vide for:

a. Dense windbreak polewards or uphill of the settlement, and to the east and west (a "suntrap" structure) **Figure 12.1**.

b. Dense attached vines on all sound masonry walls, or out from wooden walls, to assist insulation.

c. Deciduous trees to sunwards chosen to admit low winter light to all facades to the sunward aspect, especially in mid-winter.

- Siting to avoid unstable soils, avalanche tracks, or flooding areas, and where possible above local frostlines.
- Site to be off radioactive or radio-emitting rocks if possible.

Preferably, settlements in cool areas should present a stepped aspect, so that each dwelling presents a full facade to the winter sun (**Figure12.2**).

## HOUSE DESIGN

### Glazing

Given that settlement site is carefully selected, and landscaping is as carefully designed, the individual house can self-provide for heat and hot water by good construction technique. Glazing of the facades in any cool-area site should ensure that:

- There is from 30% (Lat 3035°) to 100% (Latitude 60°) glazing on the sunward walls.
- No glazing on the west walls (a window in the east for a kitchen is controllable).
- Minimal and perhaps double-glazing in the pole-ward walls (above Latitute 40°, in cold continental interiors or alpine sites).

### House Proportions

Houses should be no more than two rooms (10 m) deep on the north/south axis, and may be 1.5 times longer on the east/west axis, so that winter sun can penetrate windows to the walls of the poleward rooms. Now, it remains to adjust the sunward roof eave width, and the sill height of windows to admit winter sun to the interior (from early autumn to late spring) or in very cold climates, to attach a solarium or glasshouse for day use in winter. Clerestory or attic windows to the sun side heat rear rooms or roof space.

### Floor and Sub-floor Area

As for construction materials, concrete slab or mud, brick, or tiled floors in contact with the ground are ideal to absorb heat into the underfloor earth mass. These can be covered with wooden parquet, carpet, or any preferred surface without long delaying heat transfer efficiency, so that any usual floor covering can be used, including wooden flooring over battens.

The floor area and the earth beneath it are the critical heat stores for winter, radiating solar heat at night, or over cool cloudy periods. As most of this stored earth heat escapes via surrounding soils, and most of that loss occurs within 0.5 m of the earth surface, we must insulate the entire earth mass below the floor by digging a 1 m deep foundation trench, and providing 5-15 cm thickness of insulation around the whole periphery of the floor outline.

### Insulation

Given that the subfloor area is insulated, the next most important sources of heat loss are the ceiling and the windows at night or on cool cloudy days. The ceiling should therefore be fitted, concurrently with construction, with 5-15 cm of insulation (as fibre, wool, seagrass, sawdust, feathers, or shredded paper), and the windows provided with oversized floor to ceiling curtains. In areas of severe cold, sliding insulated shutters are appropriate. Insulation adds 5-8% to house costs, but pays for itself in 35 years in energy savings.

### Walls

Walls can be massive, of stone or pise, or double-walled (reverse brick veneer is ideal: bricks to the inside, timber or wallboard to the exterior) and the wall cavity also insulated. Light insulation suffices in the east and west walls, mainly as a sound barrier, if houses are conjoined.

In all areas of cold winds and blizzards, double entries are essential, and in alpine and snowy areas, farm housing is usually conjoined to barns, feed storages, and wood or fuel storage so that one need not

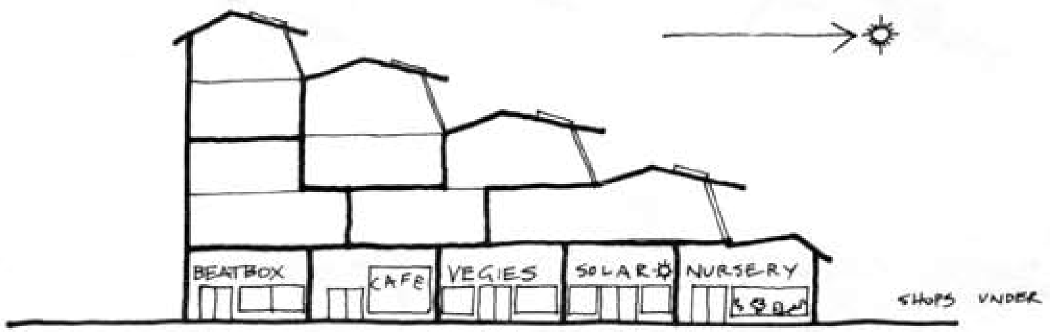



**FIGURE 12.2**
STEPPED ASPECT OF SETTLEMENT.
Dense, sun-facing tiers of housing are the most economical systems to build for solar heating in cities or in cold deserts.

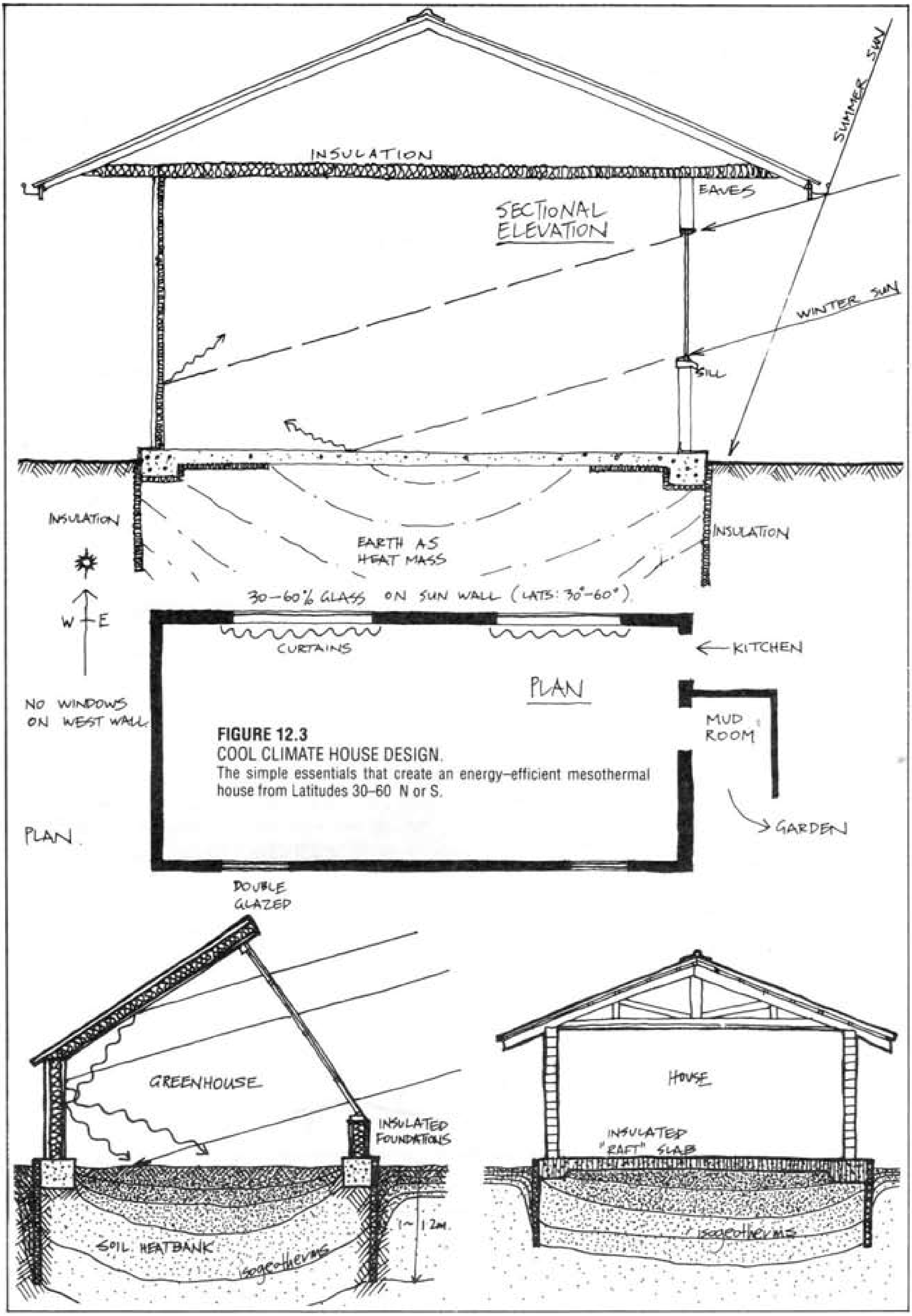



**FIGURE 12.3**
COOL CLIMATE HOUSE DESIGN.
The simple essentials that create an energy–efficient mesothermal house from Latitudes 30–60 N or S.

go outdoors in blizzards or deep snow to feed livestock or obtain fuels. In such climates cellar storage of house food, and deep placement (1–1.5 m) of all water lines is also essential.

## 12.6
## THE HOME GARDEN

(See also Chapter 10—the Humid Tropics—for mulching, geometry of beds, etc.).

One special feature of cool area home gardens is the need to grow and store crop (in the field or home) over the winter months, as growth effectively ceases from late autumn to early spring. The middle of spring is known as the "hungry gap", when winter crops are finished and new crops are not yet yielding.

The winter food gap is bridged by growing root crop, cucurbits, and subsequently processed crop for preservation. These crops mature in late summer, and are stored or preserved (some crop can also be left in the ground). Staple root crops are the potato, parsnip, carrot, and minor species such as oca, sunroot (Jerusalem artichoke), and bulbs such as onions. Field crops left to over-winter include fava bean, kale, chard (silver beet), parsley, and a variety of cabbage, broccoli, cauliflower, and sprouts under straw or shelters.

There are two main planting periods. The first months of spring are for salad vegetables and all summer crop, and the last month of summer or first month of autumn for all over-winter crop and all root crops of the year. In milder areas, a green crop (green manure) can be sown before winter (oats, tares, fava beans) and slashed or dug-in in the spring.

In cool areas, cellar or pit storage is extensively used to store crop. Potatoes are stored in straw or ash in dark boxes or humid cellars. Carrots and parsnips (tops removed) are in mounds of sand or ash. Apples are separately wrapped or spread out on attic floors (they are not stored with root crop because of their ethylene production, which causes root crop to shoot), and cabbage or kale can be stored, uprooted, by covering with hay in the open, as a ferment (sauerkraut) in large jars, or as sterilised or frozen storage. Today, many crops are stored frozen in deep freezes, and retain good nutritional value.

Planning the garden thus means small beds for the spring planting, with main crops of potato, tomato, and sweet corn, then a reversion to larger mass beds in the autumn planting for winter storage crop (potatoes, carrots, parsnips, turnips, cabbage, fava beans, peas, *Brassicas*). Chard and parsley are important all-year foods and several successions can be sown to reseed at irregular intervals, so that they are always in the garden.

Otherwise, the garden layout is very much the same as that given under the tropics chapter, but omitting any overshaded areas or tree crop interplant, as light levels can be low in cloudy weather and light saturation is rarely a problem. Mulch is, however, appropriate, and the sole exception to this may be for spring carrot planting, when mulch is pulled from the seedbed to let it warm up early. All other crops planted in mulch catch up with bare-soil crop and mature at the same time.

For cool areas, a small glasshouse for seedling trays, and a series of cloches for early transplants are invaluable. Even potatoes can be sprouted on old hessian bags indoors, or in any open shadehouse, and transplanted complete with leaves and roots by cutting up the bags into squares.

There are several ways to perennialise annuals, some of which are:

- Carrots: cut a disc off the top, sprout it on soft wet paper in a shallow tray, and replant; one gardener told me she has been eating the same carrots for 9 years!
- Leeks: let one in four go to seed and dry off, then remove the small bulbils from the base and replant. When harvesting, cut off the leek 2 cm below ground level. The central shoot quickly regrows. There is also a variety of perennial bunching leek (called pearl onions).
- Lettuce: pick single leaves, allow to go to seed, scatter seed. Mignonette variety is a good self-seeder, are some Italian varieties.
- Cabbage: cut the head 8 cm above the ground, then deeply crosscut the stem. Each quarter of the stem regrows a small cabbage.
- Garden fennel: this plant self-seeds, as does chard, parsley, parsnip, etc. if allowed to go to seed. Judicious thinning, weeding, and transplanting is in order.

When saving seed from any umbelliferous plant, collect the strong, mature seed for the terminal panicle only; this germinates best of all. Side panicles contain immature and small seeds, and can be pruned or rejected.

TRELLIS CROP in mesothermal climates is important. Many peas, beans, and cucurbits will trellis, as will varieties of tomatoes. But trellis *over* the garden is inappropriate (unlike in deserts), and either vertical zigzag, inverted "V", or house wall and garden fence trellis is best, aligned north/south where possible for even sun effects (**Figure 12.4.**)

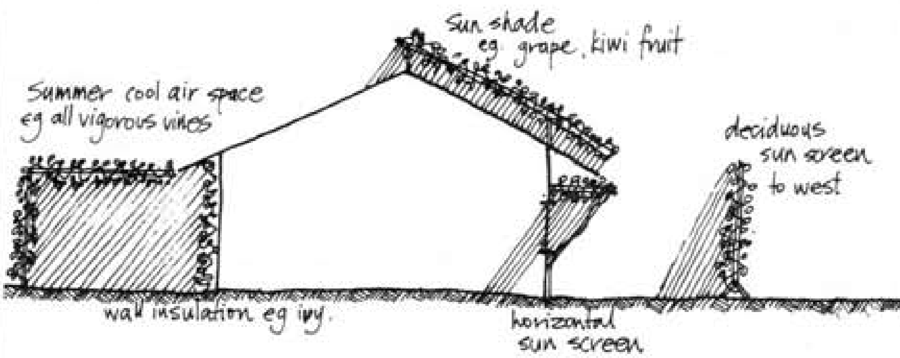
SMALLFRUIT, as currants, gooseberry, raspberry or trellis blackberry, is a feature of cool-area garden. Six to fifteen plants of 78 species yields a great deal ot tresh or frozen food of high vitamin C value. Many such rows can act as windbreak in the garden.

### SEED AND SEED RESOURCES

There is no need here to restate the evidence that seed, especially the 20–30 basic food crop seeds of grains and grain legumes is today subjected to a conserted effort at total control by a few agro-chemical multinationals, as part of a global power play to control nations (or rather mineral resources) by starving regimes who try to use local mineral resources fairly, or to dislodge the parasitic grip of exploitive multinationals; see, for example, works by Pat Roy Mooney (*Seeds of the Earth;*

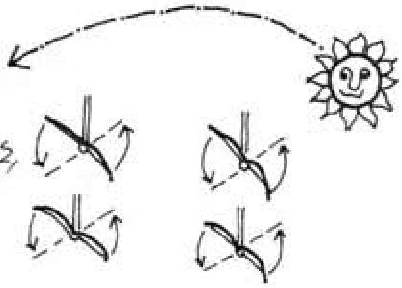
## HOUSE TRELLIS

STYLES AND PLACEMENTS FOR DWELLINGS.

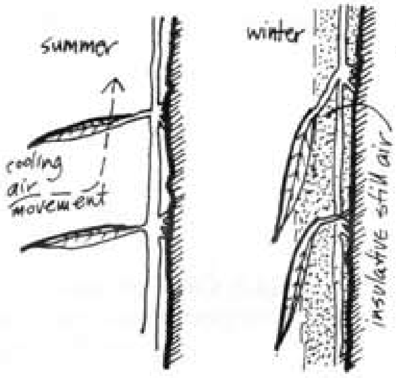



## LEAF MOVEMENT BY DAY & SEASON

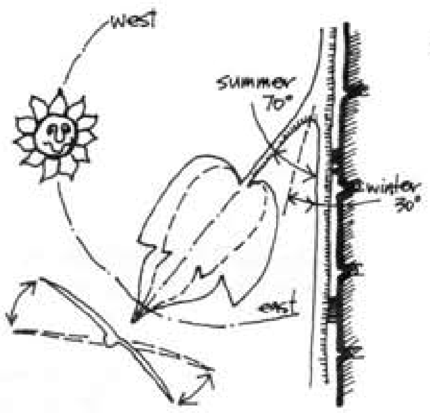
(FROM DAS NATURHAUS, Rudolf Doërnach & Gerhard Heid.) 1982



DAILY MOVEMENT



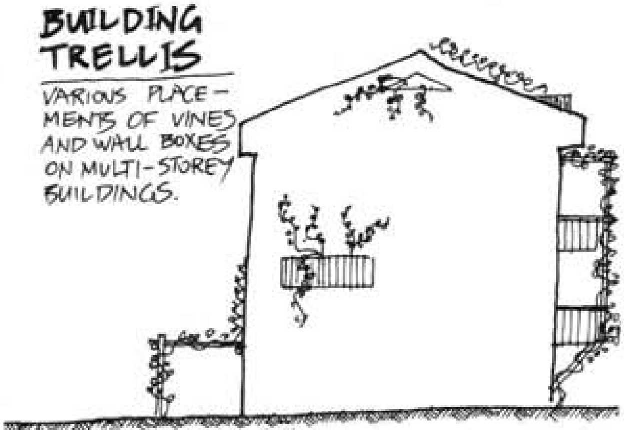

SEASONAL MOVEMENT




SEASONAL MOVEMENT

## BUILDING TRELLIS

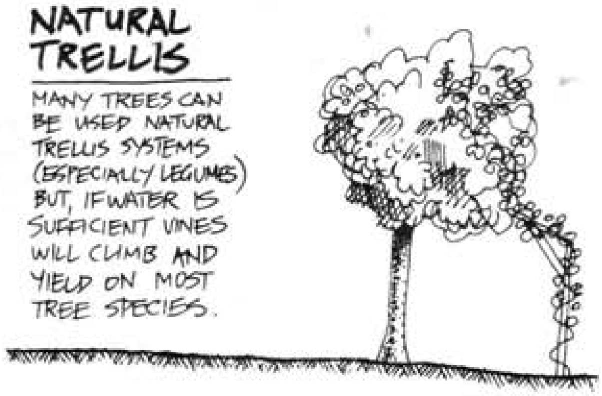
VARIOUS PLACEMENTS OF VINES AND WALL BOXES ON MULTI-STOREY BUILDINGS.



DAS NATURHAUS

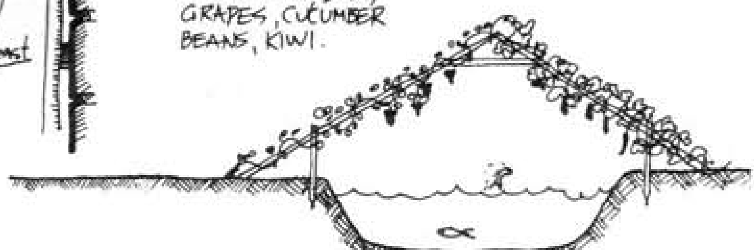
## NATURAL TRELLIS

MANY TREES CAN BE USED NATURAL TRELLIS SYSTEMS (ESPECIALLY LEGUMES) BUT, IF WATER IS SUFFICIENT VINES WILL CLIMB AND YIELD ON MOST TREE SPECIES.



## WATER TRELLIS

TRELLIS OVER CANALS OR CHINAMPA E.G., GRAPES, CUCUMBER BEANS, KIWI.



*a public resource*, World Council of Churches, Canada).

In short, by contracting seed trade, seed patents, and seed retail outlets, the few powerful state/industrial cooperations are preparing the ground for de facto government by controlling food, via "aid" allocation and market control; a sick and destructive use of power. In response, people and organisations everywhere have set up seed exchanges, seed libraries, open pollinated and non-patented seed companies, and hundreds of thousands of growers have studied home seed saving systems.

Despite the enormous loss of locally adapted seed (estimated at 85% of European varieties) that resulted from the monopoly control of market by seed patenting, the encouraging result of "people power" is that most gardeners or farmers today can assemble more species and varieties of seed than ever before in history, by using the seed exchanges and local

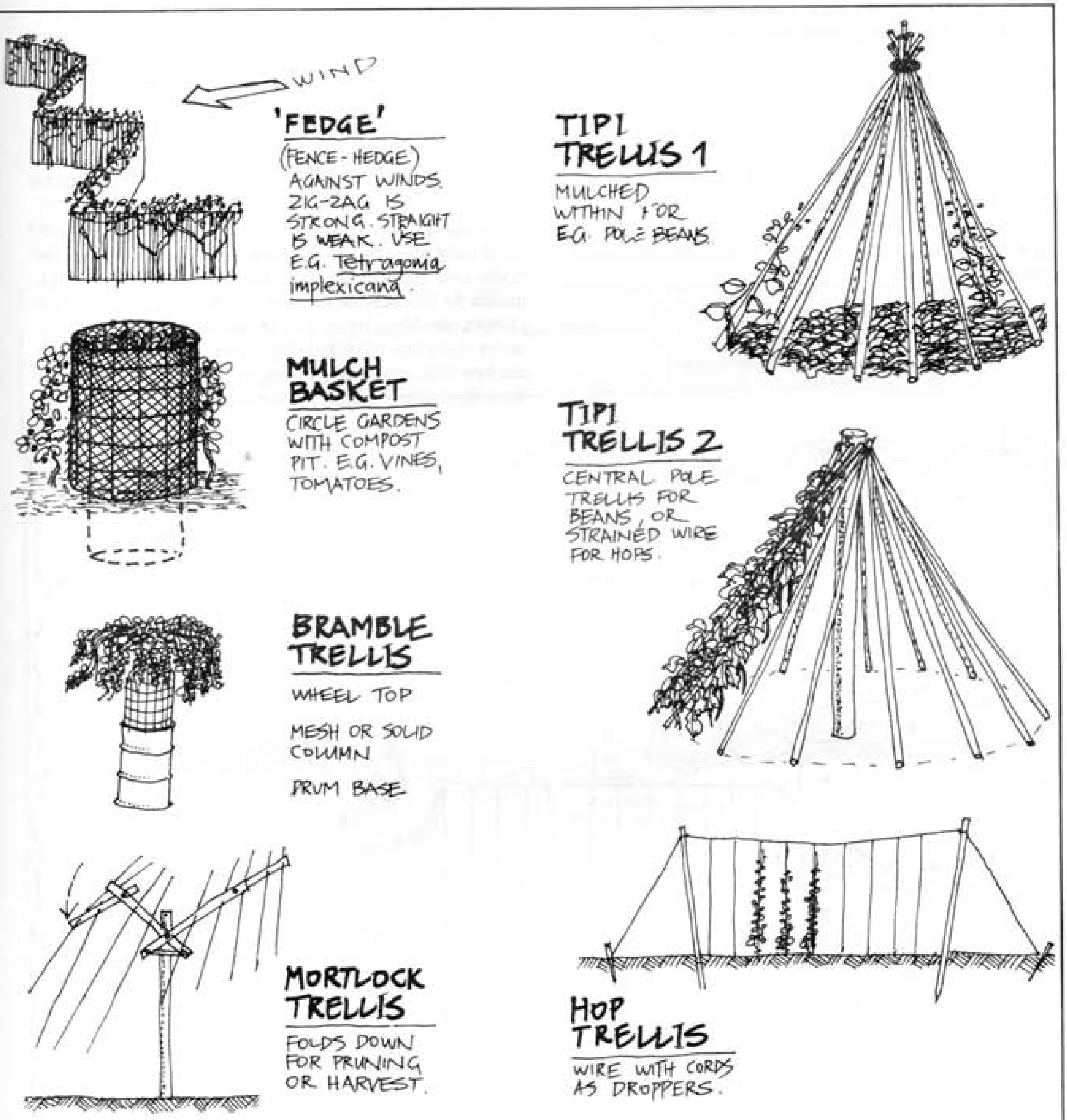



**FIGURE 12.4**
SOME TRELLIS SYSTEMS.
Trellis systems at buildings and in field or garden greatly enlarge crop options and control climate at house.

collections instead of the patented hybrid seeds offered by the controlled markets.

Every gardener who is opposed to external control (which is *why* we garden) preserves a few valuable varieties: many of these are heirloom or locally reliable traditional food plants specific to site, climate, or regional preference; in total, these species and varieties give any new gardener a vast range of potential product.

Thus, a region in any climate can escape external food control via a local, regional, and national network of seed exchanges and open pollinated (non-hybrid) non-patented seed. It is particularly important for small farmers to grow and share seed, as seed outlets for farmers are bought up by the agro-chemical industry, and seeds altered to suit their purposes (not the purposes of local food production). Seed sources are numerous, and are listed in most organic farming or permaculture publications; note too that perennials and trees providing staple food have largely usurped seed patenting.

## 12.7
## BERRY FRUITS

No region so suits berry production as the cool humid climates. There, one or other berries occupy niches from high montane to seashore sites, and natural stands of berries fill forest clearings and edge roadways and paths. They are food for a variety of birds, for foxes and rodents, and for people.

In the coastal or upland bogs, *Vaccinium* spp. (blueberries, cranberries) thrive in oxygen-poor soil (each has a specific heathfamily root associate to provide nitrogen), and in the clearings of forests bird-carried berry seed germinates on fallen logs and tree stumps, where 46 species may compete for space. So favourable are these stump sites that slabs of fallen trees will proliferate berry mounds on lawns or in gardens, and peat-like bricks of groundcover berries such as salal will convert lawn edges to berry groves.

Berries demand little but a humus-rich and somewhat acid soil, high ammonia nitrogen (provided by birds and rodents in the wild as urea), and a thick mulch to discourage grasses. Berries pioneer for, and protect, seedling trees, so that advancing forest edges often develop bramble and cane thickets. In these thickets oak, chestnut, plum, apple, and birch thrive. Brambles, in particular, protect and nourish young fruit

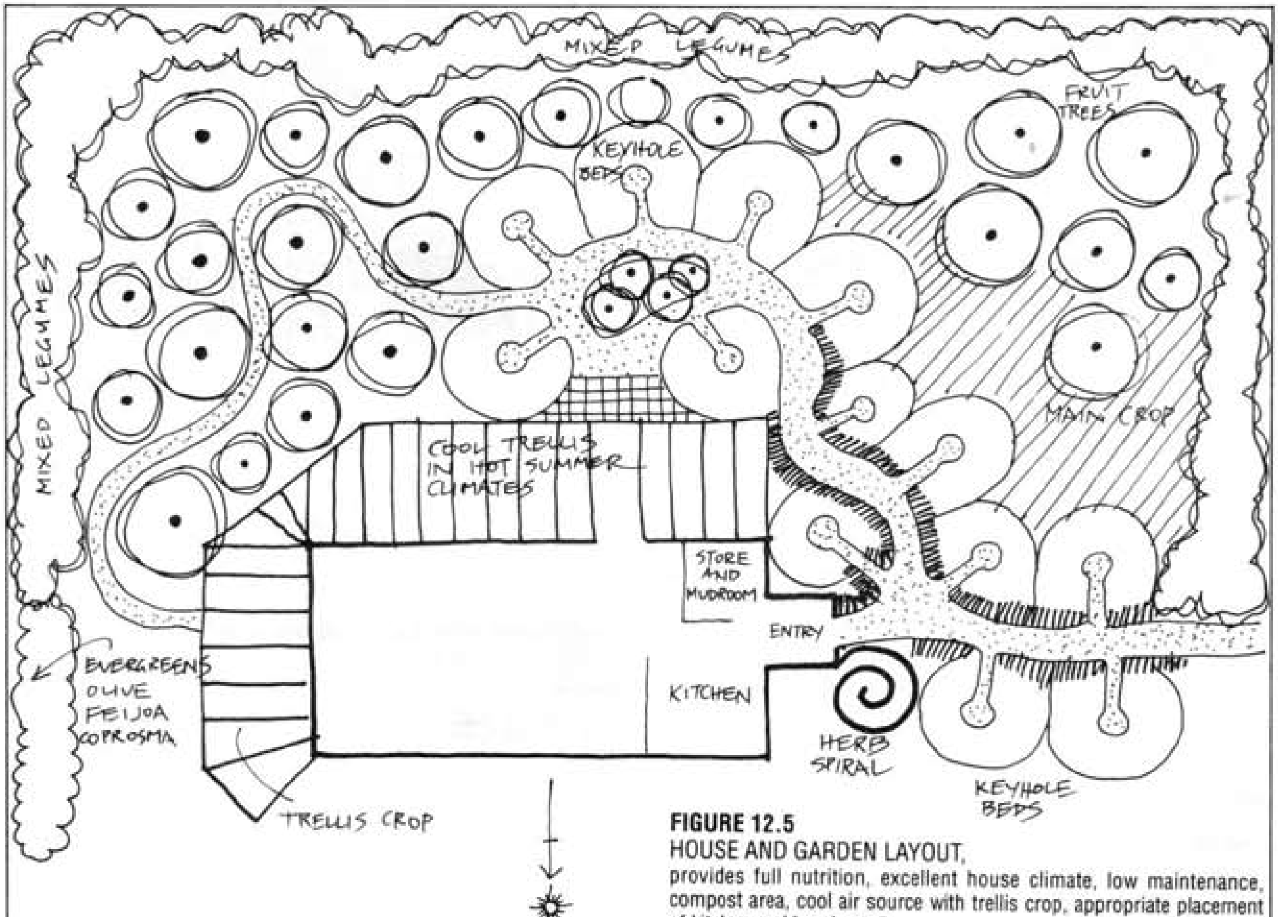



**FIGURE 12.5**
HOUSE AND GARDEN LAYOUT,
provides full nutrition, excellent house climate, low maintenance, compost area, cool air source with trellis crop, appropriate placement of kitchen and "mudroom".

trees, and on farms bramble clumps (blackberry or one of its related cultivars) can be used to exclude deer and cattle from newly set trees. As the trees (apple, quince, plum, citrus, fig) age, and the brambles are shaded out, hoofed animals come to eat fallen fruit, and the mature trees (7 plus years old) are sufficiently hardy to withstand browsing. Our forest ancestors may well have followed some such sequences for orchard evolution, assisted by indigenous birds and mammals.

