPITAL FLOW WITHIN AND WITHOUT A VILLAGE.

The aim is to keep as much money as can be usefully & productively used within the system; thus to reduce taxation, consumption of outside resources, energy costs, & outside investment, and to return resources to income and consumer products within the village.

Consumption is reduced by life style change, vehicle sharing, etc.
Taxation is reduced by legal strategies
Energy, by technological strategies & conservation.
Trade, by developing local resources.

Little of this is possible unless investment, via the village bank, is controlled by the village.

Village Homes, Davis, California

- Stores all surplus storm-water into swales for groundwater recharge
- All buildings face the sun and contain solar devices
- Streets narrow with few parking spaces (but enough) to cut down on heat build-up from streets
- Many bicycle paths throughout the community
- Common spaces for recreation; lots smaller than usual
- Privacy on street-side (usually fenced) with shared "public" backyards, usually containing gardens and fruit trees.
- Common food-growing areas, particularly grapes, fruit trees, jujubes.
- 10% of houses allocated for low-income families (who apparently do most of the planting and even have an on-site tortilla business).

COMMERCE

- Cooperatives
- Strategies applicable to small businesses
- What makes a small business successful

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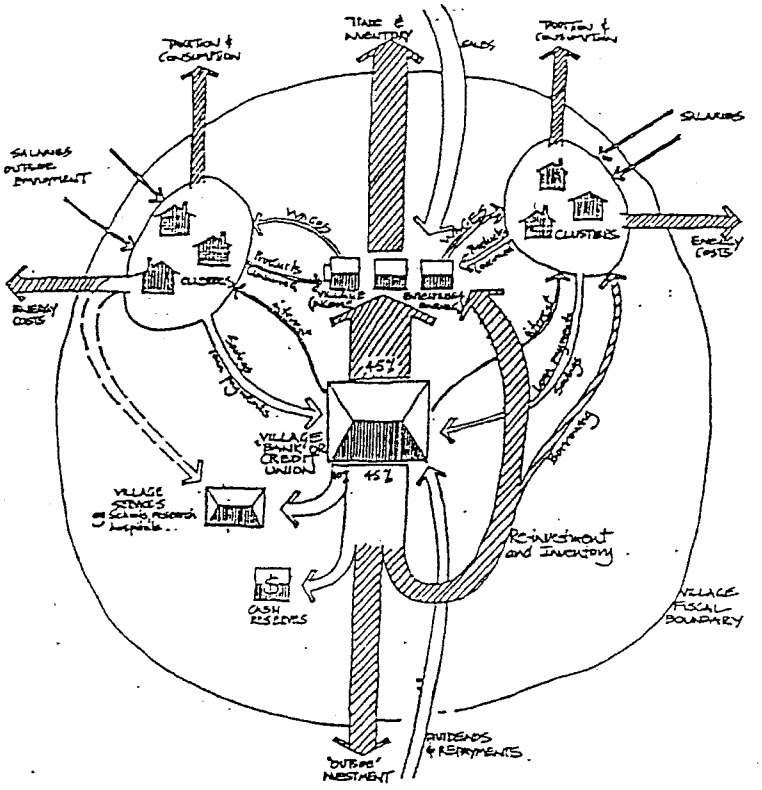

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- Cooperatives
- Strategies applicable to small businesses
- What makes a small business successful

Cooperatives are formed to help in community revitalization and worker productivity and contentment.
Decentralised, worker-owned, and (usually) socially-conscious, co-ops are a useful alternative to single-ownership businesses. Famous example is of the Mondragon Cooperatives in the Basque region of Spain, where 10% of profits are returned to the community for public services; a cooperatively-run bank oversees businesses and gets them started; and there are no redundancies--workers are re-trained and new jobs found in other expanding cooperative endeavours.