BIRD PROBLEMS WITH BERRY FRUIT PRODUCTION.

Production of blueberries, strawberries, and raspberries attracts fruit-eating species such as blackbirds as thrushes, starlings, and parrots. There are several practical aids to reduction of crop losses due to birds:

- Cage Culture. Growers of sweet cherries, blueberry, and table quality raspberry all report economic advantage in completely caging over the area of crop. Such an advantage gives yields of up to 30 times that of open field conditions. In these cages, some about 20 m by. 10 m by 24 m high, using 10 mm mesh, a polyculture of smallfruit plus espalier fruits (nectarine, peach) is safe from birds and even large moth species. One or two such cages of piping plus mesh will support a grower aiming for high quality markets (**Figure 12.6**).

Ground preparation may involve ridging for species such as blueberry (ridges of 1.5 m wide, 0.6 m high, with a drainpipe at base is ideal), the fitting of drip irrigation, a deep mulch for pH adjustment and soil moisture conservation, and a careful schedule of liquid manures selected for crop. It is beneficial, in cage culture, to use species such as tree frogs, small lizards, and insectivorous birds (such as quail) in the cages for pest control, and to select plants of high fruit yield. Given such care, a family livelihood can be obtained. Cage walls may support trellis of bramble fruits (youngberry, boysenberry). Maintenance is mainly that of pruning and adding mulch as needed to maintain

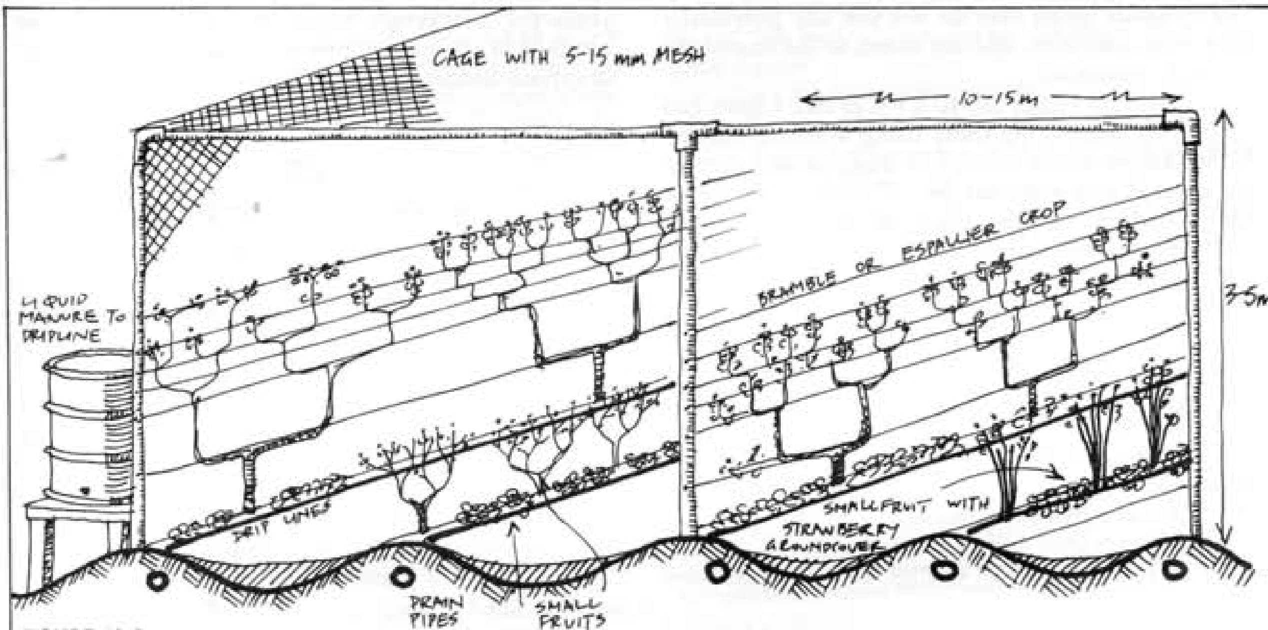



**FIGURE 12.6**
CAGE CULTURE.
Highly intensive , mulched "organic" fruits selected for their excellent flavour can provide a modest living from one 10 x 20 m cage; bird and insect losses are few; cage can contain quail, small insectivorous birds, lizards, and frogs for pest control; ground crop of melons and small fruits.

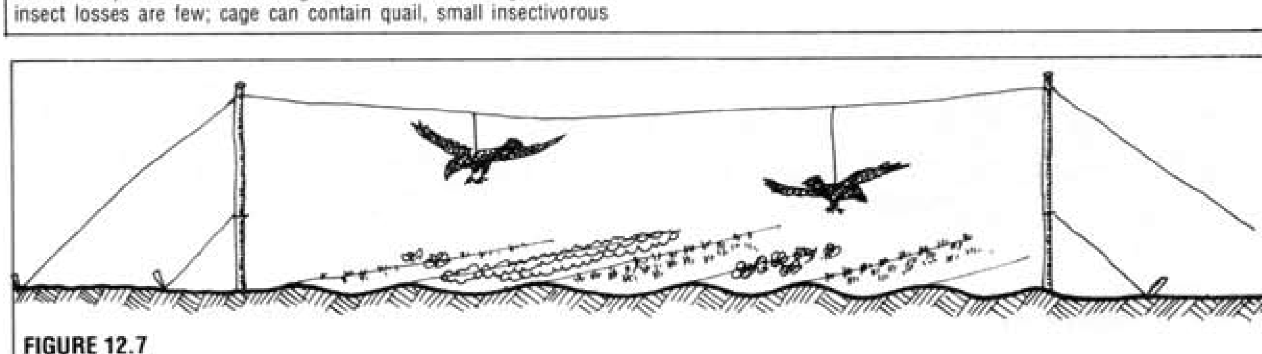


**FIGURE 12.7**
HAWK KITES.
Realistic kites are very successful deterrents to birds in strawberry beds, and are commercially available in Australia.

soil health.

• Field Culture. In field conditions, losses to birds are unavoidable but may be minimised by using tethered predator hawk kites above the crop at critical ripening periods. Such kites imitate local hawks or eagles, and are very effective bird repellents. They should be removed after the crop is picked so that birds do not get accustomed to them (**Figure 12.7**).

As much of the berry crop cost is in picking, it is preferable to plant for self-pick sales where farms are within 15–20 km of town markets. In this case, the berries (currant, gooseberry, raspberry, strawberry) are best planted double row on contour mounds 1–1.5 m high, with grassed paths and a wider spacing of mounds or ridges than in cage culture, so that pickers have easy access to crop. Selfpick farms need parking and weigh-out centres, buckets for pickers, and produce tubs for crop.

RAMPANT BLACKBERRY CONTROL.

The methods given here do not use any potentially dangerous chemicals, and are suited to the size of the area to be controlled.

1. Individual Plants (up to 0.1–0.25 ha). I have had success in eliminating these using a strong rubber-backed carpet, tearproof fibre, or tough plastic. Clumps are covered and weighted for 710 days, when leaves have rotted and branches blanched. The clump is then uncovered and the roots dug out.

2. Areas of 0.1–2.0 ha can be completely controlled by erecting permanent electric fencing to reduce the area to 0.4 ha (1 acre) lots, and releasing 20 pigs per lot, followed by 12 goats (on rotation). In 24 years, the pigs have eaten the roots and the goats any regrowth. This is permanent if:

• The areas are grazed by sheep or goats later (even geese help);

• The area is planted to thickish forest later; or

• The area is used for hay and regularly cut.

3. Large Areas in Steep Gullies. Two methods have worked:

• Cattle are fed in the winter with *untied* bales of fodder thrown into the blackberry gullies. They trample and destroy the vines, and "sow" grass. Such gullies need reafforestation later. This method has been used successfully by Lance Jones of Tasmania over many acres.

• Apple, fig, quince, pear, and plum trees (ungrafted whips) are planted inside the edge of blackberry clumps (12 metres in from the edge). These grow and fruit in 4–6 years. Cattle come in to eat the fallen fruit and trample out the blackberries. This method has been used over many acres by Geoff Wallace, Kiewa Valley, Victoria. The fruit trees are now up to 20 years old; no blackberry survives.

There are several methods used in confining blackberry brambles:

1. If a field is normally cropped or mown, many farmers leave walls of blackberry along fences and creeks as cattle barriers. These do *not* spread where crop or slashers are used and the fields grazed.

2. Blackberry does not penetrate through (or do well under) 3–5 years of pines or in pine plantations after years 4–7. Blackberry edges have been reported as confined by comfrey, wormwood, *Coprosma repens*, pine, or cypress hedges.

## 12.8
## GLASSHOUSE GROWING

The cool temperate climates are those places where greenhouses are most commonly used for speciality crop or aquatic species production, for house heating, and for the winter production of vegetable and fruit crop.

Modern glasshouses are becoming very sophisticated with respect to heat energy conservation and heat absorption, as 70–90% of the cost of crop can be that of artifical heating.

Insulation is essential not only for the ground below the greenhouse, usually as a trench 1 m or so deep provided with a panel insulation, or with straw or sawdust-filled plastic bags, but also for the endwalls, the poleward walls, and the poleward slope of the roof (all can be solid insulated walls). The sunward roof slope

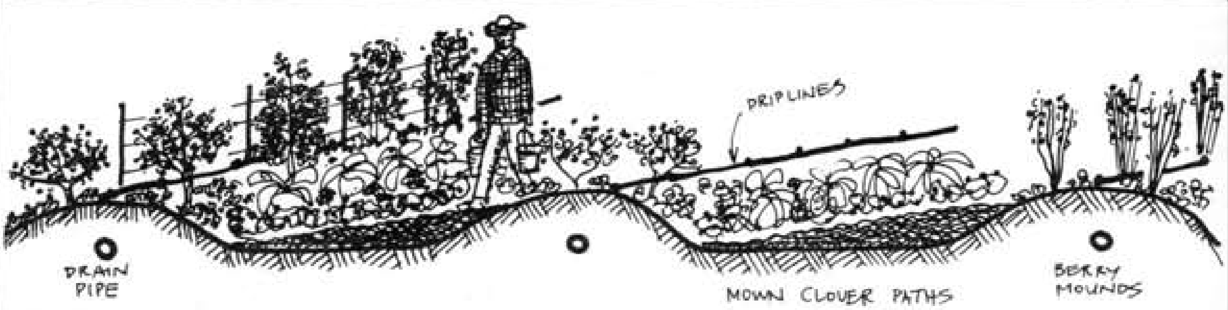



**FIGURE 12.8**
SELF–PICK SYSTEM LAYOUT.
Mulch or clover paths, raised mounds, adequate irrigation, good drainage, wide access ways are the essentials of self-pick smallfruit systems.

and wall can be air-insulated, either by using trapped bubble insulation as standard plastic sheets, by keeping air at pressure between double plastic walls, or by using insulated shutters at night to cover the glazed areas.

Inside the greenhouse, where the whole earth floor inside the walls is insulated from the cold earth outside, several additional heat masses can be provided, most commonly as plastic or metal tanks or drums of water (some can be fish ponds), but also by providing active heat sources such as domestic animals, compost heaps, or hot water storages filled from panel or trough-concentrator solar heat collectors.

The areas below plant benches, if used to house rabbits, guinea pigs, poultry, or any small domestic animals at night will provide considerable winter heat, as will long compost boxes along the poleward wall, or external to, but below, the level of the greenhouse itself. Dark curtains within the greenhouse also act as heat (long wave) absorbers and radiators.

Lastly, manual or automatic venting of the greenhouse, fans to create air circulation inside, and a close watch on excessive humidity (relieved by a heat exchanger to the exterior, or by venting hot air) completes the design of efficient greenhouse units. Moreover, such devices as glazing over an earth trench in a sunward slope, a narrow street between houses or shops, or the sunward side of a massive stone or brick wall also provides a frost-free and warm plant environment.

All entries to greenhouses and houses need to be porches or covered areas, provided with two successive doors, preventing heat escape as air loss to the exterior.

As greenhouse construction is relatively expensive, then the crop selection in early years should be oriented towards high-value crop such as bell pepper, tomato, snow pea, ginger, kiwifruit, and so on (depending on local preferences and demands). It is manifestly less profitable to grow low-value or bulky crop, but a domestic greenhouse can profitably provide a wide range of family food (animal and vegetable) rather than a commercial market crop.

## 12.9

## ORCHARDS

Cool temperate humid orchard species include pome fruits (apple, pear, quince, medlar), stone fruits (cherry, peach, plum, apricot), nuts (filbert, walnut, chestnut, hickory), and a few hardy evergreens such as olive, loquat, and pineapple guava (*Feijoa*); mulberry and fig may also be grown in milder areas.

In selecting varieties for local orchards, care should be taken with the following factors:

- Adaptation to the Region. This necessitates a search of local nurseries, gardens, town plantings, and older homesteads to list species yielding in region.
- Resistance to Disease. This factor is of specific relevance to such species as apples, where some older hardy varieties show little effect of fungal or insect attack, so that yields of sound fruit may be obtained without using dangerous chemical biocides (fungicides, insecticides).
- Site Selection. The selection of well-drained, sunfacing slopes in cool areas, or shaded slopes where late frosts are expected (to reduce damage by freeze/thaw effects).
- The Selection of Plant Guilds for Orchards. See below for details.

PLANT GUILDS FOR THE POME AND STONE FRUIT ORCHARD.

The enemy of deciduous orchards is grass, thus non-grass crop below tree canopies is ideal. A selection or mix of the following plant groups can be made:

- Spring Bulbs (*Narcissus*, hyacinth): These flower and die back by early summer, as does *Allium triqetrum* (onion weed), and create a grass-free area below trees in fruit, plus a crop of bulbs, flowers, and honey. Iris and tuberous-rooted flowers also assist grass control.
- Spike Roots (comfrey, dandelion, globe artichoke) cover the ground and encourage worms, yield mulch and crop. Soil below their foliage is soft, free-draining, open to roots feeding near the surface, cool.
- Insectary Plants: *Umbelliferae* and small-flowered plants: fennel, dill, Queen Anne's lace, tansy, carrot, and parsnip flowers, and so on. Tachynid and other predatory wasps, robber flies, ladybirds, jewel beetles, and pollinator bees or wasps are attracted to interplants in orchard, e.g.: *Quillaja*, a small tree attracting many wasps, *Photinia*, and some small species of *Tamarix* and *Acacia* species. All of these can be placed in windbreaks around orchards, interplanted in rows, or as clumps in orchard. All bring predatory or pollinating insects into crops.

In the herb layer, catnip, fennel, dill (or any *Umbelliferae*), small varieties of daisy (or any *Compositae*), *Phyla (Lippia) nodosa*, and flowering ground covers generally attract wasps, pollinator bees and insectivorous birds.

- Nitrogen and Nutrient Crop. Clovers, and interplants of tagasaste or *Acacia* provide root-level nitrogen. Some control of root nematodes (*Crotalaria*), as do marigolds (by "fumigation" of soil).

In general, we aim to maximise the floristic or flowering components of orchard interplant, to reduce or even to eliminate grasses, to attract a variety of pollinators and predatory insects, insectivorous birds (using *Kniphofia* spp. *Fuchsia spp. Echium fastuosum*, *Salvia* spp.), and to provide ground cover for frogs and insectivorous lizards (small ponds or troughs throughout orchards will breed frogs for leaf insect control). Soft ground covers such as *Nasturtium* prevent soil drying and give mulch, as does the interplant and windbreak trees, and the herb layer generally.

Thus, pest species in orchard can be reduced to 4–7% of monocrop orchard by a combination of these strategies:

- Selection of disease resistant stock of the main fruit crop;
- Minimal damage by pruning, or no pruning;
- Predation by birds, frogs, lizards, wasp and predatory insects;
- Interplant of leguminous trees and other than main crop species;
- Reducing crop stress with windbreak and mulch; and
- Ground foraging by chickens, pigs, geese to clean up windfalls, or careful collection of windfalls for juice processing or disposal.

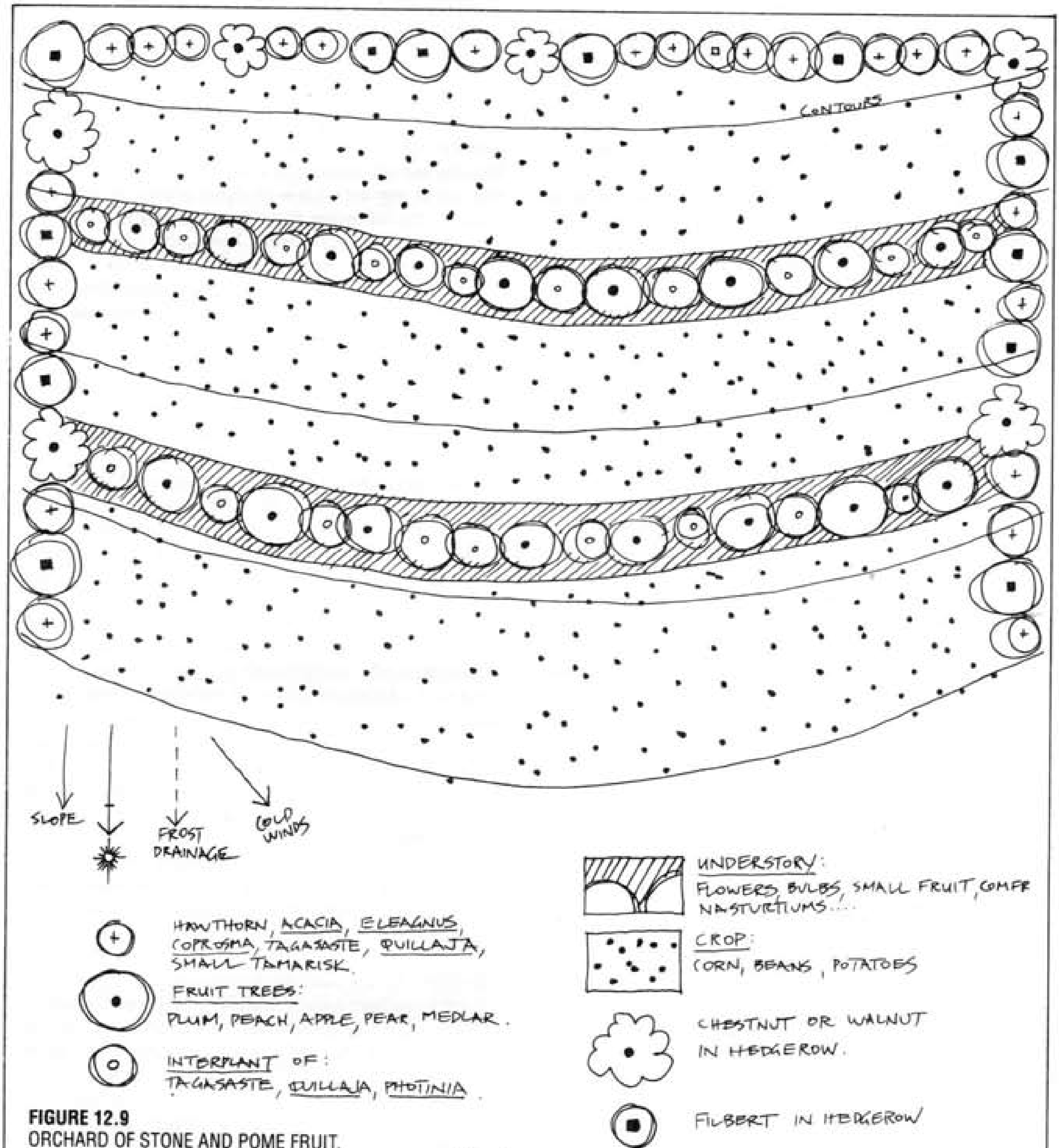



**FIGURE 12.9**
ORCHARD OF STONE AND POME FRUIT.
Fruits can be mound-planted, swales above; crops are sheltered between mixed hedgerows of fruit, nuts, insectary, and leguminous trees as per key.

ANIMALS IN THE ORCHARD.

Once young orchard trees and their associated plant guild species have established, small livestock can be introduced into the orchard system. Initially, bantams and small poultry breeds can be on range. Poultry have several functions in orchard systems, where they scavenge most soft fruits (and any larvae or pupae of pests), help control ground covers, provide a manurial turnover for the orchard trees, and self-forage seed and greens.

Chickens at 120–240/ha (70–100/a.) do not greatly affect the density of ground covers, and they scavenge most windfalls. They have a well-tested effect on such orchard pests as codlin moth and fruit fly, reducing their incidence to insignificant proportions over a few years of ranging.

When orchard trees are 3–7 years of age, foraging pigs can be introduced as fruit matures to take care of windfall fruits that breed pests. In standard-pruned orchards of from 7–20 years of age, first sheep and later controlled cattle grazing can be permitted. Trees of 10-plus years of age are far less susceptible to grass competition, and thus groundcover guild plants are less needed.

## 12.10

## FARM FORESTRY

In the last decade, or from about 1972 onwards, farmers in the mesothermal climates have commenced to develop tree systems on farm. There are several reasons for this including:

- Loss of farm firewood and building materials due to overclearing of forest;
- Concern for wildlife, especially birds, important to crop pest control;
- Concern about soil erosion on steep slopes (more than 15°), along watercourses, and on steep ridge country;
- The realisation that trees provide forages in hard times for livestock and wildlife.
- Variation of product, which buffers economic changes in prices for crops and livestock;
- A more assured income from tree crops, coupled with a wider market for relatively exotic vine crops, fruits, and nuts;
- Gains in all other yields (crop, orchard, livestock) due to the shelter effects of trees; and
- Transition to a tree-oriented production less subject to drought or cold effect, and away from mass market crop product controlled by large retail or processing firms.

Many farms can select specialty crop, specialty processing, or unique product lines from the many thousands of species of trees, vines, and perennial herbaceous plants recently researched and accessed by tree crop associations, permaculture groups, and agricultural or forestry research centres.

Thus, the last decade or so has seen a very marked transition from cropping to perennial and long-term development of a part or the whole of farms. This is as often as not coupled with ownership changes, so that capital from urban professionals, new village groups, industries, and farm developmental trusts open to public subscription have all contributed to a beneficial set of changes in the farm landscape, often in contrast to, but also in support of, traditional farming practices (those prior to 1940).

A new look at farm design is required (and in demand), not only for forest products but for a rapidly growing increase in aquatic products on farming areas. For such endeavours to succeed, support services are needed, such as combined plant nurseries and new species collections for the provision of seed, bud, and scion materials, vegetative propagules, and grafted, layered, or tissue-cultured plants, as well as processing and market systems.

Pioneer or innovative farmers are now often providers of plant materials to other people requiring sufficient plant materials to commence commercial operations. If a bioregion is integrated and cooperative, such enterprises can cope with very different plant/animal groups, as the short list below illustrates:

- Bamboo nursery, together with canegrasses and large clump grasses. Bamboos are a currently neglected forestry.
- Aquatic and edge plant nursery, including fish forages, insectary species, and marshland perennials for bee fodders, duck forage, and wildlife refuges.
- Berry fruit and vine nursery, a great many species grow in these climates.
- Fish breeding: just a few reliable species is all one establishment can handle for providing farm ponds with stock.
- Poultry species; providing breeds of poultry to suit local soils and conditions on range.
- Bee fodder plants (also, butterfly and insectivorous bird attractors); many such species provide hedgerow and forage crop, fruits, and flowers.
- Hedgerow Tree species; a regionspecific selection for district; also pioneer tall grasses, vines for "fedges" on coasts.
- Conservation and Reforestation Trees for extending natural forests; includes pioneer and selected high-value tree crop species.
- Speciality Nurseries for herbs, salt-affected areas, smog tolerance, medicinals, food dyes, and stabilisers, and so on, are all valid enterprises.

None of the above enterprises are competitive. Troubles occur only where large investors and short-term entrepreneurs create large areas of indentical crops; this is usually the result of out-of-region investment.

Given regional resources of this nature, many farmers can then access unique species assemblies for site, enterprise, and preference. Thus, the second support service that will follow tree and vine establishment must be as processing and marketing systems. Quite a few farmers and cooperatives offer leasehold or hire of planting, harvesting, or primary processing machines to a more general subregion or district. Both nursery supply and primary or final processing are essential to new farm enterprises using new species. However, the range of potential crops and processes is, for all practical purposes, unlimited. Layouts of farm forests can vary enormously, and are for the main part governed by the labour and machinery available, landscape features such as slope, drainage, and soils, and the requirements of sustainability or internal farm self-reliance. Some much-used systems include:

Timber Crop in Pasture

Selected high-value trees are widely spaced in rows, and more closely spaced in line, to permit good pasture development between rows. Ideally, tree rows are on contour, or form a matrix on flat sites. Animals are let in as trees harden (years 36), and pastures are cut for hay over this period. Early grazing is supervised, or the area used by "soft" animals like sheep or geese.

Many trees are hostile to pasture, competing with pasture plants for water or nutrients (forest eucalypts, some pines), while others are less competitive (*Acacia melanoxylon, Eucalyptus camaldulensis, Grevillea robusta*, honey locust, as examples). The system enables a gradual integration of livestock and forestry, but note that many trees so planted may not assist the livestock forage. Trees such as poplar, fig, willow, chestnut, oak, and pine may all provide forage and other products in the medium term. Bamboo may be regarded here as a forest product for many farms, and has multiple end uses.

Woodlot

Woodlots are planted primarily for forest yields, and although they provide shelter and some browse for livestock, are usually less integrated with livestock. Also, woodlots can be themselves very variable in end use. For example:

• *Firewood production* on a 2–7 year rotation (one-half to one-seventh of the plants cut annually). Depending on the culture, firewood can be cut as coppice or stickwood, or grown to 4–10 cm log size. In most cases, firewood species are chosen for persistent coppice (regrowth from stump) and good fuel value (calories/t). Tagasaste, *Acacia* species, *Casuarina*, and eucalypt species are examples of good fuelwoods, but almost any vigorous tree can be used

• *Polewood production*. Polewood is of increasing importance for fencing, house, and furniture construction. In this category, it might be important to define durable timbers such as chestnut, raspberry jam acacia (*Acacia acuminata*), osage orange, black or honey locust, cedars generally, and eucalypts known to be rot resistant (river red gum, turpentine). Polewood of less durable timbers is widely used for indoor work, furniture, and as scaffolding or formwork support in building. Poplars and *Acacia* species are planted for these less durable uses, as are timber bamboos for scaffolding and house frames, furniture, and household mats or articles.

Special uses of fast polewood production from Chinese elm, poplar, or like species include chipping for wallboard or fuel bricks, crushing for fibre or cellulose production, fermenting for stock feed or alcohol distillation, and chipping for distillation to oils, resins, and chemical products such as creosote and furfural.

• *Longterm fine timbers*. Some farmers reserve off steep land, valley sites, rocky soils, or islands for selected fine timber stands. These can be revalued at every stage of growth, as they add to farm value from their first year. Black walnut, oak, rosewood, fine cedars, redwoods, blackwood, and many other species are planted as potential retirement trusts for the farmers or their families, and also as foundation trusts for schools or limited institutions with long-term aims Council rates in villages can be completely offset by urban forestry operations.

Stands of such fine timbers can have complementary pioneer species interplanted for medium-term yields (leguminous trees and small cedars generally), but are at their greatest value at 40–100 years for fine furniture, inlay, panelling, and plywoods.

• *Hedgerow*. Hedgerow and contour-bank forests, roadside forest, watershed forest, and steep slope forests permit a true polycultural forestry with 6–30 species of trees chosen for fruit and nut yields, forages, honey, special wildlife foods, browse, and both mulch and stickwood production. Unlike some other forest types, hedgerow and conservation forests can contain numerous species, as cropping of product is not on a cut-and-run, but gather on a gather-and-select basis, with constant replant.

There can be 5–6 types of forestry on any farm of 50 ha or more (or in and around villages), including orchard production. Some special forests are possible on specific sites such as swamps or acid uplands. Thus, farm forest design should be oriented to site and purpose to enhance other farm enterprises, to supply local needs, and to give the potential for a wide range of end product. A whole bioregional forestry devoted to one species of eucalypt or pine is the antithesis of this secure approach, and sets up the conditions for several very undesirable end results, some of which have proven to be:

• Glut conditions in market leading to a depressed local economy;

• Land ownership change based on remote ownership and often very unsympathic control;

• Setting up conditions that may lead to catastrophic fire in the area (eucalypts and pines provide fuels for firestorm in settled districts); and

• Displacement of bioregional needs by industrial feedstocks, thus unemployment and social disruption leading to longterm social problems.

All these problems have been developed by industrial, not regional or village, forestry.

For very small farms, trees need to be carefully selected and placed to maximise short- to medium-term uses (forage, mulch, honey, nitrogen fixation in soils), to assist crop and building efficiency, and to assist the microclimate of the property, so that small farm design (as with small garden design) needs as much detailing as large forest design systems.

A Small Forest Farm for a Cool Humid Area
Large logging operations waste 30–70% of a harvested timber resource, and produce very few forest products apart from wood or woodchips, whereas a small (12–16 hectare) forest site managed by a family or families can yield fungi, seed, smallfruit, furs, meat, wild fruits and nuts, honey, poles, coppice, bark for craft and dyes or tannin, medicinals, and mulches on a sustainable basis. A layout for a tree forest farm is given in **Figure 12.10**, based on observations made in Oregon (USA). The farm is zoned for frequency of harvest.

## 12.11
## FREE-RANGE FORAGE SYSTEMS

To rear animals on range, the following factors must be studied:

• The social behaviour of the animals themselves; preferred sex ratios, ranging behaviour, prefered flock or herd size, and the adaptations of special breeds to soils, pH, site factors, and foraging. This factor decides varieties (breeds) and herd or flock sizes.

• Nutrition over a full year; adequate provision of energy foods, vitamins, and minerals essential to animal health. This factor decides on forages developed or minerals provided.

• The interactions (beneficial or adverse) of ranging animals with crops, forests, other animals, and people. This is the factor deciding the placement and nature of shelters, fences, and water points.

Thus knowing the BEHAVIOUR OF THE ANIMAL is intrinsic to good range management (lessening social stress), and knowing the CHARACTERISTICS OF GOOD RANGE is also critical to factors which include all of those grouped under environmental stress (shelter, nutrition, climate). Livestock management on range is a skilled job, and involves a great deal of observation and monitoring, unlike factory farm systems regulated by recipes and automation. We can choose from three very different animal species—bees, chickens, and pigs (all critical to domestic self-reliance) to illustrate the way to proceed.

BEE RANGE
Bees produce several valuable and unique products: honey, wax, pollen, propolis, and royal jelly. They also

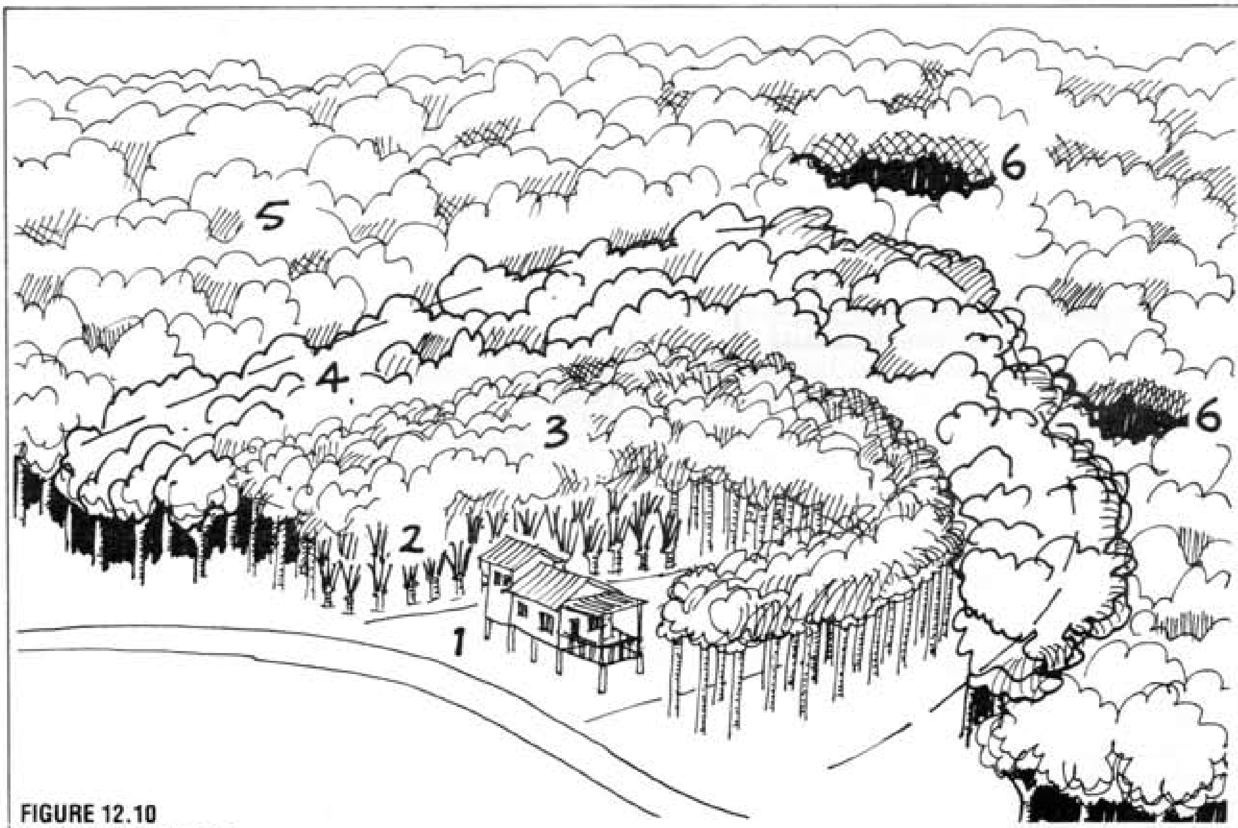



**FIGURE 12.10**
SMALL FOREST FARM.
For intensive forest management: **1**. house and garden; **2**. smallfruits on forest edge; **3**. coppiced woodland; **4**. high–value managed nut and fine timbers; **5**. mixed age and species stands; **6**. forest clearings; fungi and seed are also crops.

carry out the essential service of pollination for a wide variety of food, oil, fruit, and seed crops (such as mustard, clovers, buckwheat, most smallfruit, apples, and grain legumes). Bees form a hive or clustered hive site range over an area about 2.5 km radius, and commercial registered hive sites are thus sited 5 km apart in order to restrict disease transmission from hive site to hive site.

The hive site itself should be sheltered from extremes of cold, wet, wind, and sun. However, the site should not be atypical of the climate of the range, or bees are tempted out in adverse weather, and perish. As many as 100–150 hives are commonly grouped at one site, depending on the richness of the range resource. Bees prefer to fly 100 m or more to forage, and their flight assists in the evaporation of nectar to honey, so that forage species are planted this distance or more from hives. Bees more efficiently harvest clumped rather than scattered nectar sources, so that hedgerows, fields, or clumps of preferred forage species are better than a scatter of the same species in a mosaic of individual plants.

Cold winds most restrict foraging, so that hedgerow (even low hedgerow of 0.5–1 m) is essential cover, preferably leading from the hive site (bee village) to the forage. Such hedges can be made of rosemary, *Acacia*, or even soil ridges with catmint, capeweed, thyme, or field daisies to assist foraging.

As well as nectar producers, bees need pollen to rear replacement workers, especially early in the season. Thus, willows (especially pussywillow), *Acacias*, pines, and vine crop yielding early pollen are very beneficial on range. Bees also gather propolis, a hard waxy substance, used to plug wind gaps or repaint hives, and some sources of this are *Xanthorrheas*, poplars, and pines; very few sources of propolis are needed in the whole range.

Finally, clustered hives use very large quantities of water, which is used by the bees to cool the hives. The bees ventilate hives as a "super organism", inhaling

**FIGURE 12.11**
IDEAL BEE FARM.
Cross-wind forage hedgerows shelter bee-dependent seed crop, herbs, vines; adequate water, pollen, shelter, and a well-designed honey house complete this system.

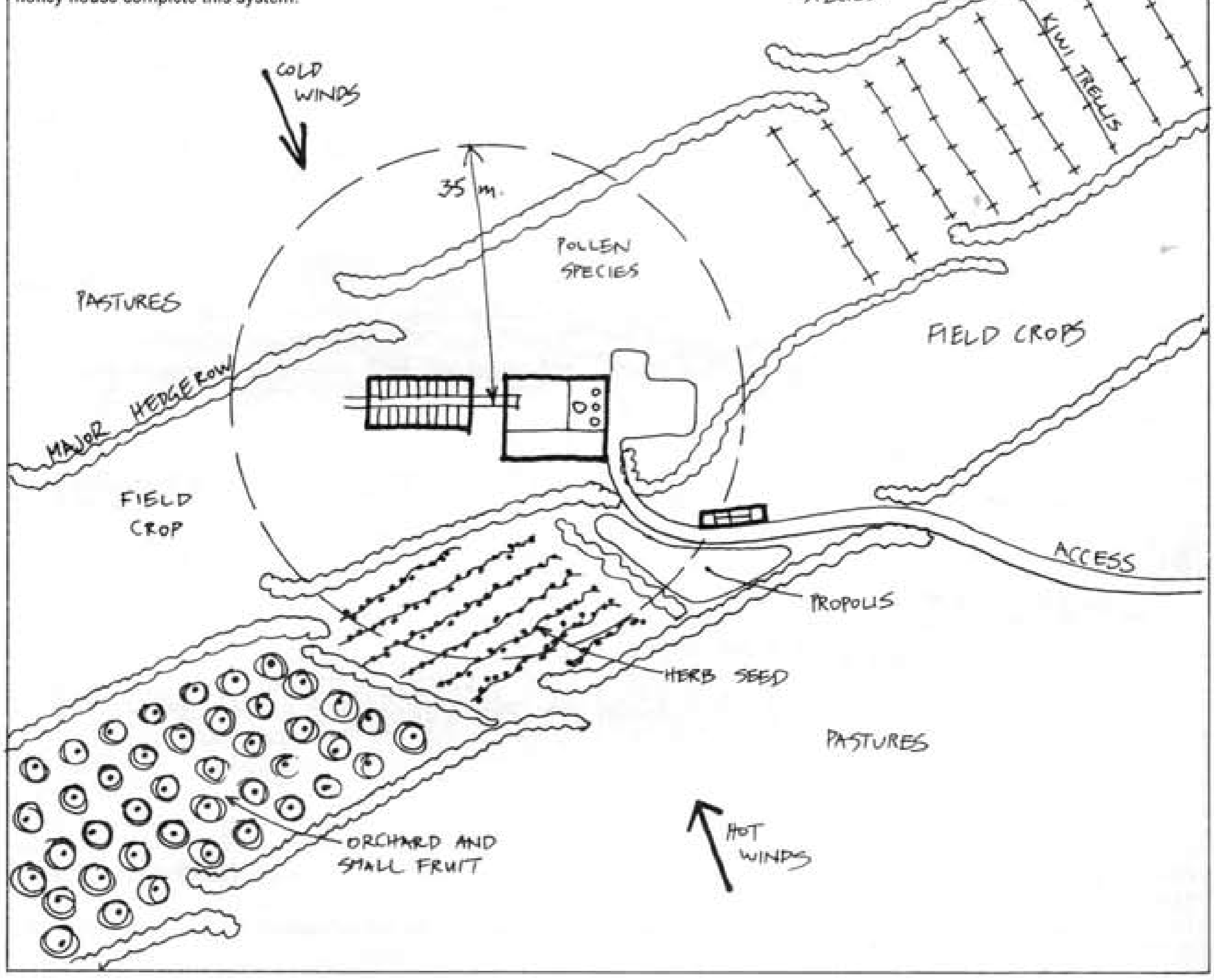


**TABLE 12.1**
BEE FORAGE SPECIES TABULATED FOR SEASON AND TYPE OF HONEY (COOL TEMPERATE CLIMATE)

| | EARLYMID Season | LATE Season | Season |
|---|---|---|---|
| CLASSIC | Rosemary | Leatherwood (*Eucryphia billardieri*) | |
| BULK | *Echium fastuosum*<br>Acacia<br>Catmint | White clover<br>Blackberry | *E. fastuosum*<br>Eucalypt |
| SPECIAL & CROP HONEYS | Gooseberry | Smallfruits | Mustard |

and exhaling in about a 1.2 minute rhythm. As hive temperatures are normally high (at about 21°C), so hive insulation in cold weather is important, and in Denmark bees are over-wintered in thatched attic areas, or stored in insulated hive houses in other parts of Europe. Conversely, in areas of hot summers, hives need shade and good ventilation, or honey is lost as energy used in cooling (fanning) by the hive.

Access to water is most safely achieved by providing soaked mats or hessian at pond edges, so that bees cannot drown while drinking, and *small* ponds or troughs free of dragonflies give less losses than large ponds (where dragonflies are efficient predators).

Having designed the physical outline of a bee range (which in truth resemble any well-sheltered farm), then local lists of honey plants can be consulted for pathsides, road verges, hedgerow, and forest. It repays the beekeeper to do careful research into bee forage species. We could handily divide forages into early, mid, and late season for a good spread of yield, and again into classical, bulk, and special honeys and pollens for mixing and specific market. Some classical (highly preferred) honeys are: "heather" honeys (sage, thyme, catmint, rosemary); pine tree or basswood (*Tilia* spp.) honeys in Europe and the USA; marsh tupelo honeys (subtropics), leatherwood (*Eucryphia*) honeys of Chile and Tasmania, and citrus honeys.

Bulk honeys suitable for blending derive from clovers, eucalypts, *Acacias*, field crops such as mustard and buckwheat, fruit crop usually from the family *Roseaceae* (blackberry, raspberry, apples), and "mixed garden honey".

Special pollens are those collected from plants such as some *Acacia* and goldenrod, the pollens of which may cause asthma if inhaled by susceptible people. Eaten, these honeys or pollens (like the young leaves of poison ivy and poison oak) act to prevent allergic reaction.

Thus, the selection of forage species can be entered into a 3 x 3 table, as in **Table 12.1**, for any particular site and climate.

It is best to have 35 main forage species over the whole season, as species such as clover and eucalypts may vary in yield from year to year. Similarly, pollen species are selected on the same basis, and pollen traps fitted to the hives at periods of high yield. Hives should yield about the same weight of pollen as honey, and the latter provides a high-protein additive to any flours or starchy foods.

Given that we have designed a range for bees, then the same areas presents a unique opportunity to grow crops—especially seed crops—dependent on bee pollination. Such crops are: kiwifruit, any bramble berry, smallfruit, mustards and *Brassicas*, clovers, apples or pome fruits, buckwheat, *Acacia*, stone pine, and so on. Crops within a mile of hives will outyield crop in bee-deficient areas by a factor of 3–10 times.

Thus, we can sketch out the essential ground plan of an excellent bee farm, which would also and ideally be a production farm for fruits and seeds (**Figure 12.11**).

### POULTRY RANGE

The two basic breeds of modern chicken are the *light* and *heavy* breeds. Light breeds derive from Spanish ancestors, and probably from Indo-Malaysian jungle fowl. They are flighty, poor mothers, lay white eggs in spring and summer, are cold and wind sensitive, and prefer sandy or light soils of high pH. These breeds have long legs, full combs, four toes, are lightly feathered, often possess white ear lobes, and fly well; we know them by their older Mediterranean names of Anconas, Andalusians, Minorcas, Leghorns, and more rarely by northern European names such as Hamburghs.

Heavy breeds derive from Chinese fowl, via ancestors such as the Langshan. They are non-fliers if not chased, excellent mothers, lay brown eggs in summer and autumn (even through winter), are hardy to cold and wind, and tolerate clay and acid soils. Many have heavy feathering, short and sometimes feathered legs, short combs or "rose combs", five toes, and possess names derived from northern Europe such as Scots Dumpy, Orpington, Dorking (of English fame); others have names from breeds developed in European colonies, such as Wyandotte, Rhode Island Red, Plymouth Rock, and Australorp.

Between these breeds, and a few exotic species developed in South America (Araucana), we can select from 60–100 breeds for specific soils, sites, foodstuffs, and either egg or meat production, or both (utility breeds), In laying hens, free-range flock averages of 130–150 eggs per hen per year would be normal for heavy breeds, with rare averages of 180–200, while light breeds such as Hamburghs and Leghorns can usually produce from 160–180 flock average. Unstressed flocks on range will continue to lay from 4–6 years, whereas caged animals wear out under forced regimes of light and manipulation (artificial day length), hormones, and pelleted foods containing several additives. They must be replaced every 18–20 months.

Natural or "wild" flocks of poultry seldom exceed 20–30 individuals, of which 2–3 are cockerels, the rest hens. Surplus cockerels are driven out of the range area or killed, and usually fall prey to hawks or other predators. Larger flocks of 40–60 individuals will break up of their own accord, and form two flocks.

Light breeds are excellent foragers, and breeds such as Hamburghs and Leghorns can obtain most, or even all, of their food on a free range with hedgerow and pasture. Heavy breeds forage well but need supplementary food, especially in winter, and this is generally supplied as grain, grain legumes, and grain mill wastes or root crop mash. All breeds eat domestic and garden wastes, forage fallen fruit and seeds, and pursue and eat insects in the field. Normally, and on correctly stocked range, we would expect poultry to obtain 65% of their food as insects, invertebrates, greens, and grains, and we should supply 30–35% as concentrated grain products (usually weed seed and the cracked or undersized grains from the threshers).

Poultry rearing combines well with a mixed farm economy of orchard, dairy or home milk cow, and some grain crop. In this type of environment, they scavenge many wastes, obtain maggots from manure and cleanse the orchard of the windfalls of soft fruits. In the tropics, abundant fruit like papaya supplies most of their needs. It is true to say that no soft fruit, apple, or citrus orchard thrives without poultry as foragers.

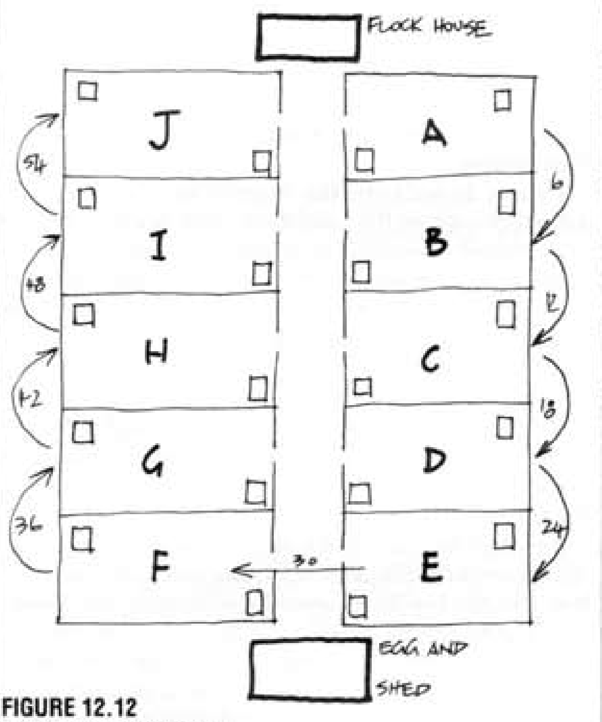



**FIGURE 12.12**
CHICKEN PEN SYSTEM.
Here, flocks are moved every 6 weeks, followed by a vegetable or small fruit crop. Vines on fences add yield; bared areas are limed, raked, sown to crop; figures indicate weeks for a full year's rotation of a 'chicken tractor' system.

Population Density

Chickens (chooks in Australia) are unstressed at up to 800–900/ha, providing these are housed as 20 or so small flocks in sheds about 2 m per side (**Figure 12.12**). More ususally, households keep one flock of 20–30 hens as a food supplement, and these may never range on greens where space is limited, but have cut greens supplied to them from garden weeds to roadside grasses.

At 800/ha, chickens forage so well that other livestock cannot find sufficient browse, but at 350–400/ha sheep and cattle can also use the range. Densities of from 120–180/ha are needed just to clean up windfalls and supply fertiliser to orchards. A flock of this size can be rotated around 12–16 pens on one hectare every 18 months, when they remove all weeds, surface bulbs, weed seeds, and grasses and can be used as a "chicken tractor" to clean the ground of nutgrass, kikuyu, onion weed, *Oxalis*, or indeed almost every persistent weed.

As pens are cleared, chickens are moved on, the ground limed, and vegetable or orchard crops placed. Before they return, forage crops of buckwheat, wheat, sunflower, millet, black nightshade, cleavers, chard, and mustard can be sown, and given 2–3 months to mature. The chickens thus plough and clear for their own forage. A separate pen of comfrey, arrowroot, chard, and sunroot can be kept as drought forage, or "throw-over-the-fence" crop.

On range, full nutrition can be obtained by providing seed from such abundant trees and shrubs as *Coprosma repens*, *Caragana*, tagasaste, boxthorn (*Lycium* spp.), pigeon pea, most *Solanum* species with berries, mulberry of 5–6 varieties, and normal fruits. *Acacias* with edible seed (most species), *Leucaena*, clovers, grasses, and "weeds" such as cleavers, chicory, comfrey, *Oxalis*, and dandelion supply the rest of the diet, together with insects and their larvae. Some farmers deliberately pile manure for flies to lay in, and let the chickens in to eat maggots. Others use piles of mulch, cockroaches, termites bred in sunken pits, just loose compost piles to breed insect foods, or mealworms in bran and root mixtures.

Table scraps supplement diets, and large acorns, chestnuts, or starchy seeds can be sprouted or rolled to crack them for chook food, using a garden roller on a hard surface such as concrete or steel. In hot periods, and fed–out grains can be sprouted for 2–3 days, but in winter unsprouted grains and grain legumes are preferred.

Given a free range of such richness, diseases are rare or absent, chooks healthy, and their only needs are dry dust baths with a little diatomaceous earth or dried bracken and neem tree leaves for ectoparasite control, a few wormwoods for intestinal worm control, abundant shell grit or calcium (limestone) gravel for eggshells, hard silica grit to grind food in the crop, adequate predator protection, clean water, and good shade and

**TABLE 12.2**
BENEFICIAL ANIMAL/ENVIRONMENT INTEGRATIONS.

| LIVESTOCK | Market Gardens | Small Fruit | Orchard | Pasture | Wetlands | Range-lands | Flowers & Herbs | Forests |
|---|---|---|---|---|---|---|---|---|
| Bees | • | ••• | ••• | • | •• | • | ••• | •• |
| Poultry | • | • | ••• | •• | • | •• | | • |
| Waterfowl | •• | •• | ••• | •• | ••• | • | | |
| Pigs | • | | •• | •• | •• | •• | | •• |
| Sheep | | | •• | •• | | ••• | | |
| Dairy Cattle | | | • | ••• | • | •• | | • |
| Beef cattle | | | | •• | • | •• | | • |
| Game | | | • | • | •• | ••• | | ••• |

• Compatible  •• Good association  ••• Excellent association

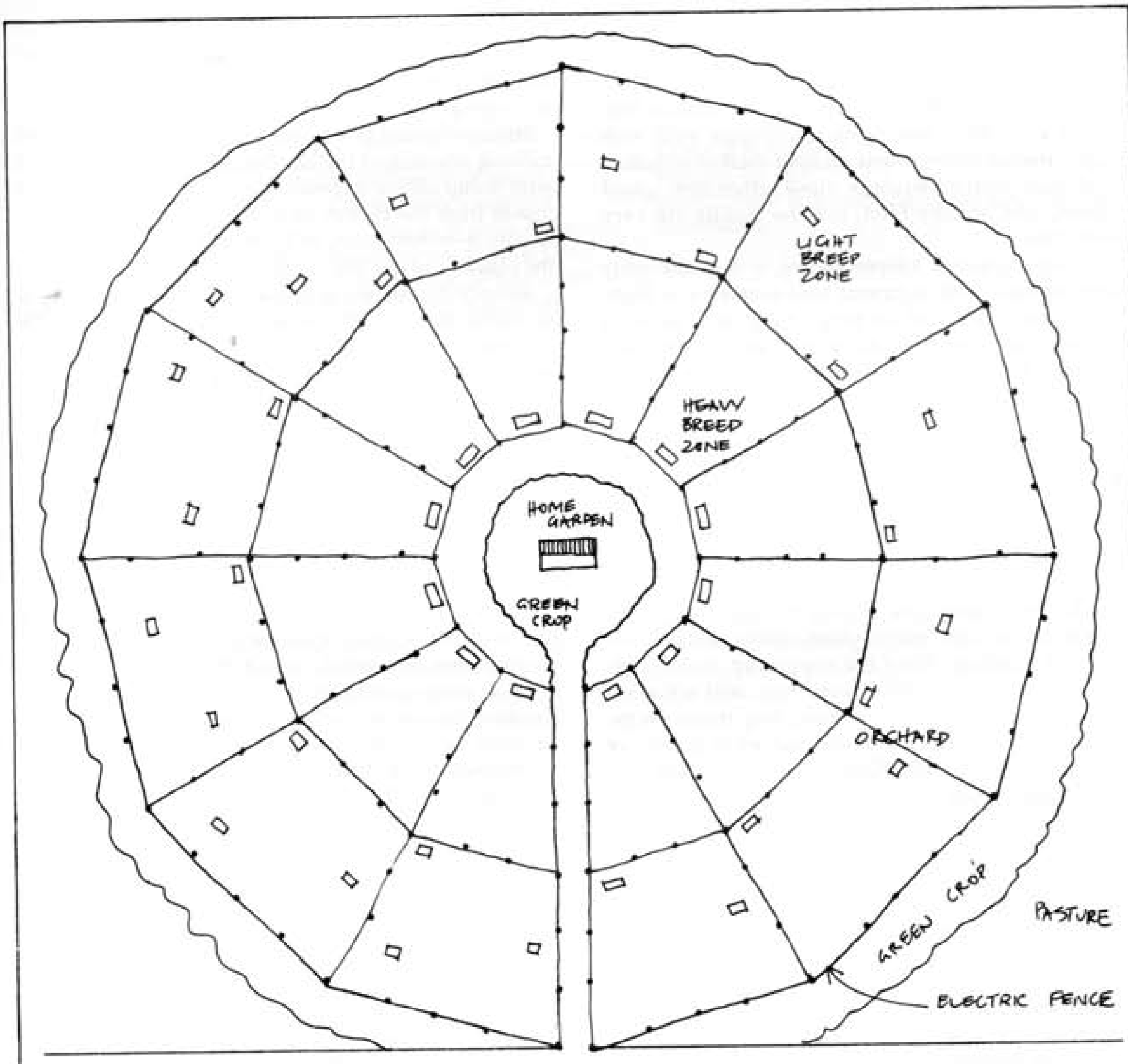



**FIGURE 12.13**
CHICKEN/ORCHARD PENS.
Idealized free-range layout; heavy breeds close to house, some pens always rested, limed, sown to forage crop. Fruit and forage trees omitted.

night shelter.

People who breed their own chickens in the field keep a small flock of Wyandottes or Silky Bantams as mothers or broody hens, and provide secure pens for hen and chicks. Most hardy bantams breed their own chicks on range, as do older breeds such as Hamburghs, Australorps, or Dorkings.

Specialty breeders are numerous, from those who maintain, select, and breed high-performance layers or growers, to those keeping many pure breeds for show or sale. About 13 ha is plenty for commercial egg production, given a careful range plan. By field selection, tender chickens of up to 3.5–4 kg weight can be produced, and the contrast between these and the soft, fatty, bitter, diseased products of caged flocks fed on commercial pellet foods must be experienced to be believed.

All chicken flocks need observation, culling, replacements, range adjustment, predator control, clean water, and good shelter. Running a 13 ha flock of 3000 birds is a full-time family job, combining well with chicken tractor systems and orchard fruit production. Good husbandry requires close attention, good hygiene, and healthy food, but the results are very worthwhile.

As every livestock keeper knows, it is in the early stages of flock establishment that mortality is high. Once chickens are bred on range, they learn to avoid predators and then settle down to an easy-to-manage and quiet flock, and produce excellent food of high quality. As chickens are a universal domestic meat, small enough not to need refrigeration, they can fit into any mixed farm economy with great benefit. All we have said here about chickens can be said about ducks, guineafowl, turkey, and wildlife such as pheasant and quail on range. The latter species differ only in food preferences, preferring more snails, berries, and a higher proportion of insect foods.

Ducks have always been kept in the same range area as chickens, but need marsh plants, snails, and shallow water for dabbling. They too supply up to 200 eggs each/year, are relatively disease-free, and are good foragers; given predator protection, they thrive on the mixed farm. Geese are the traditional small grazers of mixed orchards, replacing lawn-mowers and tractors to control grasses and groundcovers. In the subtropics, rampant greens such as comfrey, *Tradescantia*, arrowroot (*Canna*), sweet potato greens, cassava foliage, and leguminous tree leaves all supply green crop for poultry and domestic animals. Many also yield surplus root crop for cold periods, fed as a boiled mash.

Whenever we think of keeping small livestock, it is wise to think of running an accessory plant system (aquatic or crop) that both benefits from the livestock, and gives them a benefit. Some beneficial integrations are given in **Table 12.2**.

## PIG RANGE

Pigs on range are healthier, cheaper to feed, and have less saturated fats than pigs kept in sheds. The greatest expense is in fencing (now much reduced by the use of electric fencing). The ideal site is preferably wooded, well-drained and dry in wet seasons. Mud and wet soils encourage worms and disease, and can cause trouble with suckling. Winter shedding may be necessary in very cold winter climates, but sheltered ranges and good dry beds help.

Pigs are most economically kept where some dairy, orchard, root crop, or meat wastes are available, and do well on restaurant or household food scraps. As pigs will not eat or do well on coarse grasses, grazing beef or horses may help in reducing these on range, or mowing may be necessary.

A farrowing pen is used by a sow and litter for nearly 3 months. Rested for 6 months, each pen can be used by two sows a year. Various small (or one large) shelter sheds (best thatched or insulated against cold) can be used on rearing ranges, or dense thickets provided in the tropics.

Strong diagonal posts wrapped in hessian make ideal rubbing places, and the hessian can be kept dampened with sump oil, or vegetable oils with some neem oil (made from the berries of *Azedarachta indica* or *Melia azedarach*—white cedar) or pyrethrum oil added to keep the pigs free of lice (**Figure 12.14**).

Restricted wallows and dust baths can be arranged by sheltering or dampening sites, and so add to the comfort of the pigs. Dust baths (a roof over a soft dry area) kill lice and can be laced with some dry neem tree leaves or pyrethrum flowers. Rested mudwallows planted to cattails (*Typha* spp.) provide excellent root and shoot foods at any time of year. Duck potato (*Sagittaria*) can be planted in pond margins for summer-dry forage.