Small Business Strategies (including for co-ops)

- Presales and pledges: Can start a business off. Books are often "pre-sold" in order to pay for printing costs. One example of a restuarant (Zoo-Zoos) printing food vouchers redeemable up to a year (discount on a meal) to buy out the original owner. Individuals contemplating a small business should ask the people in the community whether they would buy his/her goods or services.
- Cooperative catalogue: Individuals and businesses can get together to put out a catalogue of all their goods and services. This has been done in the U.S. in "The Catalogue of Wonderful Things" (crafts) with each product and address given individually. Can also try the idea of a cooperative "label" and the filling of orders through a co-op business set up for such a purpose.
- Loans: should receive loans from a local S.H.A.R.E. or C.E.L.T. group; there are even government agencies that make low-interest loans to cooperatives (which must demonstrate viability).

The Successful Small Business

- Start small; learn how to run a business
- Start a business in an area in which you are interested (not which you think will make $)
- Gain a good reputation for service and durability
- Action: once decision is made, effort is made quickly to adopt it
- Belief in a set of values for the company, often re-stated
- Respect and encouragement of co-owners or staff
- Use a simple organisational structure, with "management" in close contact with staff & customers
- Look ahead

HOW PERMACULTURE TRAINEES OPERATE

What Next?

- Graduates of a permaculture design course are designated as "trainee permaculture designers" and must complete at least 2 years work in any permaculture field (as designated below). Evidence of work must accompany written submission, usually an accompanying letter signed by (1) your initial permaculture design course teacher(s); (2) a permaculture designer who has received a Diploma from the PC Institute(s); or (3) a reputable, independent person known by both the designer and the Institute.
- A Diploma of Permaculture Design shall be issued in the following fields (check Permaculture JOurnal #19, page 13 for fuller description):
  - Site design
  - Media and communications
  - Site development
  - Education
  - Administration
  - Trusteeship
  - System establishment and implementation
  - Manufacturing
  - Community development
  - Finance
  - Research
- Diplomas are issued by the continental Permaculture Institutes (see references). Higher degrees may be obtained: contact Bill Mollison at Permaculture Institute, Australia. All design course graduates should maintain a subscription to the Permaculture Journal to keep abreast of news and changes.

Report-writing and client needs

1. Clear addresses: client home and business addresses, your own address, client's property location
2. Client needs and resources: lifestyle; future development; number of people and form of involvement; expenditure; other resources, skills, interests.
3. General property description: size, titles, sub-divisions; aspects, orientations, slopes; present vegetation, soils, water, access; areas defined (planning units) Attached maps, aerial photographs if necessary (caution: do not over-do general property description as client generally already knows it).
4. Detail of areas: e.g. Zone 1: house and yard design, intensive culture; Zone 2: cultivation, animals; Zone 3: forest; Zone 4: shaded slopes, water, etc.
5. General themes affecting the site, e.g. fire, marketing possibilities, mosquito control, aquaculture, and so on.
6. Include useful references: resource people, other clients, books & publications, government assistance, financial help, organisations.
7. Documentation, e.g. plant lists, details of retrofits, layouts of areas (designer may need illustration assistance).

COMMON ERRORS

- Assumption of client knowledge of all facets of report
- Lack of detail sketches
- Depersonalized approach
- Recommendation of difficult technologies
- Resources not noted or explained
- Generalities, e.g. "suitable plants"
- Poor patterning
- No management data
- Priorities not stressed
- Recommending illegal or impossible-to-get species

For methodologies of design, see page 2 of this handbook.

Creating Work

- Find a niche and fill it!
- Start to teach and design, even if its free at first--paid work will eventually come
- Research and assemble data for other designers
- Cooperate with co-designers to form team
- Start a permaculture association or consultancy in your area (combine it with earthbank or bioregional services)
- Offer services and help set up community social services, e.g. city farms, food co-ops, teaching and demonstration areas for permaculture, etc.

Ending

- 1/2 day of assessment; class to indicate future work and ideas, volunteer for responsibilities, etc.
- Complete curriculum vitaes for the continental permaculture institutes.
  - Name and home address (please notify if address changes)
  - Qualifications (Education)
  - Skills
  - Affiliations
  - Ability to lecture
  - Phone numbers
  - Job experience
  - Interests
  - Ability to travel