Free-range pigs are not always suitable for bacon, and may need grain-feeding for 2–4 weeks to harden (saturate) the fats. However, for fresh or frozen pork the soft fats are quite suitable and healthier for human consumption. A lot of vegetable oil from avocadoes, oil palms, olives, or oily fish will produce soft fats in pigs.

Good range pasture is of legumes (clover, lucerne), comfrey, chicory, and young grasses (grazed by horses or cattle, or mown). Pigs will eat 11 kg wet weight of this material per day, and have larger appetites than confined pigs. They also need seed, fruit, or kernels. Good quality green feed halves the necessity for protein meal and grains. A sow in milk needs 3.5 kg of dry rations when piglets are new, and 5.5 kg when they are 2–3 weeks old.

To prepare for a free-range planting, the ground should be ripped and limed, then sown down to good grass legume mix, with comfrey, sunroot, and arrowroot pieces pushed into the rip lines. Trees can be planted just outside fences and in corners protected by electric fencing. Any fruit trees are useful, and pigs are beneficial in mature orchards. A selection of plants is given in **Table 12.3** for the tropics and cooler areas.

When considering stocking densities, 20 pigs/4,000 square metres (1 a.) will "plow" (by scratching and

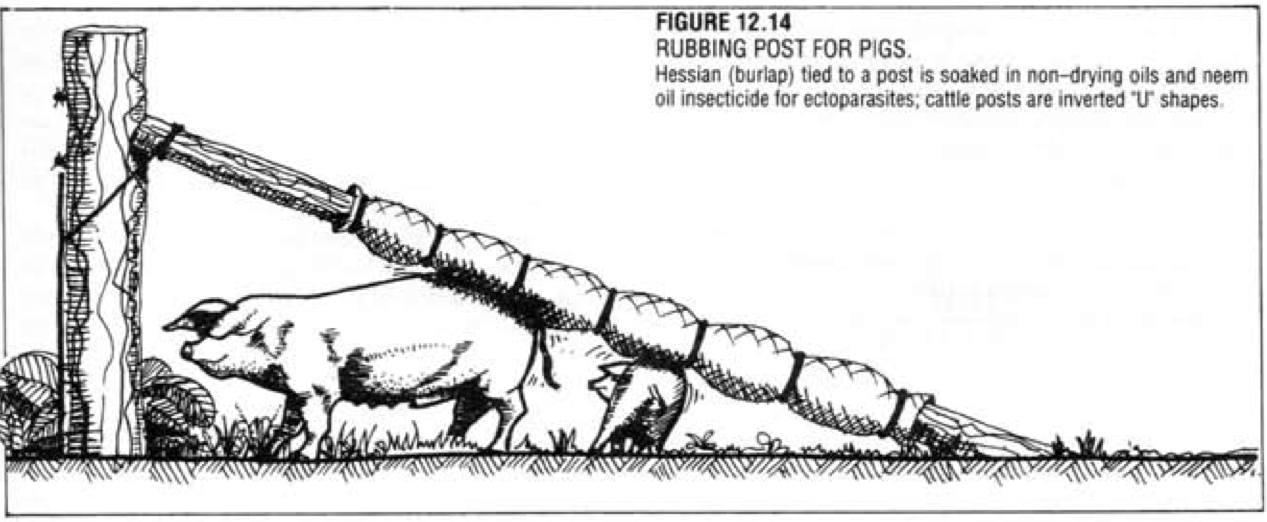


**FIGURE 12.14**
RUBBING POST FOR PIGS.
Hessian (burlap) tied to a post is soaked in non-drying oils and neem oil insecticide for ectoparasites; cattle posts are inverted "U" shapes.

**TABLE 12.3**
SELECTED PIG FORAGE SPECIES

| TYPE | TROPICS | COOLER AREAS |
|---|---|---|
| **Trees** Planted in protected areas, outside pens | Mulberry, Bunya pine, fig, Inga *(Inga edulis)* Palms: Chilean wine palm *(Jubea spectabilic)* Jagua palms *(Jessenia spp)*, Buriti palms *(Mauritia spp)*, Babassu palms *(Orbignya spp)*, Assai palm *(Euterpe oleracea)*, and *Atallia spp.* Oil palm *(Elais guineensis)*. Date palms (*Phoenix spp*), coconut *(Cocos nucifera)*. | Mulberry, fig, olive. Palms: Chilean wine palm, canary date palm *(Phoenix canariaensis)*. |
| | Oaks, chestnuts, chinquapins, breadfruit, jak fruit, and *Prosopis*. pods. Honey locust, carob (dry areas). Chinese tallow tree, *(Prosopis)*. | Oaks, especially white oak group, cork oak, turkey oak, chestnut, chinquapin (some need to be collected and shared!) Rain tree *(Samaea (Albizzia) saman. A. dulcis Argania sideroxylon*: fruits. |
| **Roots** Planted in rooted-up pens as sets. | Cattails *(Typha)*; arrowroot *(Canna edulis)*; Jerusalem artichoke; comfrey, yams, taro; sweet potato, potato, cassava (boiled), elephant-foot yam, *Marantia*. | Cattails; potatoes; Jerusalem artichoke; comfrey. |
| **Greens** As sets and seeds following rooted ground. | Chicory, lucerne, comfrey, white clover, pigeon pea *(Cajanus cajan)*, *Desmodium ovalifolium*, pumpkin, chayote (choko), sunflower (heads), cowpea. | Chicory, lucerne, comfrey, white clover, grasses, broad beans (favas). |
| **Fruits** Protected 3 to 5 years if valuable. | Papaya, mango, banana spp., and avocado are staples. Guava; anona; *Inga* in grasslands; sapote; canistel. | Apple, pear, plum; pigs assist orchard health. |
| **Pests** | Neem tree oil for mites; the fruit is poisonous to pigs. | Pyrethrum daisy-flowers dried and used in nests or dust baths for mites; also use diatomaceous earth for lice. |

rooting) the area for planting comfrey, sunroot, lucerne, chicory, and clover. It then needs to rest. One hundred pigs in 2 ha (5 a.) pens will plow 40 ha (100 a.) in 18 months. They will remove gorse, blackberries, and small shrubs. They can be followed by sowing, then cattle, then pigs again.

Count on at least 1 ha (2.5 a.) per breeding sow, laid out somewhat as in **Figure 12.15**. Areas for tree planting are outside and in the corners to start with; later, pens can be planted out in blocks using electric fencing to keep pigs away from young trees. In the tropics, banana, papaya, and like fruits will be rooted out by pigs, so these need to be outside the pens. As pigs are moved, root crop can be planted in the pens.

The whole site plan can be handled fairly casually for a few pigs on a large range, or a clean pen will hold a family of pigs for using surplus crop, but needs very careful planning and siting if pig-raising is to be an occupation. It takes 3–5 years to develop a full complement of foods on range, and even some of this must be thrown over the fence to the pigs, as is the case for bananas and papayas.

## 12.12
## THE LAWN

"Lawn aesthetics do not permit the chaotic intrusion of vegetable gardens...since vegetable gardening smacked of poverty or peasantry, many of the new middle class (from 1897 onwards) were loathe to sully their turf with mere food." (Bob Schildgen, "Lawns: America's Creeping Carpet", *Pacific Sun*, November 1982).

We can, to some extent, trace the development of the lawn from those shortcropped vistas developed by geese and sheep on rural estates in cool humid climates. "In a photo from the USDA Yearbook of 1897, a flock of sheep grazing in Central Park (New York) are described as 'the lawn mowers or turf makers' of the park." (Schildgen, *ibid*).

In the USA, it is estimated that 16 million acres were devoted to lawn by 1978 (*The Integral Urban House*, Farallones Institute, 1979), and a vast expansion of lawns has taken place there in recent years. At that time, lawns were considered to be the single largest "crop" system in the USA, requiring 573 kilocalories per square metre to maintain—more than the energy used in the production of corn or vegetables. The yields of this agriculture create a massive public disposal problem, consisting as they are of poisoned grass waste, rich in Dieldrin, DDT, biocides, and nitrogen.

Millions of litres of petrol are used in lawn and turf maintenance. By 1978, lawns used 15–20% of the annual fertiliser production of the USA; equal to that used on the total food agriculture of India. As for water use, 44% of domestic consumption in California is used for lawns, which is another enormous public cost of lawns, as well as longterm groundwater, atmospheric, and soil pollution costs.

Let us now say that every society that grows extensive lawns could produce all its food on the same area, using the same resources, and that world famine could be totally relieved if we devoted the resources of lawn culture to food culture in poor areas. These facts are before us. Thus, we can look at lawns, like double garages and large guard dogs, as a badge of willful waste, conspicious consumption, and lack of care for earth or its people.

We can clearly see the lawn as the world's "third agriculture", after food gardens and farms. Few people realise just how large this agriculture has become following the development of automated mowers, slashers, "whipper snippers", edgers, plug-cutters,

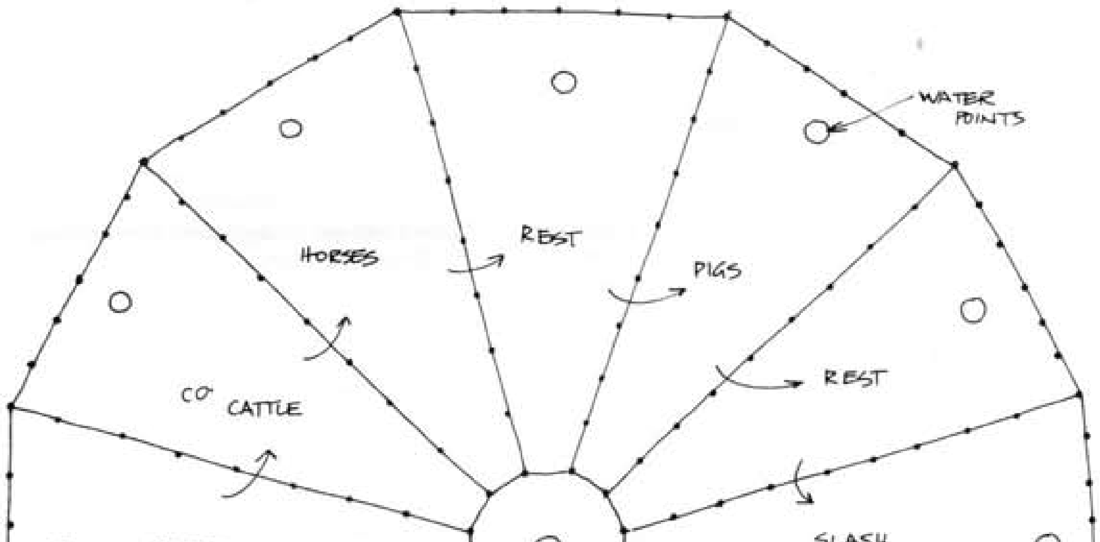



**FIGURE 12.15**
DIAGRAMMATIC PEN LAYOUT
for mixed species successions on range; forage must be closely watched in order to time moves; ideally there are 15–18 pens, 4–6 animal species, and mixed forage stands.

aerators, sprinkler systems, and the development of teaching institutes, journals, retail outlets, and very large firms to service the turf and lawn industry.

It is now probable that the lawn cultures of affluent nations use more water, fertiliser, fossil fuels, biocides, and person–hours than either gardens or the formal broadscale agriculture of that country, or indeed any agricultural resource of the third world. Of the lawns developed today, perhaps 13% have any use in recreation, sport, or as rest areas. Most lawns are purely cosmetic in function. Thus, affluent societies have, all unnoticed, developed an agriculture which produces a polluted waste product, in the presence of famine and erosion elsewhere, and the threat of water shortages at home. Some actual case histories:

- On the dry island of Moloka'i (Hawaii), golf courses are being developed near resort hotels, and an engineer there estimates an annual cost of some $400,000 as maintenance, interest on capital, and repairs to pumps, water systems, and turf areas. This is more than is spent annually in food gardens on that island.
- In Massachusetts, Connecticut, and Kentucky, many small farms are being converted to lawn systems by city owners; even in towns, the average suburban lawn area is about 650–900 square metres (5000–7000 square feet), and the yearly maintenance cost is about $30 per square metre, with up to six heavy biocidal sprays per year for pests (chinch bug) and weeds (flat weeds).
- In Perth (West Australia) lawns use 254 cm (100 inches) of water per year, in a water scarce area where salted land is extending annually, and the groundwater table is falling from about 90 m to 450 m.
- On the Canary Islands, resort hotels with lawns, swimming pools, flush toilets, and irrigated aesthetic gardens have effectively dried up a productive small farm economy; now atomic power is being contemplated as a method of creating fresh water from seawater.
- In one agricultural college (Orange, NSW, Australia), the energy officer calculates that the fossil fuel and personhours spent on maintaining the 10 ha (24 a) of lawns exceeded costs for the mixed farm of 50 ha (120 a). He recommended shrubberies for all but the 1.5 ha of lawn used by students.

The lawn has become the curse of modern town landscapes as sugar cane is the curse of the lowland coastal tropics, and cattle the curse of the semi–arid and arid rangelands.

It is past time to tax lawns (or any wasteful consumption), and to devote that tax to third world relief. I would suggest a tax of $5 per square metre for both public and private lawns, updated annually, until all but useful lawns are eliminated.

Exemptions would be for non–mown swards grazed by productive animals, short natural turf such as is produced by *Phyla (Lippia) nodosa*, or chamomile, and handmown areas of lawn that use no water or bio-cides. The rest is a shameful waste of global resources.

To reform the lawn, new permaculture businesses are evolving, using natural (non–irrigated) ground covers, berry and smallfruit shrubberies (salal, blueberry, cranberry), flowering meadows of native bulbs and perennials, copses of small trees, ponds, marsh or fen areas, and rock gardens or specialty gardens of perennials. Even vegetable plots are slowly becoming respectable as values change from the production of waste to the production of food for the home. A new ethic is arising that will reverse the status of waste producers, and new ethical investment portfolios are eliminating support for many such destructive industries.

Lawn reform, on the basis of health, costs, and ethics alone, is a rich field for innovative design, and needs disadvantageous taxing to bring it under control, or we risk converting all land not in housing to sterile lawns.

## 12.13 GRASSLANDS

Perennial grasslands (veldt, prairie, meadow, steppe, herbal ley, pasture, and heathlands) are a feature of mesothermal climates. Many, in fact, are treeless areas established during periods of icecap retreat, and have never established as forests, although both soils and climatic factors will permit forest establishment. Other grasslands are maintained by fire (natural, from lightning strikes; or managed, from human interference) against forest invasion.

Many aboriginal peoples so managed their environments as to maintain herd species, berry crop, nettle crop, or some aspect of the fire–succcession ecology of benefit to their food supply or resource base. The management of natural grasslands by fire is a skilled task; too frequent or too hot fires not only destroy soil structure but tip the balance from perennial bunch grasses and herbaceous species to fireloving annuals (wild oat) of low nutrient value and poor yields in the winter or late summer season.

Most natural grasslands lie in the Eurasian land mass, with Africa and North and South America providing veldt and pampas respectively. Areas such as the poa tussock plains of New Zealand and southeast Australia were fire–created and maintained by aboriginal peoples. Except in nature reserves or sparsely settled regions, even the great prairies of North America and the pampas of Argentina and Brazil have been converted to pastures or cropping, as have the Russian steppes and the African veldts. In every case, net protein production has been reduced and soils eroded.

Perennial grasslands (*not* crops of annual grass species) are very stable systems, and while a forest may have a visible "standing crop" of 207 t/ha, and grasses only 7 t, below the ground forests produce 184 t/ha of organic matter to the 345 t/ha of natural prairie in equivalent soil/climate regimes (Foth, 1984, based on other studies). Forests have most of their biomass involved with gaseous exchange in the atmosphere, and also with deep nutrient recycling, while prairies of grasses, forbs, and their associates act more on the near soil surface, and are copious producers of litter and shallow root masses (195 t/ha versus a forest's 106 t/ha in the top 30 cm of soil). Both function to complement the other in different strata of the soil/ atmosphere interface.

The profound difference lies in the fact that the regeneration time after "harvest" or removal of all or part of the standing crop is measured in decades for trees, and seasons or even weeks for grasses, so that yields from the standing crop (where this consists of the vegetative parts of the plants and not the seeds, honey, or fruits) may favour grasses. If the forest takes 80 years to regrow from the ground level, then it "yields" or gains about 2.5 t/ha/year. If the grasses can be cut or grazed twice in a season, then they can yield some 10 t/ha/year. Grasses do this by developing their buds or growth points close to the ground, below cut or browse damage, and keeping a lot of their mass in living roots (97% or so of the total biomass). Trees, when cut, lose most of their meristems (growth centres or buds) and have relatively less root reserves (less than 50% of their total mass).

Yields to people or cattle are not, however, the important factors in the sustainability of systems, as we have often proved to our cost. Trees both shelter, provide nutrient to, and supply offseason or complementary yields when grasses are affected by drought or cold. It is, as ever, a matter of balancing the components of the system so that both trees and grasses can serve the stability of the whole, whether we use them or not. It repays us too, in the long term, to see that a balanced system persists in its yield, rather than our demands run it down to a desertified endpoint of low total yield. Like machines, plant systems are of greatest benefit when they prove durable and reliable, and we should always think of "yield" as complexed by the length of time that yield can be maintained. Grasses, in effect, offer for our use only a little part of what they have, while forests make most of themselves visible and available (sometimes at their peril).

Grasslands (or rather herblands) lie between forests and deserts. Alpine herblands lie above the treeline, and below the barren upper slopes of mountains, as savannahs lie between humid rainforest and deserts, and riverine or shoreline herbfields between the forest and open water. Grasses and herbs can always retreat to the buffered atmosphere of the topsoil and escape cold and heat, while trees must stand and endure the changes of seasons. Every forest has its herbland edges, each characteristic of that place, soil, and history.

Of all of earth's great plant systems, it is grasslands that we most favour by our use of fire and plough. Waiting for the right wind and weather, pre- industrial peoples sent fire across the dry grasses to kill or invade the forest edge. We built many of our plains this way from the edges of water and deserts to the hills and valleys of humid and fire-resistant forests. Maori, Inca, and aboriginal African and Australian peoples explored by fire, and destroyed forests to do so. Behind the fire front, trees (perhaps adapted by developing fire-resistant bark, foliage, buried buds, and hard seed) advance to reoccupy the land, so that many plains have a dark, wet rainforest edge polewards, and a savannah forest of adapted trees (most are fire-dependent) following along from the direction of the hot winds. It is a common pattern to find these "moving plains" in areas still subject to fire management alone. Eventually, we too become dependent on the grasses, the animals that feed on them, and the fire.

We flourish best, however, on the forest-plain edges, where we and our associated animals can profit from both herbland and forest, and we as conscious designers need to complex the agricultural grass deserts with many more herb species, and with clumps, lines, contours, and valleys of trees.

"Grasslands unsuited for farming exist in every continent, and there is surely no better way to use it than to preserve its wildlife." (Eric Duffy, 1979). In fact, most dry savannah veldt areas of Africa and Australia are unsuited for farming, although rich in natural protein yields (e.g. kangaroo). We may never again equal the product yield of the 60 million bison on the American prairies, with their unnumbered associated hordes of pronghorn and mule deer, and a host of minor species. The 80 or so large mammals of Africa, and the 60 associated species of antelope can never be equalled in total biomass, yield, or value to the earth by a propped-up, energy-consuming and essentially retrograde pastoral system of a few species of domestic cattle and goat flocks.

Russia has preserved and encouraged Saiga antelope (from near extinction in the 1940's) to over a million today, and can cull 40% of these annually for food. They are the best-adapted tundra animals. The Lapps likewise manage their reindeer, by travelling with the herds on their migrations, and (until Chernobyll) took a sustainable yield from the sub-arctic meadows and lichens that would be destroyed by cultivation or disturbance.

About 24% of the earth's surface is in some form of grasslands. Originally, these were not the simple grass-legume or mono-crop cereal stands that we have subsequently developed, but contained many hundreds of plant species. Even of the true grasses, which number 7,500 species, we now use only 30–40 species in pastures and less than 20 as grains. A rough classification of grasslands is as follows:

Natural

- *Mountain meadows.* Called alps in Switzerland, they are often flower-rich and least modified by man.
- *Continental interiors.* Variously termed prairie, pampas, veldt, they have been greatly modified and only exist as reserves.
- *Savannahs* or scattered tree systems, in which grasses may be less numerous than forbs (nongrass plants such as bulbs, orchids, various flowers, succulents, annual or biennial dicotyledons, forage shrubs,

and forage trees).

• *Reedbeds* and coastal dunes, coastal or river fringes, swamps.

Artificial

• *Pastures*. Some semi-permanent and relying on 30 or so grasses plus forage legumes.

• *Lawns*. A few species (5–10 common), mainly grass.

• *Cereal crops*. Usually as monoculture or simple mixed crop systems with a legume or legumes. A subset is wet padi crop (rice).

Grasses are of great value in soil protection and erosion control, especially in difficult situations such as on dunes.

A great many of the flowers and vegetables we use today were part of the original flora of meadows, including the dune meadows and seashores. These include almost all onions, poppies, cereals, peas and beans, amaranths, mints, ground orchids; all bulbs, iris and other rhizomes; anemones, sages, herbal *Compositae* such as fennel, carrots, parsnips; the *Brassica* family, comfrey, peonies, asparagus and so on. Alpine meadows still include a great many species, but we have banished flowers and bulbs from the broad "grassland deserts" of our pastures in modern times.

In the Berlin Botanical Garden, there is about an acre of reconstituted European meadow, which includes many nonagricultural grasses, and about 80 species of flowers (some now very rare in the agricultural environment). That this recreated acre is about the only area so rich in native species is a commentary on the sterility of western industrial societies and the chemicalised farm. We have eliminated almost all the ancestors of our herbs, vegetables, flowers, and root crops to make way for beef and a few crops. In Yugoslavia and Ireland, rich meadows and bogs still exist where progress (or misuse) has not overtaken the environment.

Old castles, cemeteries, rail reserves and unsprayed or unmown roadsides shelter the prairie and steppe refuges of the USA and USSR, although belated reserves of their ancient companion plants have been established in both countries. Wherever meadows still exist, a visitor will notice the richness of insect life (especially conspicuous species such as bumble bees and butterlies), and the deep springy softness of the earth itself. It is the deep tunnels of undisturbed burrowers that produces an absorbent mattress of meadow on the earth.

A single Russian ground-squirrel (suslik) will dig some 200 holes per acre, and turns over 95 cubic feet of soil per year. Susliks are eclipsed by woodchucks, moles, wombats, and (as a group) mice and voles in this deep-ploughing effect, and prairie dogs and rabbits may fully tunnel out and manure many acres.

A great many bulbs with poor seed set, and rootset plants such as comfrey are planted by these underground gardeners, who leave forgotten storages of tree and meadow seed, root cuttings, and bulbs in shallow tunnels. A North American gardener can never rely on keeping comfrey in one place if gophers are in the area! Many plants thus came to rely on vegetative rather than seed propagation in rodent-rich meadows, while as many seed eaters became involuntary gardeners. Even the regurgita of owls sprout meadow seed caught in the fur of their victims, while the neglected underground stores of their prey species are left uneaten, to sprout later. As so many of these tunnelers are eliminated by plough culture and many become pests of stored grains or crops, they have largely disappeared from civilised parts, leaving hoofed animals to compact the earth without relief.

In the tree clump savannahs of Africa and Australia, and in the marshlands, only the raised mounds of termites and ants present well-drained and manured tree sites. Everywhere in grassland, the burrow spoil of ants, moles, mice, and rabbits dot the landscape. On these soft bare-soil places, dogs and cats defecate, and blown seed finds a seed bed. Fox and dog dung as often as not contain the seeds of mulberry, plum, loquat, and vine fruits, which rely on a combination of loose soil and manure.

We can recreate meadows and prairies. A little research and gathering will provide the seeds and bulbs, and today many meadowseed mixes are sold. If we do the job properly, however, we must also tolerate the burrowers and their predators. Today, many thoughtful and observant farmers are including more and more herbs in their leys (mints, chicory, dandelion, cleavers, daisies, plantain, and vetches) to the great health benefit of their herds. When we eliminate the bulbs, herbs, mushrooms, copses, hedges, and small animals of the agricultural landscape, we also lose part of the body of the earth and of ourselves. There is nothing so dull, anti-intellectual, and sterilising as the contemporary agricultural scene. We may yet die of the poisonous policy of: "CLEAN, DEAD."

For cool humid areas, perennial pastures usually consist of a sward carefully composed of grasses and legumes. Traditionally, good strains of perennial ryegrass (*Lolium perenne*), cocksfoot (*Dactylis glomerata*), white clover (*Trifolium* varieties) and some lucerne (*Medicago*) would be sown, and carefully managed for grazing on the basis of short-rotation stocking. However, there are several more innovative ways to increase nutrition, drought buffering and mineral balance in such pastures. In high-value landscape (well-structured soils at gentle slope) fenced-off browse lots and hedgerow tree forage strips are obvious ways to extend and buffer the system. Today, permanent electric fencing is cheap and effective in partitioning pastures and protecting new forage hedgerow.

In the contoured hedgerows, an under-sowing or set planting of lucerne, comfrey, chicory, selected dandelion; and a midlevel planting of tagasaste, *Caragana*, *Coprosma repens*, and pampas grass (*Cortaderia*), with a tall overstory planting of willows, poplar (selected high-value forage cultivars), white oak, chestnut, honey locust, and known desirable woody browse (hawthorn and *Rosa* spp e.g.) could be designed to occupy 10% per annum of the area, until year 4, when 40% of the total area would be broad, complex, contoured hedgerow of deep-rooted woody plants and forbs, with evolving tall-tree browse and mast-crop species, some of long-term value as timber. After years 4–5, timed and observed access to such browse could be permitted for sheep, young stock, and cautious harvesting by cattle. From years 6–8, longer browse times can be permitted, and in emergencies species such as willow and poplar cut and fed as drought rations.

In farming, we distinguish between temporary grasslands sown to rest the soil and provide hay or green meadows [leys, or short-rotation pastures (1–4 years)], and the permanent pastures sown for constant grazing (100 or more years). Soil crumb structure, humus, and soil nitrogen all show a slow improvement under permanent grasses, so that 25 years is needed to notice a pronounced effect on these factors. For cropped soils (nitrogen 0.11%), a climb to 0.17% takes 25 years and often 100 years; 0.25% nitrogen is measurable under permanent grassland. In every case, legumes sown with grasses are essential to soil improvement, and arable crops soon after leys show increased yields for 3–4 years. In a traditional cool temperate farm landscape where soil health is valued, some 25% of land will be in 1–4 year leys (red clover as a legume) and 15–25% in permanent pasture (white clovers). The rest (60%) would be in grains, green crop, and root crop. In such a landscape, soil condition is usually good, but modern farming rarely follows such conservative methods.

As livestock must be housed in colder snowy climates for up to 200 days a year, very large quantities of manures and urine are available from barns to keep sward and crop in fertiliser. Manures are more evenly spread as a liquid slurry, or more recently are fed in below the sward using a soil conditioner (**Figure 12.16** shows an illustration of such technology from *New Scientist* Aug '87, p. 30). The latter method prevents loss of nitrogen to the atmosphere, hence deters pollution, and enables maximum use of the slurry by pasture swards. Incidental aeration also results from this method. Slurry is so injected at 140 cubic metres/ha, 13 cm down. Autumn is the best time for least disturbance to the sward (3-4 weeks rest).

Leys are also being used (since the 1950's) in the subtropics, again with grass-legume mixes for 2–4 years, followed by crop. Grass-legume mixes are important soil stabilisers down to 45 cm of rain, especially if sown in wet seasons, fertilised, and planted with scattered or hedgerow-drilled *Acacia* or leguminous trees. Below this rainfall level, opportunistic barley or oats in winter hold soils while leguminous trees and woody shrub seed establishes. Grasses without legumes do not noticeably improve soil reserves. Leys unbalanced towards legumes may produce an acidic soil condition and nutritional problems in livestock. Pastures are kept in balance by strategic browsing or mowing.

MANAGEMENT OF LIVESTOCK ON GRASSLANDS OR RANGE.

Despite the fact that plant breeders have "concentrated on producing grasses...that would respond to high nitrogen inputs...UK farmers now apply nitrogen fertilisers at 20 times their prewar rate, but in 40 years the number of cattle and sheep carried by each hectare of grass has scarcely doubled." This increase, as well, can be attributed more to improved grain feeds and the use of lime on pastures rather than from the application of nitrogen (Harvey, G. "Grassland Production and Nitrogen, *New Scientist* 15 Feb '79).

The great drive to nitrogen fertiliser (aided and abetted by agricultural advisors) was as a result of overproduction in explosives factories, or in fact war surplus dumped on farms. Fertiliser became 30% of energy use on farm but brought no such increase in return. Nitrogen was once supplied free by clover, which has now been discouraged by repeated ploughing (fossil fuel energy) so that grass would grow. Today, scattered leguminous trees on range are known to supply sufficient nitrogen, and free-living soil bacteria and algae also are cultured and inoculated in soils to assist this effort.

No observer of field conditions can fail to see the hunger of cattle on highnitrogen sward for the leaves and bark of trees, so that trees which have stood for years in unfertilised pastures are "suddenly" attacked and killed by cattle where nitrogen is used. Clover can, in fact, supply growth equivalent to 200 kg of nitrogen /ha and is far better utilised by cattle than is the the grass sward recommended by advisors. This energy ratrace is typical of pasture developed without any sound nutritional observations or attention to livestock preferences.

It is evident on any heavily browsed areas that only poisonous, spiny, or very tough plants eventually come to occupy a range, so that noxious weeds are another indicator of overuse of range, although we blindly blame the weeds that protect the soil, not the management or cattle.

Some changes are more subtle; flatweeds (plantain, dandelion) may come to occupy more of grasslands in cool climates or areas of poor drainage. Permanent bunch grasses, succulent in dry periods, may be replaced with ephemeral annuals which drought-off in summer, and low tree browse may be eliminated, as has happened in California and many dry areas.

There are several management strategies which can reverse these trends. For instance, in the above example flatweeds unpalable to sheep are preferred by wallaby. Bunch grasses will remain if heavily stocked, seeded again, and then completely rested (this is a question of fencing strategy). The best strategy is to balance browsing species with plant species, to allow rest periods on range, and to avoid fixed stocking of animals on any one part of the range. Good managers allow a 2–9 year rotation of herds, using 15–18 fields or runs, and pay close attention to observed regeneration of browse. The longer (9 year) period is used on subhumid desert borders, the shorter period on humid lowlands.

There are several ways to crop grasslands and associated woody browse.

• Natural or Managed Wild Systems. A great variety of plants and animals interact; adjustment to available browse is made by migration (herd species), and light stocking (residents), or by very efficient metabolic and reproductory processes.

• Long-Rotation Stocking. Domestic species on extensive range, very light stocking, long rotation (7–9 year). Drought-immune, such range maintains woody and selected browse; there are low returns per hectare but a sustainable yield and no environmental damage. OR, ideally 15–18 fields, 18–20 month rotation, 20–30 days/field, and Keyline irrigation (for beef and sheep production).

• Short-rotation Stocking. On improved pasture, humid areas only. Cows at 15–25/ha for 3–7 days, grass at 15 cm high, rotated for from 3–5 weeks. In good growth periods, some fields are closed-up for hay making or slashed as mulch. *No* grazing before animals are moved (usually 3–5 days). Dry cattle can briefly follow milk cows. In this system 8–12 fields are needed, of which 1–5 are available for mowing in all but very dry or cold periods. Fields not well-grazed can be mown 3–6 weeks before stock are returned. Many good farmers mow and mulch to improve soils.

• Strip Grazing Uses electric fences, permanent or movable, to effect the same result as above, with about an average 2–5 day rotation (grass at 15 cm or better). Intensive, used only on improved pastures, dairy cattle. Akin to *tethering* for a few milk cows or goats on limited improved pastures.

• Cut and Feed. Ideal for milk cows, small herds of 420 cows, tropics, semiarid areas. Shedded cattle are fed from mixed forage (*Leucaena*, *Pennisetum*, comfrey, browse plants). All manure is returned to the cutover area, preferably as a subsoil sludge (**Figure 12.16**). This is an excellent system for villages in poor arid areas or where large herds are not kept. Hay can be cut from surplus growth in good periods. It is *not* sustainable as broadscale feedlot, due to excessive energy costs, waste of manures, pollution, and high overheads of feedlots; this is essentially a small farmer system.

• Mixed Livestock Rotation. Not much used as yet for more than 2–3 species. This would involve horse/cow/sheep/goose/pig succession (or some such) over a mixed forb/grass/ legume/ forage system. Each animal species prepares the sward or browse for a successor. Pigs are used well in advance to plough the ground for new sowings and root sets of (e.g.) comfrey. This system was used by a farmer (Mr. J. Savage in Victoria, Australia) with success. Comfrey is a key element, also lucerne and grasses. The "pig tractor" system obviates the use of mechanised tractors and improves soils. It is well worth trials in any area, choosing a succession of animal species following each other at optimum densities and intervals. The system attempts to reproduce the high yields of natural wildlife systems.

• Fixed Stocking. This method is dangerous if the land is overstocked, and is the most used and misused system. Livestock are rarely moved, and pasture quality, yield, and soil structure can deteriorate. It is not responsive to seasons unless closely watched, and unless sale-and-repurchase pre-empts environmental damage.This system can work with very light stocking, closed winter range, permanent pastures, 6–8 home fields, and careful observation.

All the above domestic species systems relate to "livestock only" farming, and are far more simple and less sustainable than the usual mixed farm situation of crop, forest, marsh, and a variety of livestock balanced to forage wastes. Inevitably, most intensive broadscale systems call for energy and government subsidy, and are political rather than environmental systems. If the world returns to sanity, most of these broadscale systems would be curtailed, and cattle in forests, semi-arid, and montane cold areas would be removed (4% of all cattle production, and probably 70–80% of cattle damage), as they add far less to national income than ther damge they cause to national assets. If this were to happen a careful harvest of wildlife and water would exceed cattle products by many times their value.

The second factor (after cropping) that has reduced the production of natural grasslands, with their gallery forests in valleys and islands of tree species, is the seemingly intractable and modern concepts of private land ownership, hence fencing and the prevention of migratory movements of herds. We may never live to see such errors totally reversed, but it is a very worthwhile design enterprise to both recreate and to experiment with new forms of perennial and productive grasslands and their associated tree species in livestock managment, and for meadow species preservation.

The net product of a grassland in a cool humid climate has a bimodal growth curve very like that of **Figure 12.18** (derived from pasture yields in southeast Australia).

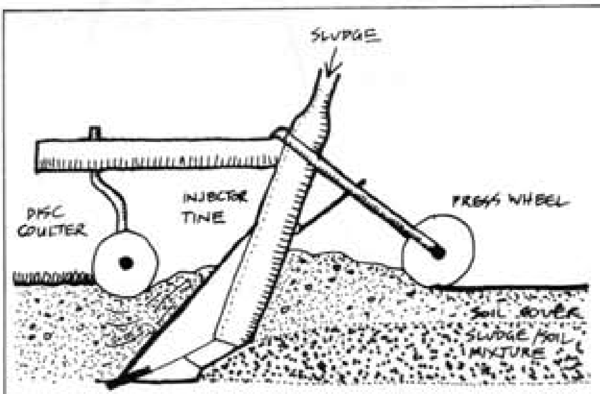



**FIGURE 12.16**
SLURRY INJECTION IN GRASSLANDS.
Liquid slurry injected 18 cm below sward or crop avoids problems of acid water from waste manures; pastures respond in 4–7 weeks.

Thus, there are two periods of deficit, which is always a feature of open grasslands. The late summer deficit arises from the shedding of grass seed, droughting, and drying-off of grasslands, and the winter defecit is simply that of slow or no growth, with snow cover or blizzards affecting herd grazing times.

As the figure shows, there is an absence of green feed in summer and winter. For the summer period, green leaf from forage tree plantation largely overcomes this shortage, although evergreen forage trees may not withstand a hard frost if lopped in the last month of autumn. Many species (such as tagasaste) need mature leaf to carry into frost periods, and so should not be winter-lopped. Such species as willow and poplar are also summer leaf forage due to their deciduous habit, and chips of their wood can be fermented to high-value winter concentrates.

Summer foliage from evergreen or deciduous forage can, like grasses, be pelleted, made into silage, or pressed as hay if dried after lopping. Tagasaste (unirrigated) produces the equivalent forage weight of irrigated lucerne. Given a seed source, such forages as tagasaste can be field-drilled with a normal seedbox used for other crop, and a mix of tree seed and daikon radish or turnip is often effective in grass suppression while the trees grow. Seed is most cheaply obtained from the soil under mature trees, which can be thrown on a series of shaker trays to clean seed from the grass sod and soil, using a sequence of three shaker trays in one frame (**Figure 12.19**).

Matthew Carpenter, on the cold Canterbury Plain of southern New Zealand, has successfully field-drilled tagasaste for summer sheep forage. One unforeseen benefit is that grasses between tagasaste strips dry out much later, and produce more growth, than grasses in the open field situation. As tagasaste produces abundant seeds for chickens, and honey for bees, it can be used as a forage crop for these species. For cut forage, spacing at 1.0 to 1.5 m is ideal (the stems kept cut at 1 m high), while for seed and bees spacing at 4–5 m produces better forage (Doug Davies, *pers. comm.*).

In constructing, rehabilitating, or producing a seed resource for mixed meadows, the following broad plant groups are involved:

• <u>Grasses, Rushes, Sedges</u>: mainly perennial, bush, or tussock species, but with some annuals, some of which are of geat value to settlement as food (grains). Examples are the ricegrasses, *Panicum* species, and

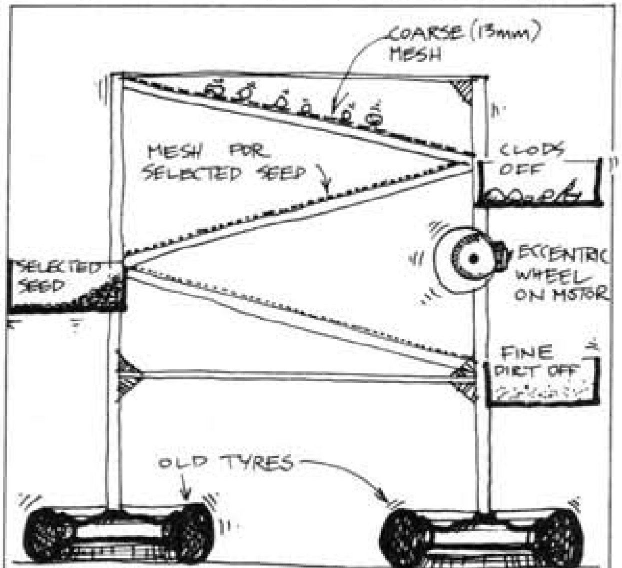



**FIGURE 12.19**
SEED SHAKER TRAYS.
Seed form below trees is easily gathered by this electrically-operated seed shaker system; soil is simply shovelled onto the top tray.

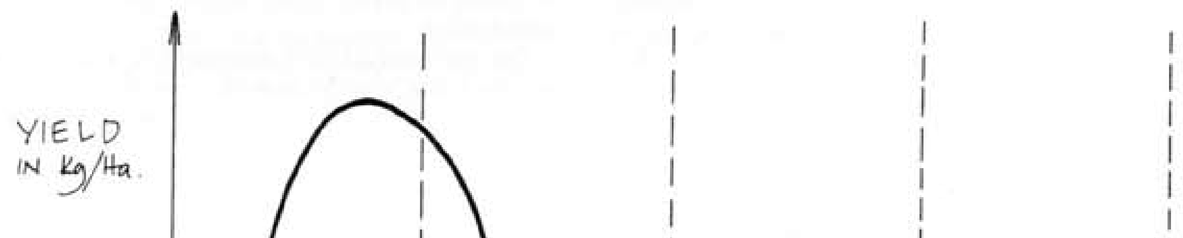



**FIGURE 12.18**
BI-MODAL GROWTH CURVE OF GRASSES.
Classic available pasture curve in mesothermal climates; browse and hay storage, or "lockup" crop, allows for deficits.

rushes used for thatch and matting.

• Legumes: the grain or pasture legumes, clovers, vetches, lupins, tares, and bulbous or deeprooted legumes, some of use for foods as tubers, some twining species.

• Bulbs, Corms, Tubers: perennial flowering plants as bulbs, rhizomes, or tuberous root masses; many are dug as food in winter. Sunroot (*Helianthus* sp.), breadroot (*Psoralia* sp.), crocus, camass, mariposa or sego lily, and a variety of orchids, are of this group. All the onion group belong to this classification.

• Herbaceous and Perennial Forbs: nettles, daisies, and species of the families *Umbelliferae* (fennel, dill) or *Compositae* generally, as well as many flowering plants of meaows (poppies, forget-me-nots, watercress, buttercups) all belong here. A few are annuals, and many have a wide range of uses.

• Spike-rooted Flatweeds: such as dandelion, thistles generally, plantains, docks, and chicory (all high- value browse and some used as salad plants and vegetables) are features of mixed pastures, meadows, and grasslands.

Whether we are designing or constructing a meadow, or rehabilitating one, it is necessary to study a few of the critical characteristics of each plant group. Such factors are:

• Mode of Occurence: Whether the species occurs as clumps, or are solitary in the system. Some species need to be set out as patches or clumps to persist, others do well alone.

• Method of Propagation. Comfrey, narcissus, and sunroot are all naturally propagated vegetatively by being harvested, stored, and forgotten by burrowing animals. Flatweeds such as thistle and plantain seed on burrow spoils, resist close grazing, and therefore occur near burrow mouths or on cropped areas with soil disturbance. Disturbance also suits annuals and windblown species.

• Preferred Soils and Sites: Drainage (from boggy to freedrained gravels or sands) is one critical factor for meadow species balance, as is soil moisture reserve. Acidity/alkalinity is a second primary factor, so that in initial preparation and placement of meadow sites, some variation in such factors can be built-in so that chosen species have a niche or site to occupy. Although meadow plants prefer free drainage, most sedges prefer poorly drained areas, while chicory will colonise compacted ground.

As a meadow is a perennial or selfseeding system, ground preparation must involve an initial earthshaping and weed removal effort. The collection of meadow species involves searches of seed and plant catalogues, roadsides, and reference books, but the end result of meadow recreation is a very useful and pleasing assembly of plants with a varied product base, producing healthy animals on range.

Up to this point, we have considered only the needs and values of meadow plants, but a meadow is as much maintained by its pollinators, browsers, burrowers, and their predators as it is by plant growth. In fact, many plants only maintain if their animal associates are present, so that owls, field mice, butterflies, bees, and worms are all part of a meadow assembly, and have specific functions in meadow development and maintenance.

## REVITALISATION OF COMPACTED SOILS AND WORNOUT PASTURES

Data on soil rehabilitation is given in Chapter 8 of this book, but any soil or compacted pasture can be revitalised by periodic sodseeding, using a broad-flanged chisel point at 6–10 cm depth and 0.5 to 0.6 m spacing to cut the roots of existing grasses and to provide a seed furrow for more vigorous, deep-rooted, more nutritious, or droughtresistant grasses or woody forages. Early spring and from mid autumn to early winter are the usual pasture species sowing periods. With the seed, trace elements, major nutrients, and water-retaining gels can be trickled into the shallow furrows so developed by the tines or chisel points in the old or degraded pasture.

Some typical seed mixes for sod seeding may include a variety of clovers, chosen for site, pH, and drainage; spikeroots such as dandelion, plantain, and chicory; woody browse species and medicinal species such as wormwood, tagasaste, *Elaeagnus*, pines, willows, or poplars, and grasses chosen (as for clovers) for the specific site and soil factors.

If labour or rootset planters are available, root cuttings, bulbs, and plant cuttings of woody browse, comfrey, willow, or poplar can be set out in deep-ripped furrow, either as a pasture browse combination, or as pioneers for farm forestry operations.

A special use of sod-seeding is in sowing down lands where round-rush (*Juncus*) will grow if the land is normally ploughed and cultivated. Here, minimal tillage prevents the spread and growth of rushes and the acidification of soil. This establishes clover and soft pasture or crop without rush competition, or with minimal rush growth (often browsed off by cattle if clover is present). Bert Farquhar of Wyambi (Tasmania) gives this data for coastal pasture establishment. As many coasts and heaths are copper and cobalt deficient, this is also added. Clover at 0.7 kg/ha is sod-seeded after a slash of brush and rushes, and an autumn burn. The sowing is completed in the first month of winter (it can be earlier if the ground was previously fallow). About a ton of dolomite per year is added. Ploughed marshy coasts often result in a pH so low that uneconomical amounts of dolomite need to be used to correct the soil condition—another instance of how high energy use causes cost and work later. The lowland so ploughed also bogs vehicles, pugs badly in winter, and may quickly go out of use. Its best usage, then, is as wildlife marshes, fish ponds, and a source of *Typha* browse or reed thatch for crafts, where acid boggy ground has been created by ploughing and hoof compaction.

## 12.14
## RANGELANDS

Brown (1972) estimates the standing crop of large herbivores on the African savannah to be about 500 kg/ha, or about the same as on improved pastures in humid temperate areas. Instead of one or two species sustained by external oil energy input, the savannah species hosts guilds of browsers (five species), grazers (eleven species) and four species that alternately graze or browse, each having specific food preferences.

This crop estimate specifically excludes the far greater biomass of smaller mammals, birds, insects, and burrowers, reptiles, other lower vertebrates, and plant products, so that it is a minimal yield figure for a natural system. No known cultivated system of livestock can surpass this sort of productivity without external inputs, nor are similar yields achieved without stressing soils, plants, or animals. Our excuses for destroying such systems, therefore, rest not on the basis of health or productive capacity or soil conservation, but on the sequestration of land for private misuse or political gain.

We limit our yields also by not considering the abundant soil life, and by not devising methods to harvest some of this product either directly or indirectly. In a clearance of rabbits, where some 1,100 were caught or dug out per acre (Tasmania, 1954), myself and others estimated yields of close to 700 kg/ha. Such degraded pastures also contain enormous numbers of insect larvae in excess of this figure. We need to assess yields more closely, and to question our direction in trying to raise a few species of animals on lands that will support many more species and much higher yields of protein from hitherto unconsidered species.

In swamps, savannahs, and in semiarid or arid plains, trees may occur in discrete groups. This may be related to natural conditions, or it may be as a result of other (animal) species working on the environment. Such species as alligators in swamps create wallows for their own comfort, as do pigs, buffaloes, elephants, and warthogs. A wallow presents a new clump plant site by altering drainage (as hole and bank), nutrient, and soil structure.

In estimating the effects of animals on browse or grazing, agriculturists have used a "stock unit" system of equivalents based on the weights of the animal. In fact, this system needs more work and modification, as sheer size also affects metabolic efficiency. A second modifier is that of individual metabolic efficiency (as with the factor of water conservation). Even within a species, certain individuals convert food to energy or growth much more efficiently than others. Such differences within species may be greater than differences between species. However, the concept of the stock unit is a useful idea, so that the available food in season or in a particular type of pasture can be assessed over the year in "cow-days" of fodder, and approximate stocking rates for other species, or complex species mixes, can be estimated. In practice, however, ground experience of the effects of stocking rates on pasture need to be adjusted by observation, especially if animals are being selected for efficient growth.

The standard stock unit is a European cow and calf, about 450 kg liveweight or: 2 African cows; 5 European sheep; 20 African sheep; 25 Thompson gazelles; or 125 dikdik antelope; and so on. Ten standard stock units are

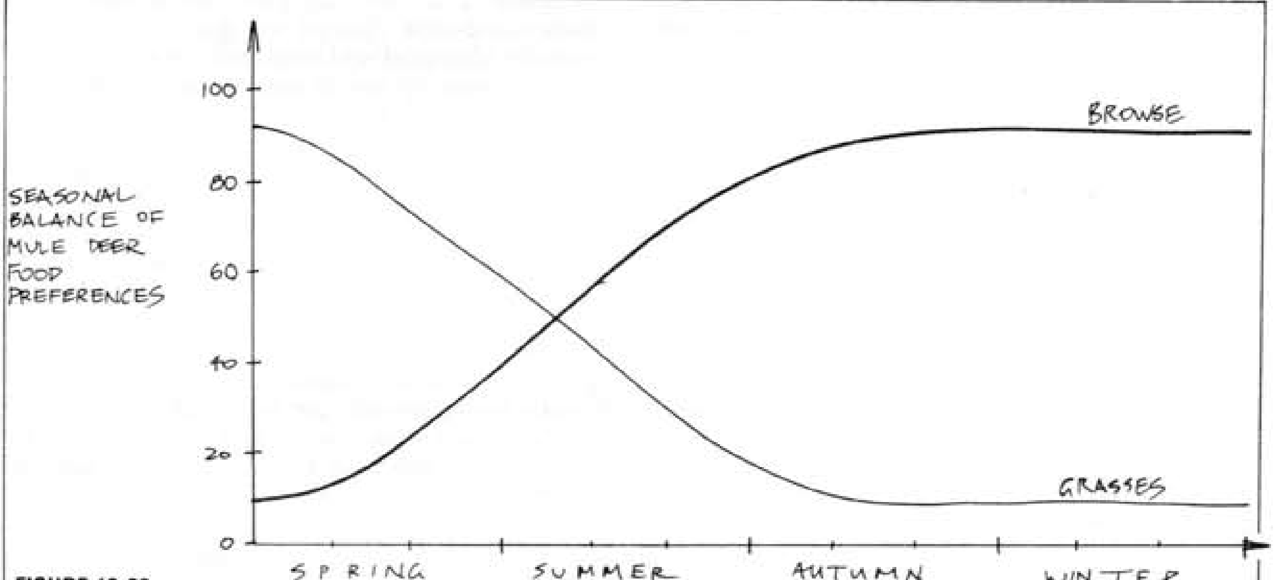



**FIGURE 12.20**
SEASONAL CONSUMPTION BY MULE DEER.
**A.** Shows the importance of browse in winter, grasses and forbs in spring; **B.** Browse types found in rangelands.

equivalent to 1 elephant; 4 black rhino; 15 zebras; or 27 hartebeest.

Animals on managed range are a valid sustainable system only if the balance of plant and animal species is carefully maintained. In broad groups, range plants are:

- Forbs (annual and perennial herbs and bulbous species)
- Grasses and other monocotyledons, annual and perennial
- Trees and shrubs
- Mosses and lichens
- Fungi and saprophytes

The first two are eaten by grazing species, the third by browsers, and the last two by small herbivores and cold-area species. Animals balance their range diets in very different ways, so that a variety of animal species is needed to utilise the available forage (**Table 12.4**). Further, these are not so much a constant proportion, but a dynamic seasonal change, which is illustrated by **Figure 12.20**).

Some animals are sedentary, some range widely; the latter are able to spread their browsing more evenly across the range. Deer, for example, may commonly utilise 92% of a range area, on which cattle exploit only 52%. Deer may also convert food to flesh at efficiencies greater than cattle by factors of 2 or 3, depending on the species of deer.

This range behaviour is in part species-specific and in part determined by the availability of such critical resources as shelter from extreme heat or cold, the placement of water holes, or the presence of predators such as wolves or cheetahs. Cattle can be expected to range only 3–7 km from water, whereas some deer, kangaroo, goats, and small antelope can exist without free surface water except in extreme drought conditions. For species with clear preferences for fixedsite resources (water), range management consists of providing these critical resources to enable such species to utilise the range.

A judicious selection of animal species enables far greater production from range than the choice of one species alone. Different species will feed at different browse levels (**Figure 12.21.** It is usual for graziers to express range values in terms of "cow browse days" or the number of days a cow can forage on a unit area. This will of course vary seasonally depending on the balance of plant species on range, and it also enables some rough equivalents to other species of animal, e.g.

One European cow browse year = 266 blacktailed jackrabbits; 164 antelope jack rabbits; 18 kangaroo; 6 sheep; or 385 ground squirrels.

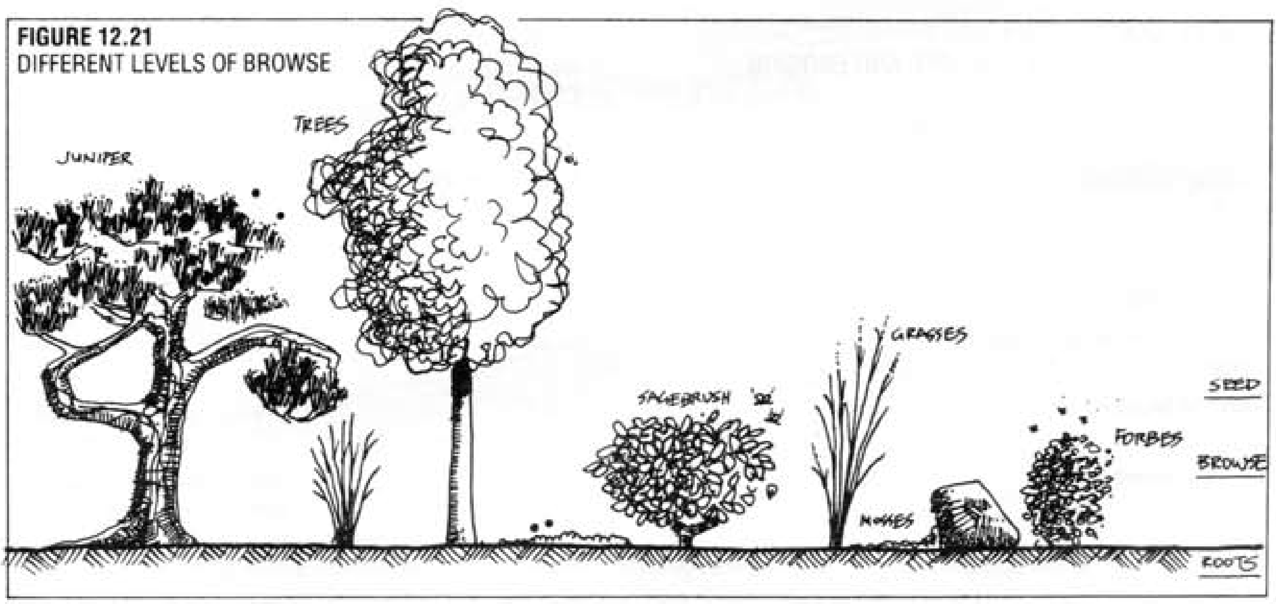
As many of these smaller species can be continually harvested and some (kangaroo) have of far higher assimilable protein content (58%) than cattle (35%), then from the point of view of protein production alone, kangaroo or jack rabbits, if well-managed and harvested, are far more productive than cattle. A judicious balance of species will always exceed in yield a monoculture of one species, and also keep the rangeland in better productive condition.

**TABLE 12.4**
COMPARISON OF RANGE DIETS

| | BROWSE | GRASSES | MOSSES | FORBS |
|---|---|---|---|---|
| **ELK** | 27 | 65 (Max: 85) | 5 | 3 |
| **ANTELOPE** | 74 | 4 | — | 22 |

(Percentage average consumption figures)

**FIGURE 12.21**
DIFFERENT LEVELS OF BROWSE



*Any* species not harvested (or where predators have been removed) can expand numbers so that rangelands are badly damaged. When such damage occurs, insect plagues may result. "Canadian workers found a direct correlation between range depletion and grasshopper outbreaks" (Stoddart, 1955), and rangelands infested with grasshoppers, plague locusts, or mormon crickets can lose 67% of their browse to insects. This is a severe reduction in livestock production. We clearly see that insect plagues are a reflection of poor mangement, as is the disappearance of preferred plant species from range.

Even insects are usable and of excellent protein value, and both fish, guinea fowl, or turkeys on range are efficient converters of plague insects into usable protein. Thus, on suitable range, fish ponds, water-fowl, and insectivorous bird flocks become integral to range management and plague control. Wetlands and ponds need to be created or preserved for this reason alone. If not harvested by range birds or fish, insect populations can themselves be cropped as part of concentrated foods for other acceptable food species. In Botswana, the drought harvest of locusts is accounted (by weight) as four times the food value of stored grains.

**TABLE 12.5**
SOIL PORE SPACE.

| Grazing Condition | Soil Pore Space (%) | Rain Infiltration (%/hr) |
|---|---|---|
| Slight (Undergrazed) | 68.1 | 4.14 |
| Overgrazed | 51.1 | 2.16 |
| Depleted by Grazing | 46.5 | 0.82 |

The plant cover on range has a profound effect on the infiltration (and subsequent river flow) of water. In the first 30 minutes of rain (after which infiltration rates level off):

- 1.2% of rainfall soaks in at 5% vegetative cover.
- 1.5% of rainfall soaks in at 15% vegetative cover.
- 1.7% of rainfall soaks in at 25% vegetative cover.
- 2.4% of rainfall soaks in at 35% vegetative cover.

This is the effect of vegetation alone, but perhaps a more profound effect is the reduction of soil pore space by trampling. In some desert areas of central Australia, I could not find a square meter of soil without a recent deep hoof imprint. After only 9 years of stocking on range, Stoddart (1955) reports that soil pore space was reduced 44% in the top two inches of soil, and 60% in the lower 24 inch deep layer of soils. Infiltration (and river flow) is correspondingly reduced, and runoff correspondingly increased, with resultant soil loss. Actual figures are given in **Table 12.5**.

Thus, up to five times less water is absorbed by eroded and degraded rangelands. This has a profound long-term effect on the general health of the region, and in particular on continuing soil loss, flooding, erosion, and drought.

The proportion of runoff in total precipitation (here given as a percentage) and the allied loss of soil in runoff varies according to range condition, assessed by herbage indicators in **Table 12.6**.

As for total plant cover on range, from 65–70 % is needed to totally prevent erosion. Stoddart (*ibid*) notes that run-off water from rangelands may carry 6–10% silt by volume, and that in a flow measured at 17,500 t water/hour, 500 t (in with the 1,750 t of soil) were of organic matter. This staggering loss is directly due to poor range management, and the effect is so drastic on all areas of the watershed that it may well be a central

**TABLE 12.6**
VEGETATION COVER, RUN–OFF, AND EROSION.

| VEGETATION | RUNOFF % of rain | SOIL ERODED T/ha | COMMENT |
|---|---|---|---|
| Wheat grass (Good range climax) | 0.4 | 0.001 | Sustainable |
| Lupin and Needle grass (early depletion of range) | 49.9 | 0.963 | Exceeds soil creation |
| Annual brome grass | 25.5 | 0.425 | "Weed" grass holds soil before final deterioration |
| Annual weed species | 60.8 | 3.094 | Almost equal to losses under plough culture |

issue in land/water policy, which itself should be the core of the policy of any nation which hopes to survive. Erosion due to cattle can be minimised or halted by fencing which falls from the valleys to the ridges.

In summary, then, the main function of rangelands may be to preserve the upland soils and water for more intensive use. The careful harvest of low (polyculture) stocking rates of mammals can be permitted, and range predators may assist in controlling browsing species, both insects and mammals. Only heavily vegetated lowland ranges are really safe areas for domestic hooved animal production, and even these may need regular soil rehabilitation to alleviate compaction.

## THE MANAGEMENT OF GAME SPECIES ON RANGE.

The first priority in game management on range is to work out a method for harmless live capture of the species. These capture methods range from very large drift (nonreturn) traps for migratory, or moulting, or surfacedriven species (jackrabbits, geese, deer, gazelle, gnu); yard traps at waterholes (goats, horses, kangaroo); large or small baited box traps (most rodents); cage traps (many birds), set net in flyways or at night (many birds, some mammals); to individual capture using fastacting knockout drugs or chemical pellets (large or dangerous species like bear, rhino, elephant). Large species are also culled by shooting where culling is essential, as sexes and ages are easily distinguished in the field.

Many capture methods operate at night, when lights, traps, and nets are used and heat stress is less a factor. Wildlife managers and researchers have worked out safe methods of capture for most game species, and in many cases good culling or management techniques (in the absence of efficient predators such as lions, wild dogs, wolves, tigers, leopards, eagles, or foxes, many of which have been reduced or eliminated locally). Given a good capture and marking method (dyes, collars, ear tags, leg bands, tattoos, ear notches), population estimates can be developed, and tied to other factors such as scat counts or browse effect on range, herd size, or breeding success. Many free- range species are attracted to or benefit from areas of special forage or crop, shade, winter shelter, or water points—all of which can be added to a depleted range to increase wildlife, as can a more general scatter of seed or forage plants of particular value in periods of browse shortage.

These studies are the essential preliminary to the development of true managed wildlife farming, where up to 40 or 80 species of birds, mammals, fish or lower vertebrates are farmed in an integrated product system, which predictably exceeds one-species yields, and may actually improve tree and prairie cover. Even by mid-1960, wildlife researchers had good estimates of yields under managed systems, and could have devised excellent game farms. We may see these developing over a wide variety of species in future, as today the pioneer farms of crocodile, emu, kangaroo, deer, and waterfowl already show economic and social benefits.

Longterm measurements of natural mortalities on range due to drought, predation, plant response, parasitism, or territorial behaviour enables us to predict natural losses with some degree of success, and pre-emptive culling can make use of age/sex classes of animals that are in any case doomed to perish in the field.

Deer (red deer and roe) are now farmed in New Zealand, but are (astonishingly) being raised on improved pasture, and with the usual hay/concentrate system used for sheep, whereas these animals are well suited to managed montane tussock and tree browse systems, and are most efficiently raised in that

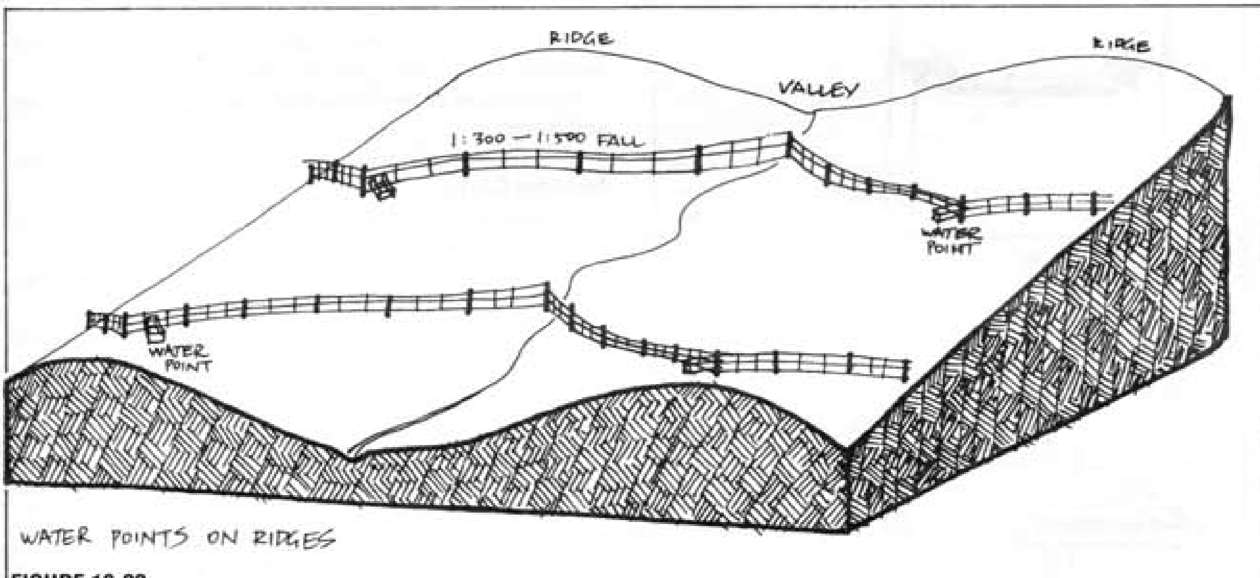



**FIGURE 12.22**
FENCING STRATEGY ON CATTLE RANGE.
This alignment of fences creates a "valley to ridge" flow of water following cattle tracks. Straight fences accelerate erosion.

environment.

Only in very recent years have we recommenced the intelligent management of game species in their preferred habitat. The benefits are as yet scarcely realised, but in most cases exceed that of "improved pasture" and selected domestic breeds of sheep and cattle, with less capital cost and better feed conversion.

Hopefully, some of the capital now misused in the production of fatty and chemicalised meats will be in future devoted to the intelligent management of healthier rangelands and products. There is no better use of capital than to use it for "increase" in the tribal sense of encouraging nature to show her capacity, instead of dictating directions and species. It has been imported European cultures which have prevented the use of kangaroo and a variety of antelope as farmed species although they are a preferred local food.

## 12.15
## COLD CLIMATES

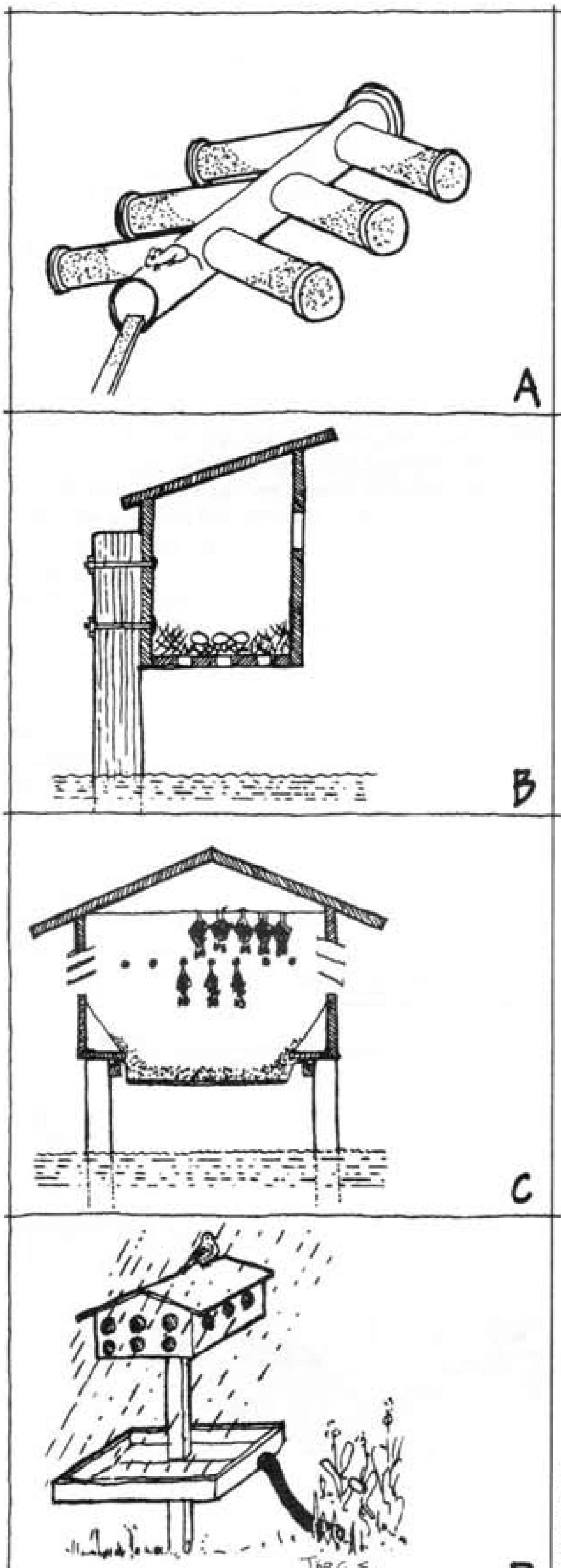
PHENOMENA OF COLD CLIMATES.

Considerable energy is needed to create snow, hail, and ice, and there are a special set of techniques for really cold areas that can take advantage of the characteristics of cold phenomena, for example:

- Albedo (reflection from) of snow as a heating device;
- Insulation values of snow over buildings;
- Preservation of ice for cold storage, summer cooling of food;
- Use of ice cover on ponds as winter access to deep areas;
- Ice effect in trees along meltwater rivers; debris trapping; and
- Stratification of the seed of cold area crops by refrigeration.

Then, there are special design precautions needed because of cold, and these include:

- Insulation of pipes and burial of pipes below frozen soil levels;
- Wells within insulated earth, preferably within the building fabric;
- Roof construction and steep roof slope in heavy snowload areas;
- General house design for extreme cold, especially for heat storage and insulation;
- Special garden techniques (frostheave on bare soil) and attached glasshouse growing;
- Water storage for summer gardens in earth dams; and
- Avalanche site avoidance.




MANAGING WILDLIFE

**A**. Pack rat; an artificial shelter acts as a store for wild rice;
**B**. Waterfowl nest safely in boxes fixed to pilings in lakes.
**C**. Bat colonies in shelters provide rich manure for ponds or gardens, and control insects.
**D**. Communal blue martin nests yield phosphates and fertilizer for crop, and the martins control mosquitoes. [Jörg Schultz].

There are multitudinous publications on heat, but very few on cold, so that although we can distil alcohol either by heating or chilling water/alcohol mixes, only the former is in common use. Freezing concentrates sugars (maple sugar), alcohol, and salt solutions as efficiently as heating distils water or alcohol from solutions. Open pans of maple sugar can have the surface ice removed regularly (each day) until a sugar concentrate remains. Salts in water, and alcohol in ferment liquors can be concentrated in the same way.

Frost heave on bare, part-eroded or exposed soils leave (in the thaw period) ideal seedbed conditions for clover and other covering seed. Only bare soils show this phenomena, and these are most in need of seed to stabilise soil erosion potential. Frosted and late snow areas present an ideal surface to spread manures in late winter, so that meltdown deposits seed and manure on the surface of the ground for spring growth. Sawdust in the mixture gives a clear picture of seed or manure spread on snow.

In the fall, acorns, filberts, and hickory nuts are gathered by wildlife as winter stores. Field and pack rats bring in smaller seed such as wild rice from the marshes. If storages are provided, these foragers will fill hollow pipes or logs, or smaller pipes, old vehicle engine manifolds, and nest boxes or wall cavities. Seed so collected is sound, clean, and neatly stored. Providing some 15% is left, and given over to winter food for these workers, 85% can be collected for human use. A few people regularly collect their hickory nuts or wild rice in this way, by providing dens for squirrels or pack rats. It is a question of cooperation and provision for others, instead of attempting to kill off the experts and do the job yourself.

Grains and nuts so gathered, and stored in bins in barns or animal houses, feed poultry and form food concentrates for other animals over winter.

As the snow melts from the forest floor and openings, winter acorns begin to sprout. At this time (early spring), pigs and poultry released from winter quarters can forage acorns, as can sheep and cattle. The food value of the sprouted seeds is higher than in unsprouted seeds by factors varying from 10–100 times (for vitamin and sugar content).

In the winter forest, piles of branches and loose compost mounds of leaves form a refuge for small animals and reptiles. These and rockpiles are essential refuges for wildlife, providing deer-immune planting sites, and reducing forest fire hazards.

The pattern of snow-melt indicates insulated, absorbent, reflective,and heat-generating environments or surfaces. Black objects, soot, and leaves sink into the snow. Snow melts rapidly in front of the bare-leaf and white-stemmed stands of birch for about 4 m or so from their stems. Rock walls backed by birch give an early warm site to plant out vegetables. The Chinese use slanted bamboo and straw lean-tos to achieve this early growth of vegetables and to extend their growing season (**Figure 12.23**). The shade side of such shelters accumulate snow for insulation.

Stone walls, embayed, form very warm early sites, as do semicircles of tyres facing into the low sun. Such embayment can be plastic or glass-covered to assit heat retention, or piles of tyres can be topped with glass as miniature grow-holes, especially if the tyres are earth-filled or half-filled with water to retain day heat. Many gardeners use glass cloches, or cover individual plants with bottomless glasss or plastic flagons in early spring.

Ponds begin to melt in time for garden watering. While the ponds are still frozen, bundles of brush can be placed on their surface to provide fish cover,or fixed anchors can be set out to sink later as moorings. Black, glasscovered tubes or tyres keep fishing holes open, as

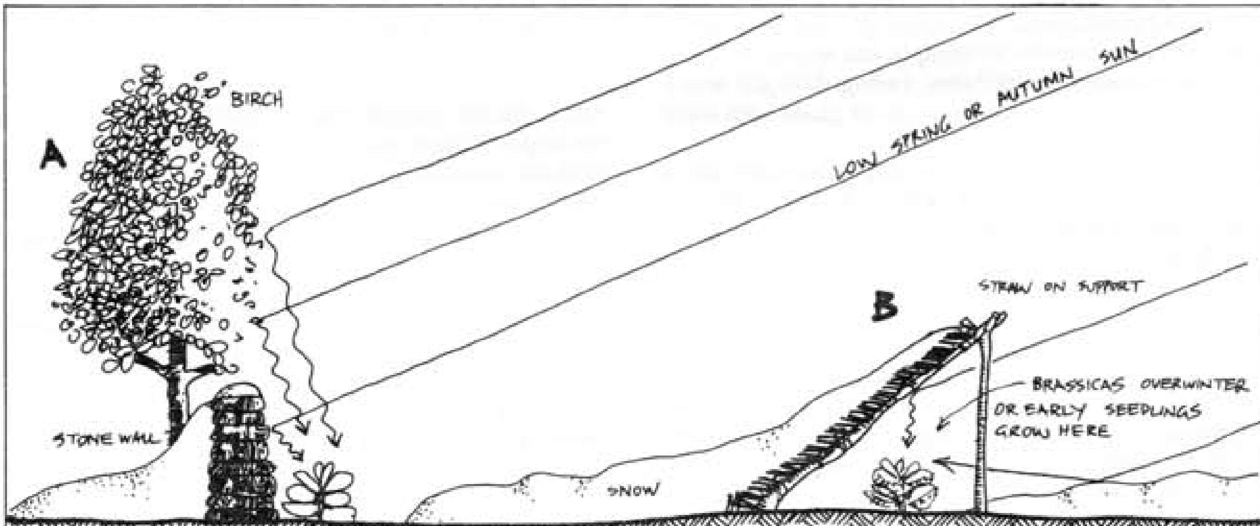



**FIGURE 12.23**
BAMBOO AND STRAW LEAN-TO
white trees, or stone walls all assist early crop or store late crop in low-sun latitudes (50° or higher).

do rafted glasshouses which act as fishing shacks. These can be towed ashore in spring or used to grow subtropic water plants in the shallows.

Ice, frozen inside insulated boxes in winter, and stored insulated from the ground, will last for a summer in very shaded places, and form an icebox store for summer use. Thick straw or sawdust lids preserve underground ice for summer. Uninsulated ice pits, into which winter snow was packed and then earthed over, were the basis of chilled drinks in this type of climate before 1830, and before the advent of mechanical or evaporative refrigerators.

## ICE

Depth is the critical factor in cold waters, especially in stillponds. If ponds freeze to 15 cm–90 cm (6–36 inches), then that depth of water is unavailable in winter for house use, so that where arid areas must calculate depth of storage on evaporation, cold areas must calculate the amount "lost" by winter freezing. Freezing expands water, so that storages need be left unfilled, slope–sided, or open–topped to cope with expanding ice (**Figure 12.24**).

Similarly, pipes must be buried to 1 metre to prevent bursting, or allowed to trickle continuously at 450 l /day. For domestic use, there is no substitute for placing the water storage within the house cellar structure, as a well or cistern below floor level. The same is true of water stored in barns. Glasshouses and houses both can use this water as a heat store with great gains in efficiency. Ice, like ploughs, may produce a plough–sol or hardpan by pressure on soils due to ice weight. Weight is the factor that most differentiates the snow and ice which accumulates from frozen water.

Ice is, like glass and water, a transparent refracting medium suitable for lens construction, so that very cold areas can construct very cheap ice lenses for solar energy concentrators. Ice lenses poured as water in moulds can be turned out cheaply, and focused to direct heat to storages or machines during daylight hours. Components of complex lenses can be glued with water (**Figure 12.25**).

As ice can be moulded in any shape that water can be poured, and reinforcement as bars or fibres added to the mould, a great variety of useful ice objects can be made, or ice so moulded around axles can be towed to summer storages as an ice buggy (**Figure 12.26**).

Snow is a handy form of precipitation, as it is more durable in landscape than mist or rain, thus easier to store. Compacted, it stores as a solid, and endures more than one season. As a semi–solid, it can be stored three dimensionally, caught and heaped on fences and plant barriers. These can be fences or hedgerows, or one replacing the other over time. The varieties of catchment are obvious from studying the way trees store snow. Some snow is stored as sheets, others as clumps or drifts. Thus, snow driving across landscape can be directed to heap in mounds for meltdown into such storages as swales or cisterns in spring.

When it snows, the weather is cold, but snow both insulates and reflects, thus earth sculpturing around either the local landscape, dwellings, or drifts can produce reflected heat of great intensity (sunglasses are required in all reflective landscapes: white beaches, quartzites, still waters, hayfields, and snow fields).

Just as we can build concert bowls, circuses, arenas, and focusing dishes, so we can build earth structures which snow covers to give winter heat concentration. In summer, these surfaces can be of white gravel or sand or clay, but in winter snow is better. So, houses built in earthformed reflectors, or that are themselves reflectors, can use snow for heat and insulation (**Figure 12.27**).

Reflected and concentrated light, even for short periods, gives intense heat which can be stored as hot water, molten metal, steamheated earth, or heated salt solutions.

## SNOW

Curiously, snow is almost a "black body" for radiation, losing heat rapidly with radiation values of from 0.986 to 0.962 (dirty snow). Thus, snow cools very rapidly at night, and thin snow cover chills soil to 35°C below air temperature. Snow thicker than 15 cm, however, acts as an insulator for soils, buildings, and permafrost. As for reflection or albedo (20% for muddy slush, close to 100% for fresh dry snow), is it most effective at the low sun angles of dawn, evening, and winter. Radiation (light) penetrates snow 10–15 cm, when most of it is absorbed by the water in the snow mass, but in the hollow ice crystals of hoarfrost, and in dry snow, light penetrates to 30–60 cm. About 30% of outgoing radiation is as heat (long wavelength), but the snow itself is completely non–transparent to incoming long–wave radiation, so that melting more commonly occurs from below due to earth (soil) heat. It is this basal melting that causes poor snow–mass cohesion, and that may trigger snow creep or avalanche.

## AVALANCHE AND SNOW INSTABILITY

On slopes of more than 6° and in the valleys of steep foothills, wherever snow builds up to 15 cm or more in depth, there is a risk of avalanche. Snow will avalanche wherever the crust is broken by strong winds (more than 13-18 km/sec. sudden freeze is followed by thaw, warm winds cause snowmelt, or normal spring thaw occurs. The saturation of deeper unstable snow layers by meltwater over layers of buried hoarfrost, or overlying ice or earth layers, weaken the whole snow mass until slides can occur. At this critically unstable point, a gunshot, the collapse of a snow cornice (overhang) or a strong wind can trigger an avalanche, as can a skier, antelope, or rabbit.

Avalanches pick up or trigger off the movement of even more material as snow, mud, boulder and clay, or vegetation. Even so, it is less the mass itself than the high–pressure air wave which precedes, and advances beyond, the avalanche (sometimes carrying on up the

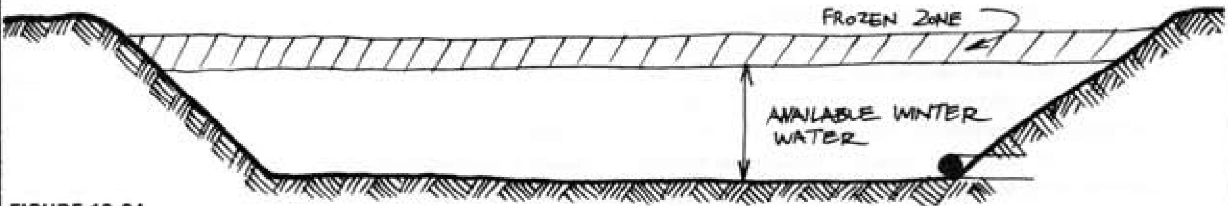



**FIGURE 12.24**
EXPANDING ICE IN WATER STORAGE.
Sides of storages need to be sloped to allow for freeze expansion; capacity must be judged as unfrozen depth over winter.

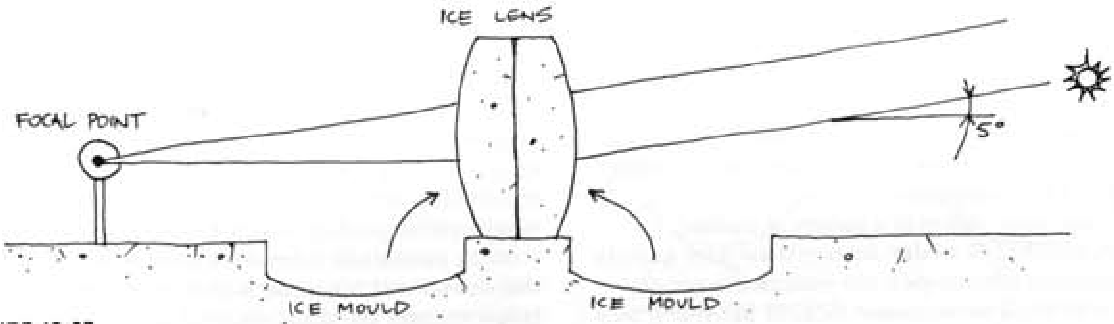



**FIGURE 12.25**
ICE LENSES.
Ice can be moulded for use in place; here, as a focusing lens.

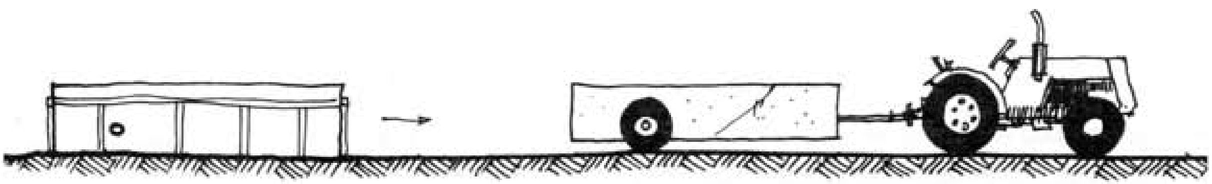


**FIGURE 12.26**
ICE TOWED AS A BUGGY.
Ice forms in moulds can be easily moved to cool stores.

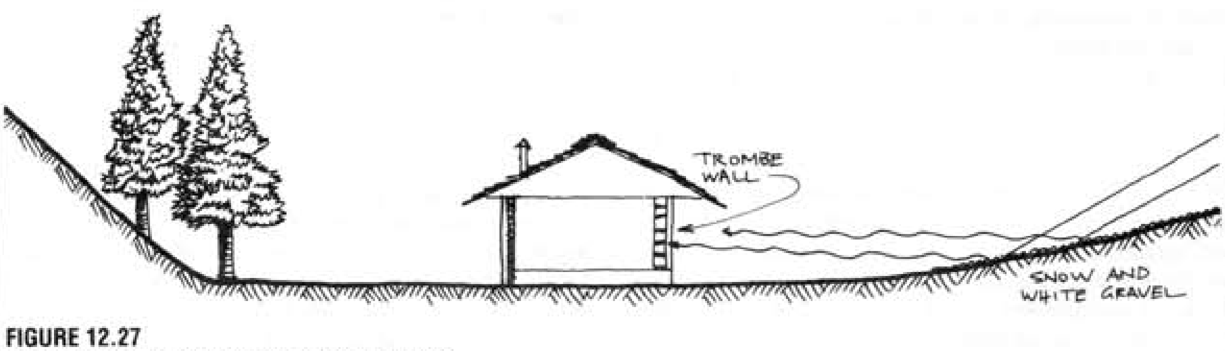



**FIGURE 12.27**
SNOW AS A REFLECTOR FOR HOUSE HEATING.
Low sun angles "bounced" off snow suraces can add 60–70% more heat to walls of houses.

opposite slope) that can destroy forest, crop, and buildings. Typically, avalanches cut roads, public utilities, and prevent fuel or aid reaching the area. Like other catastrophic phenomena, avalanche areas are often mapped, and avalanche warnings issued when conditions can be predicted locally. Avalanche chutes are often delineated by pioneer species such as aspen.

The best defense is prevention, and this is achieved by a set of strategies ranging from preservation of high slope forests, the placement of essential services in tunnels, the erection of Vshaped barriers to split up the avalanche front, and the prevention of settlement in highrisk areas. A new threat follows on the death of steep slope forests by acid rain damage. In general, crossslope terraces, walls, and barriers have not proved effective, but snow barriers on plateaus *above* the slope can effectively hold snow above the slope and thereby lessen the load .

Much of the data given here is from G.M. Kuaeva (1975) *Physical Properties of Snow Cover of the Greater Caucases*, USDA translation.

Snow, like sand, moves in a variety of modes:

- MICROCREEP, under freeze/thaw and gravity effect advances downslope a few centimetres per day
- SLIP of thick snow masses (SNOW BOARDS) may cover metres per day.
- SNOW MOUND advances from rocky uplands as a streamflow effect.
- SNOW BODIES move en masse down short slopes.
- SNOW SLIDES at velocities of 4–5 m/sec. occur and can be arrested by terraces.
- AVALANCHES of snow can increase in speed down long slopes, reaching speeds of up to 6.5 metres per second. They can be of great magnitude but are usually EPISODIC (every 35 years). SYSTEMATIC avalanches are those that occur every year, but these are unusual. Longer periods of rare heavy snow falls produce PERIODIC or rare avalanches.

Trees are useful avalanche and mudslide movement indicators, and downslope lean, lack of lower limbs and understory, bare "trains" (different age classes or pioneer species) such as aspen in downslope strips, and blown–down forests radiating from avalanche snouts all reveal past instability in valleys. Rock avalanches produce many of the same effects, which persist for at least 20–30 years in coniferous forests.

Like the plant crusts of the desert or tundra, the solar radiation crust on snow preserves slope stability. This is of necessity a seasonal protection only, and breaks up if iced or shattered by wind. Eighty percent of all avalanches occur where old, compact, or dry snows are dislodged by the condensation of moisture and rain from air of more than 70% humidity. Many of the remainder are dislodged by gusty winds, or where meltwater lubricates the mass in thaw periods (usually between midday and 3 p.m. in fine weather). Sudden falls of 50–69 cm of snow followed by long periods of cloud-free weather also cause unstable snow conditions.

Whereas the impact of a snow mass is somewhere from 4–54 tonnes per square metre, depending on the total mass and the load carried, the compressed air blast in front of the mass can travel at 330 m/sec. This produces a severe shockwave effect. Even snowdust avalanches produce waves of 10–100 m/sec and develop pressures of 35 atmospheres, enough to knock down trees and buildings.

## PERMAFROST.

Permafrost (permanently frozen ground) occupies 47–50% of such areas as Canada, Russia, and Greenland. Peaty surfaces, which are common over the permafrost, both prevent melting and rapidly admit cold, thus preserving the stability of frozen areas. Either by clearing, fire, or overgrazing plus ice particle scour (ice particles at 40°C are as hard and abrasive as sand), the peaty layers can be eroded or removed. Thaw may rapidly occur, so that bare sunken areas of clayey soils (mollisols) occur, and these thawed areas can reach 2–45 m deep in a few years. The erosion effects (plus 9% volume loss of ice) can be severe, and has destroyed many upland grazing areas in Greenland.

Much permafrost is fossil, at times to 400 m thick, so that normal melting under peat is slow; earth heat from below reduces the thickness only about 1 cm per year. In such harsh areas, soils are formed only as a result of frost shattering of rock, and both soils and rocks are sorted by ice action and thaw (geliflucti0n). Solar thaw is about 5,000 times more effective than earth heat if the peat is removed.

Loess deposits (windblown soils) are 50–80% silica, 20–25% felspar and low in calcium. Loess fields of deep soils (some deposited over foothill soils) occur throughout Europe, Russia, China, and near continental glaciers elsewhere. They support excellent forests but dry out quickly and have high porosity. Loess deposits are stable as steep walls to 300 m high. They are therefore much used for underground housing in China, and have been occupied for millenia.

## COLD AREA GRAZING

When, as in Iceland, frost penetration to 1.2 m in pastures and soil is a common feature, open ditches at 50 m spacing are necessary to take spring thaw runoff from bogs, as tile drains are still frozen in the soil until later in spring. Sheep, cattle, and horses are shedded and hayfed for 6 months of the year, grazed in uplands for 3 months or more, and on lowland (sometimes improved) pastures for 3 months. Frost heave in areas of bare–soil erosion needs levelling, re-sodding with peats, or rest from grazing, and both a mixed–livestock economy and longterm rotational grazing may help keep worm parasites (*Helminth*) under control. Kale, rape, ryegrass, barley or rye can be used as fodder, silage, or cut for winter hay. Cobalt and selenium deficiencies in sheep; and calcium, copper, and phosphorus in pasture must be monitored. Shrub and tree browsing is a factor little developed, although willow, and dwarf birch species are available as browse.

The demand for firewood, here as elsewhere, has reduced forests to 5% of the original cover, and overgrazing has denuded 50% of the total vegetative cover, especially on fragile volcanic upland soils. Historically, better animal growth was achieved in these more wooded and less "improved" highland pastures, but as these break down from overgrazing, the less thrifty lowlands are now being considered as alternatives. Less than 1% of the total area is cropped, and as in most very cold short-season areas, livestock, sea, or forest products are of greatest importance in the human economy.

In sandy, cold deserts, thyme, *Festuca*, lichens, dwarf birch (*Betula nana*), *Rhacomitrium* are typical species of hummock grassland;*Alopecurus, Phleum*, and *Poa pratensis* (whitegrass tussock) of hayfields; and sedges (*Carex*) and cottongrasses of bogs. As bogs are drained or areas fertilised, grasses begin to predominate over shrub and tussock species, and worm parasites increase.

Eroded gravel plains develop on overgrazed areas. There has been no serious consideration of high-energy browse as supplied by oaks or the twigs of such sugar storing species as striped maple. It would appear that deforestation and pasture pressures are developing the same spectrum of "limiting factors" as are found in all areas where livestock numbers and clearing expose the livestock to insoluble disease levels, together with a lack of shelter that can reduce weight gains by 16–30%.

Iceland faces the same compound of problems as warmer areas, with deforestation, severe parasite infestation of sheep on lowland or fertilised pasture, and lack of shelter and deep-rooting nutrient-yielding trees. Although no gross deficiencies have been noted for any of the three trace elements tested for (copper, cobalt, selenium), serious intestinal worm infestation on bogs and pastures does reduce the mineral content of bones, and lowland sheep in Norway have about ten times the nematode worm population of highland animals. It is only on the lowlands that high levels of nitrogen fertilisers are supplied, and where consequent lack of energy food in improved pasture species is experienced.

Iceland obviously presents a case for innovative forestry, coupled with a serious attempt to reduce grazing on the eroding soils. The shift to forest products seems to be a much-needed option for farmers.

## 12.16 WILDFIRE

Wildfire is a feature of many sites and climates, and can be created even in hot humid climates by logging, or by block plantings of eucalypts and pines. It is notoriously violent in summer-dry climates peripheral to large arid areas; "wet" savannah or chaparral scrub will burn fiercely when strong advected heat blows in from deserts.

Periods of high fire danger coincide with periods of strong ground winds from continental desert interiors, and affect many climatic types on desert borders, up to 200 km from the desert edges themselves. These winds are the normal precursors of widespread and catastrophic wildfires, which in the presence of enough local fuel may develop into terrifying firestorms, which themselves generate a type of fire tornado, with fierce ground winds. In the southern hemisphere, fire winds blow anticlockwise, and in the northern hemisphere clockwise.

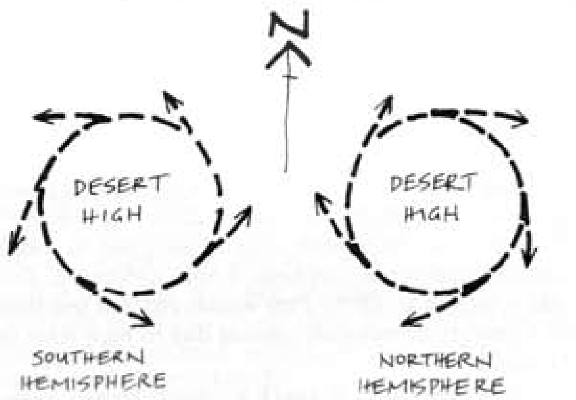



**FIGURE 12.28**
FIRE WINDS IN SOUTHERN AND NORTHERN HEMISPHERES. Highs over hot inland areas produce winds on desert borders, as figured. These hot dry winds may trigger wildfires.

The critical factors for firestorm are:

- FUEL SUPPLY; this includes the dryness of available fuels and their distribution and quantity (loose fuels of more than 6 cm diameter).
- OXYGEN SUPPLY as winds to fan the flames, especially hot winds.
- PREHEATING as upslope or radiant heat in front of the flames, or as advected desert winds in unprotected forests.
- UNSTABLE AIR MASSES, so that wind shear, ground whirlwinds (dust-devils), scattered cumulus clouds, and shifting winds all presage fire danger when dry fuels reach to less than 35% moisture. In unstable air, smoke does not level out at low altitude, but ascends to great heights, or is up and down in streamlines, and the air is otherwise clear (no fog or smog before the fire). In some forests, one can smell the volatile oils, terpenes, or resins, and light-blue haze develops over these forests.

A small proportion of fires start from lightning strikes, even in remote forests. This is why many ridge forests show pyrophilous (fire-dependent) species, and on some ironstone ridges, every tree will be scarred by strikes. Such places should be noted as areas where houses need earthing for lightning strike.

However, most fires are deliberately lit, or arise from previous "controlled" burns left smouldering (often lit to *reduce* fire risk!) Freak fires can start from electrical shorts (power lines), backfire flashes from vehicles in grass, heat focussed by bottles or curved glass, and welding, campfire, and cigarette accidents. In all, lightning and accidents are perhaps only 4% or so of total fires; the vast majority are lit by mischievious, psychopathic, or even well-meaning people. A few pyromaniacs light and attend many fires, and even enlist in volunteer firefighting organisations; in aboriginal or tribal peoples, an angry person will sometimes burn out a camp or forest.

### FACTORS THAT INCREASE FIRE INTENSITY OR SPREAD.

Once initiated, wildfire can spread with great speed; grass fires spread after 10–11 a.m. (after the dew has dried off); forest fires from midday to 3 p.m. After an initial flareup, an hour or so suffices to develop firestorm conditions, aided by:

• Loose fuels of smaller than 6 cm diameter, grasses and sticks, at less than 20% water content (a chunk of 75 x 50 mm pine, unpainted, can be weighed to judge humidity and wood dryness; where saturated, this wood is judged at 100%). Pine woods erupt at less than 30% humidity or moisture content due to high resin or oil content.

• Winds of from 10–50 km/h accelerate spread, as the square of the velocity. E.g., at 20 km/h, if the spread is 2 km squared per hour, then at 30 km/h, the rate is 4 km squared per hour. At higher wind speeds, tongues of fire break up the firefront. At 80 km/h, ground fires may self-extinguish.

• Winds "backing" (shifting) late in the day may blow out a fire flank into a broad front, or even blow a fire back on itself and make it safer. However, backing winds are unpredictable, and in wildfire the best strategy is to order an early evacuation of a broad area except for teams (in safe refuges) whose job it is to put out minor house fires in the first halfhour after the fire has passed. For this reason, forested suburbs need local refuges (gravelled areas with underground shelters), as do isolated homesteads, and long stretches of roads through inflammable forests.

Wildfire will always occur on arid borders; thus we need to first be able to live with fire, and perhaps only secondarily (over a period of years) design to exclude fire from settled areas by a combination of:

• Altering the vegetation to create more fire-immune systems.

• Designing dams specifically to floodflow over hillsides subject to fire.

• Mechanical or grazing removal of fuels just before fire-danger periods—this includes dead brush, long dry grasses, and the dead lower branches of trees.

In non-inhabited areas, both "cool" fires (damp and cool weather) and "hot" fires (dry periods) are sometimes lit as a management mosaic to preserve fire-dependent flora and fauna; this is unsafe and difficult to control, and often *causes* fires.

Houses, dense surrounds, village surrounds, and intown planting (or the forests at the base of settled slopes) should all be designed to minimise fire damage and mortality. Fire can be expected as wildfire on a more or less regular schedule in specific vegetation types at about 30 years in wet sclerophyll forest, 8–10 years in dry savannah, and even annually in unbrowsed grassland. Thus, fire provides a specific problem for designers and landowners progressing from grassland to forest operations. From 3–5 years, or until forest establshment, the system has high fire risk, and we need to programme planting mosaics to reduce district risk.

FIREBREAK is a way of decreasing fire intensity; roads act as firebreak, as do ponds, marshes, rivers, stony areas, and summer-green or sappy plant crops hedgerows. Horizontal firebreak weakens or reduces the fire front energy. Vertical firebreak, to prevent fire "crowning" in trees, relies on the removal of lower branches, dead tree material, and perhaps on planting sappy ground cover under the forest.

No firebreak (even 10 km of water) is effective in firestorms, as fire tornadoes, with ascent velocities of up to 250 km/h can develop on the lee ridge side of hills, travelling downhill and lifting aloft large logs and branches and pieces of houses, and creating massive aerial gaseous explosions. The ground winds near the base of this column (some tens of metres across) can reach 100 km/hour and will roll people over and over. The noise is deafening.

In these tornadoes, or in more minor whirlwinds, incandescent material is carried aloft and dropped out from 1–30 km downwind to start fresh fires, and fresh firestorm sequences (**Figure 5.23**.)

In towns, fire resistant design (for wildfire) has these features:

• A simple roof and wall outline (no internal roof valleys or re-entrant wall corners to pile up incandescent ash).

• No tarpaper roof lining projecting into gutters. Roof gutters should have either a leaf-free profile, or can be plugged and water-filled in the event of fire (plugs are handily chained to the gutter near downpipes). Roof spaces often catch alight from leaves in the gutter.

• No unscreened windows, underfloor, or wall cavity vent spaces; all need fine-mesh metal screens to reduce spark size. Even beds can catch alight with large embers, and cellars or underfloor spaces may have dry firewood or fuel liquids stored there.

• No inflammable door mats, nor wood piles or shrubs against the house walls. Large cans of petrol, or explosive materials, should be stored in a shed away from the houses, tightly lidded.

### SITING OF HOUSES AND BUILDINGS.

In fireprone areas, houses are at most danger from *upslope* fire; few houses survive wildfire on sharp ridgetops, or in hill saddles that have diverging ridgelines creating a wind (fire) funnel effect. The same funnelling or intensification of fire is created by planting inflammable trees (eucalypts) or grasses (pampas grass) along a house driveway; I have seen funnelshaped plantings of this type that would have the effect of a blowtorch on the house, when even concrete will powder, and steel posts behave like spaghetti influenced by Uri Geller (or an Indian snake charmer).

For every 10° increase in the angle of upslope, fire speed and intensity doubles; the effect is that of updraught plus enhanced drying out of the fuel ahead of the front due to upslope flame and wind. That is, if the fire speed is at 16 km/h at 0° slope, it is 32 km/h at 10°, 64 km/h at 20°, and 128 km/h at 30°; thus slope effect alone can wipe out hill ridge settlements. It is critically important therefore that downslope forests are *not* pine or eucalypts, but slowburning deciduous trees, with low leaf oils, and are sappy or thick-leaved forests with a clean floor, or with succulent groundcovers and lily clumps, or succulent vines and crop interspersed.

To reduce the ridge effect, site houses not only off the ridge, and if possible on downslope plateaus, but also excavate the site instead of raising the downslope house wall on stilts or stumps. A house nested into a shelf on the hill is protected from radiation, has no open underfloor area, and can have a rimwall, pond, or earthbank on the edge of the plateau as further protection. Such houses can more easily develop a cave or dugout refuge behind the shelter of the house itself (these are fully earthed over and have a wet blanket door and a dogleg or curved entrance to further escape direct radiation). Each such fire or radiation refuge needs a small (270 l) permanent water tank incorporated, a few old blankets, and a bucket of water or two. This is absolute "fire insurance" for those caught at home (often, women and young children). All these fire aids also apply to barns, livestock shelters, and outbuildings.

Around house and building sites, it is essential to reduce forest and grass fuel to a distance of 30 m (100 feet). This does *not* mean tree removal, but rather the planting of such trees as *Coprosma*, deciduous fruits, figs, willows, poplars (*not* olives, pines, eucalypts), lines and clumps of lilies (*Agapanthus*, spring bulbs, arum, *Canna*) or "summer-green" ground cover (comfrey, iceplants, *Tradescantia*, *Impatiens*, shortgrass sward) to reduce flame and radiation effects.

My own family survived in a dense eucalypt forest only by prior removal of all lower limbs, loose bark, twigs, fallen leaves, dry brush, dry grass, and dead stumps (every year); most of this material was chopped down and stoneweighted into hollows and swales, or burnt as cooking fuels. The tall tree stems not only saved the house from fire wind, but regenerated after the fire. A downslope line of willows and fern-leaved (*not* hardleaved) *Acacia* was firekilled but rejuvenated from the roots when cut down. This sacrificial hedge, or fire barrier, dampened out the ground fire, and even the leaves of the willows did not combust, but shrivelled and gave out steamy ash as the flames reached the trees. The house was blistered, and the zinc roof coating flaked off, but the closefitted boards were unburnt. All walls were whitepainted, and screens fitted; we had ample bucket water stored both indoors and out for the many small spot fires that were left after the front had passed. Apart from sore eyes and some short beards and hair, little damage resulted (Hobart 1967, a firestorm condition). In my street alone, 70 houses were burnt to the ground, with 1,100 houses burnt in the area, and 90 people killed.

The safest house sites are in damp valley mouths, in well-tended buit-up areas, on farms with flood-flow or Keyline irrigation fitted, in irrigated areas, on peninsulas in dams and lakes, and in any plateau site where the design and maintenance criteria are rigorously applied.

It follows that all designers should take fire into account over many climatic regions, and especially where we are developing forest from grazed areas, as long grass or tall stands of straw are the worst fuels for fast fire spread and for ground survival.

Important to human and plant survival are RADIATION SHIELDS; these are solid or reflective (or both) objects that reflect or harmlessly absorb the radiant heat from the fire front. It is radiant heat which quickly kills plants and animals. Most human casualties of fire are not at first burnt, but either smothered by

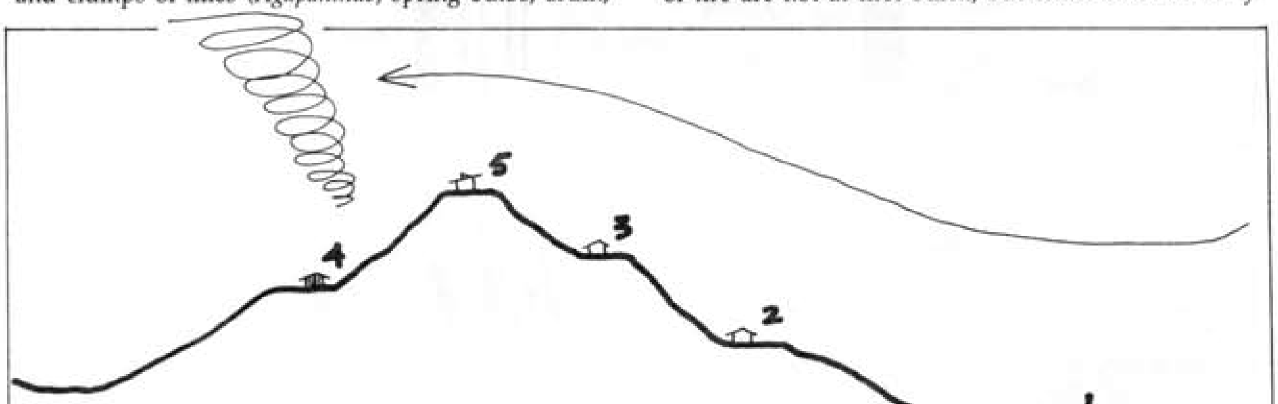



**FIGURE 12.29**
HOUSE SITES IN ORDER OF SAFETY
Risk increases from numbers 1 to 5; spiral shows where fire cyclones develop on lee side of hill crests; these then travel downwind.

toxic smoke or fumes from furniture or plastics, or killed (unburnt) by radiation.

Thus, radiation shields can be houses, stone walls, thick tree trunks, hollows or caves, hedgerows, and car bodies; a whitepainted brick wall is ideal. White paint on houses reduces radiation absorption, as white roof areas reduce sun heat. Fire-proof or slow-to-burn insulation in houses (mineral wool, seagrass, sawdust, feathers, wool) all keep the interior cool and assist fire control. Wooden panelling transmits little heat, while stone, brick, and mud may convey heat indoors, unless of sufficient thickness to absorb and disseminate it. Thatch and shingle areas must be replaced by tile or metal roof cladding in fireprone areas (by law in some districts).

Note that a fire shadow is tapered to about 4–5 times the height and width of the solid radiation shield, so make shields of trees or walls extend past the house (**Figure 12.32**).

### A NOTE ON FUEL REDUCTION

Wildfire will always happen, often every 8–30 years, on many sites. It will not be severe if normal annual fuel reduction is practiced; the most *unsafe* way to do this is to "cool burn". The safe ways are to graze off, slash, compost in swales, use as firewood, or to replace tinder with sappy green plants. Part of bioregional planning must be to keep monocultures of inflammable trees to uninhabited ridgetops, or better to scatter such stands throughout grazed or wetforested areas, or to tend them very well indeed in the matter of fuel reduction.

Ida and Jean Pain (*Another Kind of Garden*, 1982) have clearly laid out a broadscale, beneficial, fire-reduction system of chipping all dry forest fuels, composting or using them for biogas, which in turn fuels the chipping and carting operations, and lastly using compost and sludge to grow gardens, improve soils, and further reduce litter. Every bioregion should, perhaps must, adopt these methods if forests are to be preserved and eventually made fireproof.

Likewise, in the case of scattered suburbs, it should be compulsory for houses to build to fire specifications, have large roof tanks and ponds, and for developers to build fire-damping dams able to operate by radio-control to sheet water over slopes on a Keyline principle. Fire will then be restricted to remote dry-ridge forests, and lightning strikes (as it should be).

### FIRE EFFECT IN FORESTS

Fire sharply reduces litter, and leaves a nutrient-rich light ash that can wash or blow away, or wash into lakes and streams as a clear or cloudy nutrient load. Hot fire will remove from the soil in low intensity burns:

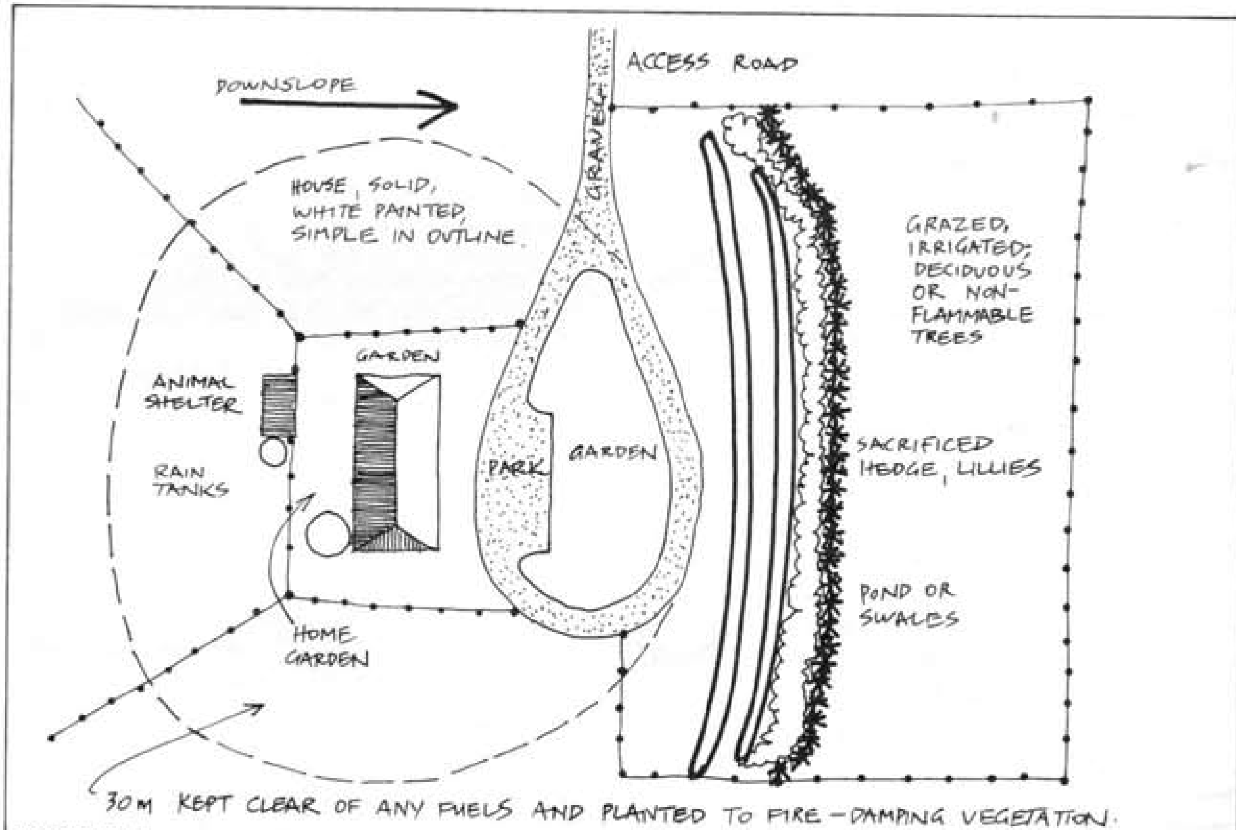



**FIGURE 12.30**
COMBINED DESIGN FOR FIRE SAFETY.
Radiation shields, multiple downhill firebreak, selected "wet" plants, and fuel reduction near the house creates a safe fire control at settlements.

Nitrogen: 54–75% (109 kg/ha); replaced in 11 years by legumes, rain.

Phosphorus: 37–50% (3.0 kg/ha); replaced in 20+ years by rain.

Potassium : 43–66%

Calcium: 31–34%

Magnesium: 25–43%

Boron: 35–54% (Figures from *Ecos*, 42 Summer '84/85)

Additional losses come from those shrubs and trees where foliage is burnt, and particularly so if the fire occurs early in the growth season. As fires "glow" at 650°C and burn fiercely at 1,100–1,400°C when strong winds blow, sulphur and nitrogen are volatilised, as is carbon. Phosphorus and potassium are volatilised at 774°C and calcium at 1,484°C (cement structures powder at this temperature). However, organic compounds containing these elements may volatilise more easily than soil elements.

Obviously, there is a very slow recovery of soil nutrient after fire, and this depends on trace elements brought in by rain or birds, and minerals recycled to topsoil by deeprooted vegetation. Clearly, fires never improve soil status. Humus loss of 10–12 cm occurs in forest soils, and peats often combust to greater depths. Clays lose structure, and mud flows can result.

## STOCK LOSSES IN FIRE

Good stock managers can, by pre-planning, reduce losses in fire. Some ideal situation would be to make sure that some paddocks (small areas) have been closecropped from late winter (or late summer in monsoon areas) to early summer, so that these small fields carry no inflammable fuel and can be used as general refuges in fire. Even more effective is to place a water trough in a deliberately bare soil area, even one where topsoil and shrubs have been bulldozed into a surrounding earthbank (for protection against radiant heat), and to use such areas as always open refuges off 4-6 prepared range paddocks; stock can be confined there early fire danger days. Stock enclosed by a temporary electric fence will clean off rocky knolls of grasses before the fire period; these too can be used as refuges.

Tethered goats or sheep reduce patches of fuel near houses, as do close grazers such as geese, wallaby, and rabbits. Wild wallaby or geese can be "fed in" with

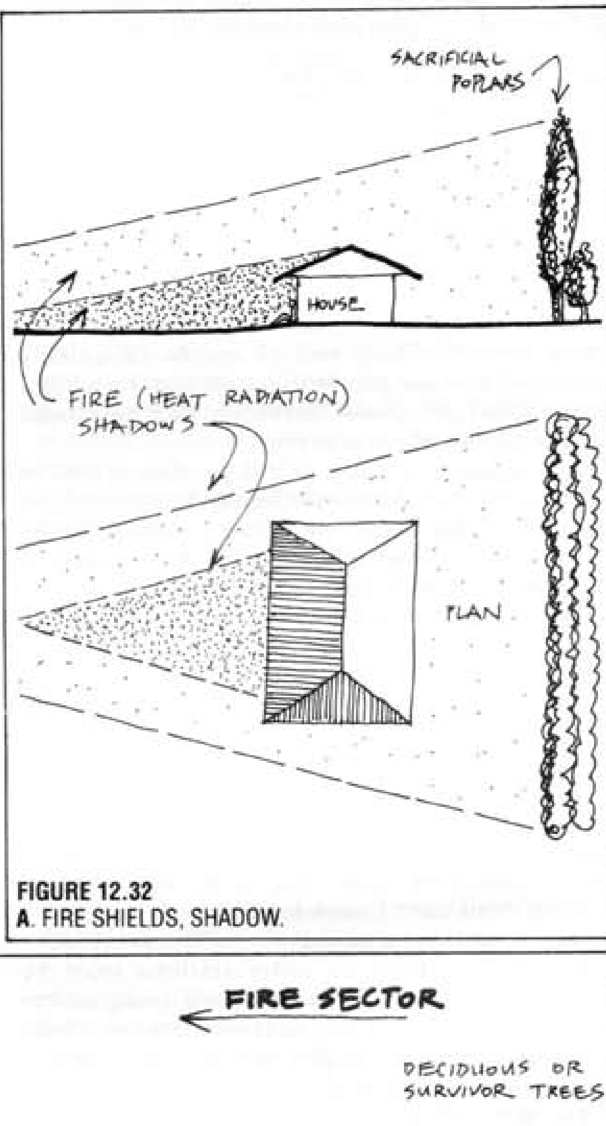



**FIGURE 12.32**
**A.** FIRE SHIELDS, SHADOW.

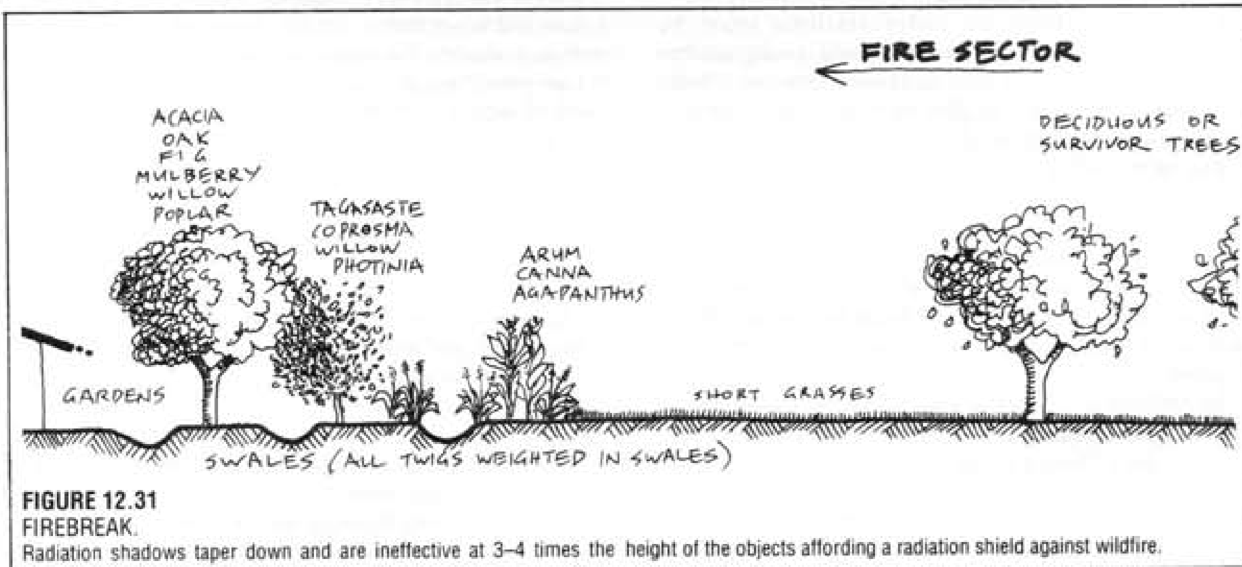
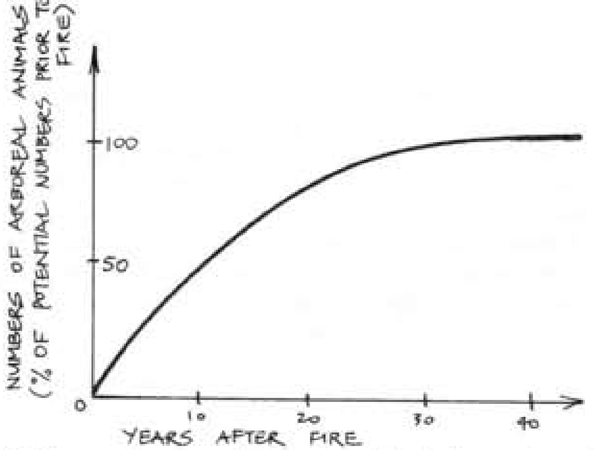



**FIGURE 12.31**
FIREBREAK.
Radiation shadows taper down and are ineffective at 3–4 times the height of the objects affording a radiation shield against wildfire.




**B**. This curve for recovery of arboreal animals after fire could as well serve for the slow increase of fire–removed nutrients in soils and leaves.

pollard on such areas, and thus encouraged to create marsupial lawns (or rabbit swards). A forest of young deciduous trees, fig, mulberry, or oak will make a stock refuge if closebrowsed before fires are expected (dry grass period). Short swards are fairly quickly developed by close grazers if first slashed, then limed and fertilised (phosphate). Eventually, such fire refuges become popular places with stock.

With respect to a house or village, close–grazed or mown areas form part of the (upwind or downslope) firebreak system, and in fire danger periods stock can be fed in or mustered, and secured in these areas or in the settlement itself. Chickens survive well in solid housing, as they often produce bare areas around such houses, or chicken sheds can be part–buried in banks to give complete protection.

PERSONAL SURVIVAL IN AND AFTER FIRE

For people, the main survival factor is to cover the body, wearing wool or cotton, and to shelter from fire front radiation behind a tree, car, house, or in a trench; all the better if the whole body can be caped in a wet blanket. Wait until flames have passed, then move cautiously on to burnt ground.

For civil authorities, radio stations must be commanded to keep constant reports going on fire direction, open escape routes, family location centres and refuge areas, and to give constant instructions to householders and travellers.

Just as the fire passes, well–equipped ground teams preceded by a bulldozer should clear roads, and put out spot fires in unoccupied houses. Police need to roster guards, or *well–disciplined* volunteers, to prevent looting until the area is re–occupied and services re–connected. Such services must be on stand–by at the fire periphery as it is suicidal to put forward teams in the path of the wildfire.

In firestorms, oxygen is periodically exhausted, and the fire goes out briefly. People cannot breathe and they faint, so they should never take refuge in small water tanks, dams, or rivers, as they will drown while unconscious. The sea, and large rivers of 100 m or so across, are safe to run to, but beware of fainting from lack of oxygen in the air and water (the skin needs oxygen too). Drink a lot of water to prevent dehydration, and make sure children and stock also get water to replace lost body fluids.

We survive better if we have planned ahead, built fish ponds or bought metal buckets, prepared blankets and important papers to be picked up by the rear door, filled roof gutters, removed doormats, hosed down the garden, tied up or penned the stock, prepared woollens to wear, taken in the clothes, filled baths and sinks with water, and so on.

We *recover* faster if we have expected the noise, confusion, sense of isolation, and are prepared for looters and for "survivor guilt" (that is, "why should *I* have survived when people around me have died?"); for weeks, months, perhaps years, we can feel desolated by the losses we know of. It greatly helps if we have assisted others before, during, and after the fire, as we know we did our best. This applies to all catastrophes, not just fire. Even so, in every large wildfire in settled areas, people will be lost or very badly injured, much property and stock will be destroyed, and the psychological and social effects will persist for months or years.

And if your house burns down, do *not* build another "just the same" as most people do; build one to survive the next disaster. Thus, have realistic expectations, act on them, have some planned moves, and prepare better for next time!

## 12.17
## DESIGNER'S CHECKLIST

Design solid housing to cope with winter cold; shelter the house with earthbanks, walls, or dense crescentic plantings to poleward winds. Drain house and barn areas well for muddy thaw periods.

Choose midslope (thermal belt) locations for house and garden sites, and be aware of frost extent on slopes.

Where summer–dry regimes dominate, design the house and inner zones for fire protection, and provide radiation shields. Develop swales in these areas.

Use plant/animal guilds in orchards, and balance these to reduce or eliminate the need for biocides.

Use minimal or no–tillage systems in crop, maintaining or providing soil humus and soil structure. Use hedgerow for windbreak.

Beware avalanche in snowy climates, and do *not* develop ski runs in fragile slope forests or tundra. Beware acid rain effects on uplands above villages. Hedgerows and swales will harvest snowmelt.

Bury all pipes below frost level in soils, and allow for ice depth on water storages.

Do not destroy peats or dwarf trees on permafrosts; resod bare areas.

Retain and extend hedgerow and upland forests on farms around settlement.

Do very careful fencing and grazing rotations in grasslands, and try to include (or develop) a mix of grazing species in savannahs. Encourage native game species on all farms.

Study the text for data on free-range development for bees, chickens, pigs, and so on. Livestock products are important winter foods.

Plant to create winter stores of grain, roots, fodder for barn animals; integrate the house and barn in severe winter climates.

Beware the ill effects of hyperinsulation, radon, carbon monoxide in buildings, and arrange for solid-mass heaters, good ventilation.

Maximise forestry, social income, free-range animals, and special products.

OUTLINE FOR A PROPERTY DESIGN REPORT

Frequently, people are called on to locate, design, or supervise work on projects and properties, Some of these call for a written report;and a useful format is as follows:

1. GIVE CLEAR ADDRESSES of designer and client, location (with map) of the property, i.e. *identify* place and people.

2. STATE MUTUALLY AGREED-UPON SCOPE (instructions) for this job; this sets the limits of the report. Establish whether any discretionary money is available for (e.g.) maps, travel, soil analyses, aerial photos, water analysis, minor equipment.

3. DESCRIBE THE PROPERTY IN GENERAL TERMS, including climate, rainfall, winds. Such factors as soil erosion, fencing, access, fire risk, water sources or potential for water harvest, slope, and aspect should be clearly marked on maps. Energy supply, market potential, human resources and skills, capital available for development, wildlife and potential pest species can be included as part of the report.

4. PARTICULARISE LAND USE on the basis of soils, slopes, potential species and activities—do not forget *social income* from accommodation, teaching, and so on.

a. Areas: Treat similar areas (marked on a map) alike, e.g. "steep eroding slopes for forestry"; "swampy lowland suited to chinampa", etc.

b. Themes: Themes cover access, roading, fencing, soil treatment, specific crop or forage systems, water sources and control, and potential for farmlink, commonwork, trust management, village development. Point out unique existing resources (gravels, clean water, young forests).

5. ATTACH APPENDICES such as maps, drawings, plans, layouts, details, plant lists, resource lists (addresses of people or services), some photocopies of excellent relevant studies, and any photos taken.

However poorly you think of yourself as a designer, you cannot do a worse job of settlement and agricultural planning than those you see about you! However, to persuade people to accept an externally *imposed* design is a form of insult, an implicit assumption of superiority on the part of the planner. Our best strategy is to work with and educate owner-designers and community groups, who are then part of the design process; or to proceed in stages, working alongside the people who ask for a design. What all good designers come down to is the willingness of the people on the ground to make it work, and they will only try to do this if a great many of their ideas are also incorporated.

For myself, I keep property reports informal, offer free enquiry on details, try to revisit at various stages, and increasingly prefer to train people to self-design, to visit other properties, and to join support networks. It is a good idea to supply a one-year subscription to a permaculture journal.

Work is appreciated if it serves a local or community need, or if it is taught to others; work that nobody wants done is rightly deprecated. For these reasons, and others, it is essential that we have the courtesy and sense:

- Never to knock on closed doors; to go only where we are invited.
- Always stay on the ground. Do not instigate grand projects that nobody really wants, and then expect people to accept the project. Rather, try to define needs as stated or requested and work towards supplying these.
- Always pay your way. Save people more than you cost them.

## 12.18 REFERENCES

Bishop, John P. *in* G. de las Salas (ed.), *Workshop on Agroforestry Systems in Latin America*, Turrialba, Costa Rica, 1979.

Brown, L., *The Life of the African Plains*, McGrawHill Book Co. New York, 1952.

Farallones Institute, *The Integral Urban House*, Sierra Club Books, 1979.

Pain, Ida and Jean, *Another Kind of Garden*, self-published in France, 1982. Available in USA from Biothermal Energy Center, PO Box 3112, Portland, ME 04101.

Reid, Rowan, and Geoff Wilson, *Agroforestry in Australia and New Zealand*, Goddard & Dobson, Box Hill, Victoria 3128, 1985.

Snook, Laurence C., *Tagasaste (Tree Lucerne) High Production Fodder Crop*, Night Owl Publishers, Shepparton, VIC 3630, 1986.

Stoddart, Laurence A. and Arthur D. Smith, *Range Management*, McGrawHill Book Co. New York, 1955.

Whyte, R. O., T. R. G. Moir, and J. P. Cooper, *Grasses in Agriculture*, FAO Rome, 1975.

# Chapter 13

# AQUACULTURE

Whoever discovers how to cultivate the eel should get a Nobel Prize, don't you think?
(Daijiro Murata, eel chef, Tokyo)

Catfish farming is living; everything before or after is just waiting.
(Don Carr, entrepreneur, Eagle Pass, Texas. Quote in Huke and Sherwin, 1977)

The highest fish production per hectare can only be obtained by using a combination of species of different feeding habits.
(Swingle, 1966)

Water conservation and irrigation is the lifeblood of agriculture. Grain can be taken as the basic crop, and around it developed industry, animal husbandry, forestry, aquaculture, and other integrated occupations.
(Mao Tse Tung)

## 13.1 INTRODUCTION

The term WETLANDS covers both natural and artificial impoundments of water: lakes, ponds, bogs, swamps, marshes, and the shallow water or intertidal areas of estuaries and marine marshes. The emphasis here is on those areas used by people for foraging and fish-farming. Because of the complexity of the wetlands environment, and of the species within it, an attempt is made to cover some of the design and planning principles and to restrict descriptions to a relatively few systems. The breeding and rearing of any one species is also omitted, as a comprehensive specialised literature exists on this aspect of aquaculture.

Except in very favoured areas, or on recently glaciated shields, water as ponds is a minor part of the total landscape, although we are constantly increasing the area of impoundments in an attempt to cope with the energy demands and water supply to cities and industry. In impounded areas, on wet terraces, and in canals and raceways, water ceases to be a merely erosive influence and becomes a very productive medium for plant and animal cultures. Associated with water are those specialised plants and animals which are adapted to or seek out water margins, shallows, and the water meadows (plains) which are inundated in floods.

Of all existing systems, tropical rainforest and shallow-water aquatic environments have the greatest natural yields. Mangrove swamps, marshes, and estuaries produce sometimes prodigious biomass of great complexity. Our attitudes to these systems has historically been ambivalent, and since the invention of the bucket dredge and bulldozer, typically destructive. Many marshes, estuaries, saltflats and ponds have been drained or deeply flooded to suit our private purposes, often in disregard of their total yields and values. Only in recent times have we begun to appreciate that a great many of our other activities, such as salmonid and inshore fisheries, depend on the conservation of the wetland habitat.

For millenia, we have occupied the shorelines and islands of marshes, and developed complex civilisations on the floodplains and deltas of major rivers. Swamps have always yielded a variety of foods for people. One of the bases for the concept of bioregion is that of WATERSHED and this too is an ancient natural division of tribes and languages. Cooperative communities and bioregional democracies have been based on water rights, as have hydraulic tyrannies; both exist today.

There is an intimate and indissoluble link between the health of a river, and the health of the catchment; here we can sense the literal truth of the concept of the "upstream and downstream costs" of our activities;

Pollution, in all its forms, most rapidly permeates landscapes and societies via water. Wherever we have used biocides in a catchment, we can reap death in the rivers and the seas offshore as far out as the reef areas, and in the sea itself. The death of coral reef areas is closely correlated with the use of 2,4-D and 2,4,5-T inland. Preservation of the cleanliness and variety of water habitats is as critical to the survival of nations as is the conservation of soils. Both are in peril today.

In specialised cultures, water becomes the main medium for life sustenance, and all island cultures neatly combine the water and earth resources, as does the old Hawaiian *ohana* synthesis (**Figure 10.28**). Elsewhere, as on the Euphrates and on Lake Titicaca in Peru, whole cultures based on reed beds derive forage, boats, housing, bread, and meat from *Typha*, *Phragmites*, *Cyperus* or like reeds, while it is said that the Aztecs at Lake Tenochtitlan in Mexico had what is possibly the most productive system of polyculture yet devised, with chinampa crop, waterfowl, reedbed, and fish culture combined.

The cultures in terraced padi (rice and taro) serve much of Asia and Oceania, with minor subsidiary crops. The deltaic mazes of the Fly, Chao Praha, Mekong, Nile, and Ganges rivers support rich cultures of great variety and resource choice, with marine, estuary, freshwater, mangrove, and land organisms to choose from. Many of these advantages can be fairly cheaply created in most humid and some arid environments, even if in miniature.

Before the 1960's, there was a lively and large global aquarium trade, and plants, molluscs, fish and no doubt disease organisms were widely distributed. Many of these were released into local streams and became naturalised. Even this effect was dwarfed by the government-assisted distribution and protection of salmonid fish as a preserve of the idle and the affluent. A few fish species, notably *Tilapia* and carp, were brought in as a basic farmed food for terrace rice and taro culture in Asia or in famine areas. However, it is still true that the great majority of aquacultures have a predominantly local flavour and species composition, and few introduced species have proved to be as adapted and productive, or as uniquely suited, as indigenous species. Only if there are no local species, or if all trials in using local species are fruitless, do people look to exotic forms.

Aquacultures now range from open-water cage and ring-net systems to highly intensive tank or channel-flow cultures. On islands, atolls, and in deserts, totally innovative systems have evolved—and will in future evolve—where local species were absent or of minor productive capacity. As pelagic fisheries are exploited by the oil-rich western nations, island people have been forced to develop alternative systems, and aquaculture is one of these. Unlike terrestrial cultures, many aquaculture developments have been polycultural from their inception.

## 13.2
## THE CASE FOR AQUACULTURE

Until the last few decades, we have been able to harvest sufficient fish, molluscs, and plants from natural water systems. This is no longer the case, and a new impetus is evident in the creation and culture of organisms in the aquatic habitat. Even though a limited production has existed for millenia in all continents, new species are brought into culture annually, and the problems of breeding and rearing a wide range of organisms are being solved.

There are complex reasons for the sudden revival and expansion of aquacultural systems; some of these are undoubtedly connected with over-fishing of the marine resource, but perhaps as important is the change in food habits resulting from global travel and information, with a consequent change from fatty and red meats to fish and shellfish, and a general widening of the demand for variety in foods that can be eaten raw or lightly cooked.

Water cultures had long-tested and undoubted stability, and many have persisted without external imputs for thousands of years. The stability and productivity of aquaculture systems are superior to the terrestrial culture systems so far developed. Given the same inputs in energy or nutrients, we can expect from 4-20 times the yield from water than that from the adjoining land. To summarise why this is the case, we need only to note that:

- Water supply is constant for plant and animal growth in aquatic and semi-aquatic habitats.
- Plant nutrients in particular are available in soluble and easily assimilable form.
- Water and nutrient flow is a factor not represented in fields but is a critical boost to production in water.
- Water organisms (fish, shellfish) need waste little energy in movement; they are largely free of gravitational effects and weight disadvantages.
- Light, nutrient, and plants occupy a three-dimensional medium. There are complex edges, surfaces, and conditions developed as a result, and a variety of species to occupy these.
- The often rigid (and very recently monocultural) inhibitions of farmers are not as yet evident in water cultures, where the advantages of polyculture have been recognised from the beginning.
- Energies lost in cultivation are eliminated or reduced in aquatic systems, although management may need to be as skilled as it is for land crops.
- Impounded water has a great variety of products other than food; it flows on to energy production, recreation, irrigation systems, and transport.

Although all these reasons for greater yields with less inputs have always been there, dirt farmers generally have been slow to convert to aquacultures, and perhaps rightly so where a supporting infrastructure of storage, transport, and sales is lacking. But as these begin to develop, then it becomes worthwhile to abandon the production of the many surplus commodities now clogging world food markets in the developed countries for the more stable and specialised products of aquaculture. Another reason to delay action has been to await the development of earthworking equipment, as it has taken some tribal groups thousands of years to develop terrace areas that we can now create in a few weeks or months of earthworking with machines.

There are even more commonsense reasons to develop aquacultures in areas where people are at risk from famine or flood, as ponding, water harvesting, or diversion cannot help but aid food production generally, and reduce the extremes of drought and flood, even in semi-arid areas. Fish production has long been combined with wet terrace crop, and now in many terraced areas the emphasis is changing from starch to protein production. Fish are replacing rice as a yield over large areas of abandoned padi in Indonesia, for a great gain in protein yield and a reduction in the fuels needed for food preparation (Pullin and Shehadeh, 1982).

Aquaculture, in short, is as much a stable future occupation of responsible societies as are forests, and between these two beneficial systems we will see a great reduction of the areas now given over to pastoralism and monocrop. Both these latter occupations are enterprises less and less favoured by society, and their products are an obvious risk from any point of view one cares to take (fiscal, health, social welfare, energy efficiency, or general landscape stability).

Aquaculture is no more valid as a high-energy-use monoculture than its historical predecessors—the large grain or single-crop farms. It is at its most enjoyable, convivial, and socially valuable when encountered as community taro-terrace culture, and at its most depressing as 100 ha intensive prawn or catfish farms. Thus, my attitude throughout is to stress sensible yield and procedure, but to discourage the "maximum yield of one species" outlook.

To design for greatest energy efficiency, we need to look at the whole pond landscape and configuration to aid aeration, heating, nutrient flow, and the numerous accessory benefits we can get from hydraulic technologies such as water wheels or ram pumps. We as designers need to apply the same methodologies to aquaculture as to any designed system. We can perhaps hold one idea (or species) at centre, and see how many of our designed features connect to and from it, and how many other benefits can be nested within the system, supplying as broad a range of needs for ourselves and other species as we can reasonably achieve. Wild duck do not annoy catfish, and pay their way in phosphatic fertilisers; there is no need to deprive them of islands, shallows, or nest boxes. **Figure 13.1** shows some elements of pond polycultures.

A pond can act as a mirror, a heat store, a run-off area, a cleanser of pollutants, a transport system, a fire barrier, a recreation asset, an energy storage, or an irrigation accessory. All this, and it is intrinsically productive as well. It presents a host of opportunities for aesthetic and functional placements of trees and plants; buildings and pond furniture such as jetties,


**FIGURE 13.1**
POND POLYCULTURES.
Some typical pond elements and furnishings.

rafts, boats; and habitat for birds and wildlife, for beavers, water-rats and turtles amongst fringing vegetation, logs, stones, and hummocks.

Thus water (unless treated as a monoculture) has great potential for beneficial design, both in pond configuration and for species mixes. It is an exciting challenge to the innovative farmer, and I will try to give some design parameters with an emphasis on beneficial design for nutrients, plant control, multiple use, and thus higher yields. People rearing specific plant or animal species should spend some time researching the large amount of literature on those cultures.

Skills in pond management, and especially in integrating species and yields, or in judging and regulating water quality are hard-won. To gain in yields and not lose out in costs or disease is a difficult balancing act. We need to start small and build on successes, planning better strategies at each point. For the home-owner a set of tanks or a small pond is pleasurable and probably profitable, as labour is seldom assessed. Nor is such a pond anything but a recreational and relaxing place, but for those who wish to profit from aquaculture, planning and design, and monitoring and research, are essential to success at the intensive level. Those who are able to select and develop an extensive site (20 ha or much larger) can accept lower total yields with less costs and risks. It is a question of options, lifestyle, and preferred approach and aquaculture may well be the accessory enterprise (e.g. medicinal products from algae, or silkworm culture, or cabin fishing licenses) that turns a profit.

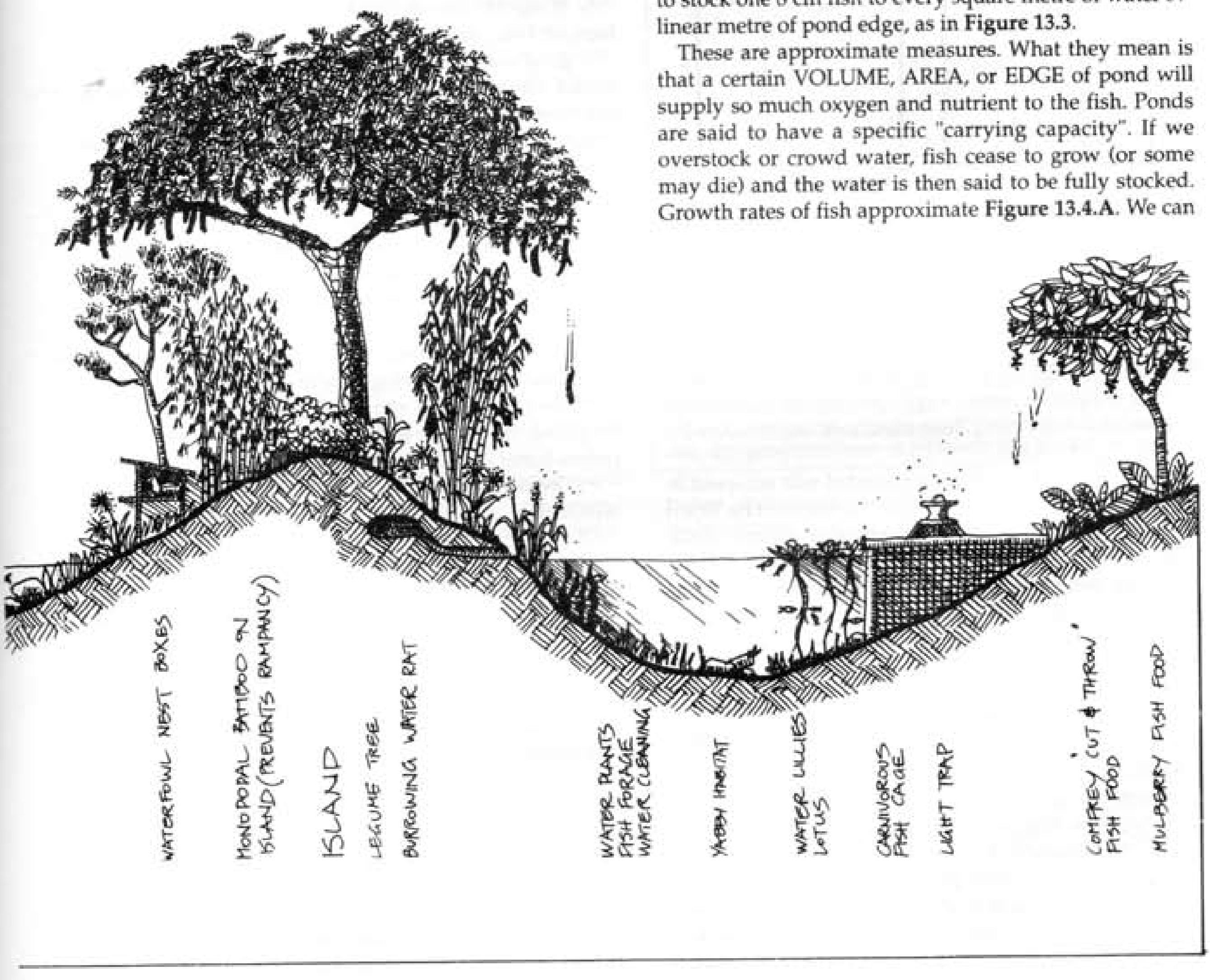
## 13.3
## SOME FACTORS AFFECTING TOTAL USEFUL YIELDS

GENERAL CONSIDERATIONS

**Figure 13.2.A** and **B** illustrate the classical relationship between weight gains in a well-stocked pond, and the reduction in the numbers of fish in one brood or spawning over time.

When we buy an aquarium, fish retailers will tell us to stock 2 cm of fish per gallon, or 4 litres. When we go to a fish nursery for fingerlings, the grower will tell us to stock one 8 cm fish to every square metre of water *or* linear metre of pond edge, as in **Figure 13.3**.

These are approximate measures. What they mean is that a certain VOLUME, AREA, or EDGE of pond will supply so much oxygen and nutrient to the fish. Ponds are said to have a specific "carrying capacity". If we overstock or crowd water, fish cease to grow (or some may die) and the water is then said to be fully stocked. Growth rates of fish approximate **Figure 13.4.A**. We can



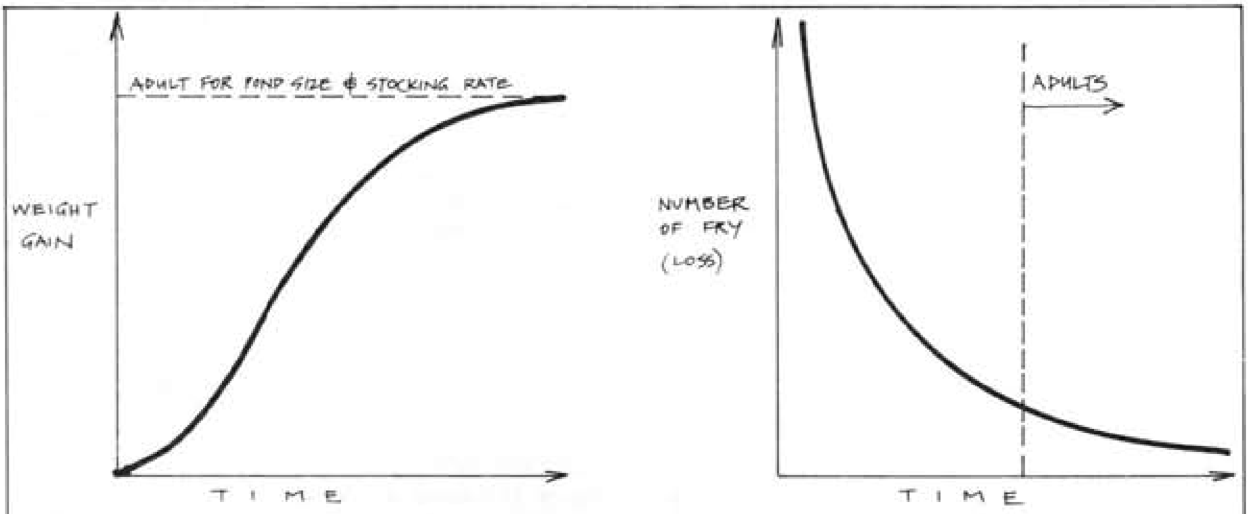



**FIGURE 13.2**
GENERAL CONSIDERATIONS AFFECTING YIELDS.
General curves for weight/number relationships in wild fish populations; ponds can also lose 13–20% of fry.

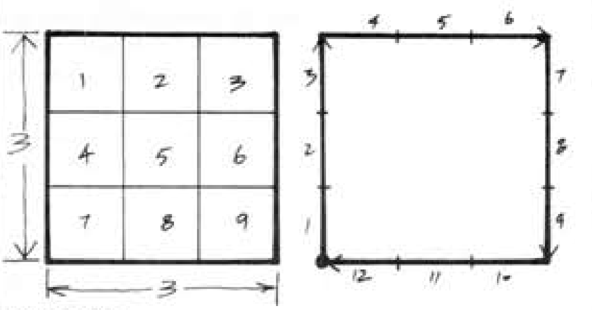


**FIGURE 13.3**
STOCKING RATES.
Fish can be stocked as a fixed weight per surface area for planktonic feeders, or per metre length of shore line for omnivores; for the latter group it pays to maximise edge.

do several things to lift the carrying capacity of ponds, such as supplying more oxygen by stirring in air, more nutrient by supplying manures, and more edge by crenellating the edges.

The highest fish production recorded was achieved in a rapid canal flow of mainly sewage. The least productive pond would be a circular, warm, clear, concreted basin in a quiet valley.

We can (after a year of trial) establish the capacity of our own ponds. We will take a figure of 200 kg of fish/ha/year—a modest yield. We can grow this much fish every year as:

- 200 x 1 kg fish;
- 400 x 500 gram fish;
- 800 x 250 gram fish; or
- 1000 x 125 gram fish.

About 300 g is generally accepted as minimum pan-fish size. Below this size fish can be utilised by being dried or made into paste.

This gives as a good guide to stocking procedure, although by liming, manuring, providing high protein food, or aerating, we can lift the base productivity. It is the same as pasture management (except we expect higher yields/ha). However, *if* our fish breed in the pond it soon becomes crowded, and we get a lot of little fish. If our fry die off quickly, we get too few fish and harvest a very few larger fish only.

A good way to overcome the breeding problem is to keep a few predatory fish in a cage or netted-off area of the pond. A good way to overcome fry loss is to rear these in small covered ponds, and release them as fingerlings or well-grown fish in order to give them a flying start. All this becomes routine after a while. There are a few other things to watch for: that predators are not too plentiful in the ponds, and that when harvesting we get *all* the fish out if possible, unless we have pond breeders continually culled by screened-off predators, when we can take some fish at all times. This is how natural ponds work.

We could go on to design for two factors:

- The mix of plant and animal species we would like to grow, or know will grow well together—our polyculture GUILD or association.
- The way we will lay out our ponds— CONFIGURATIONS.

EDGES, INTERFACES, AND GRADIENTS IN WATER

The edge effect in water is rather like that of land surfaces, but somewhat more pronounced. Anyone who goes fishing will vouch for the importance of shore-line, channel edge, weed-bed, or reef as productive environments. When stocking rates are estimated for fingerlings, the concepts of surface area or margin length are interchangeable, so that a relatively narrow drain will hold as many fish as a broadwater several times its surface area. Hence the sinuous canal is a rich environment for life forms compared with the circular or square pond, and much cheaper to construct in clay soils.

Maximum edge is assured by either swale, canal, or **chinampa** systems (**Figure 13.33**), which themselves can be sinuous in a flat landscape. Even modest canals make for low-energy transportation, either as barge, flatboat, or float. Harvesting, too, can be simplified by skimming, floating, or trapping products in flow.

Edges occur, or can be produced, in great variety at the land/water interface. Forest, shrubbery, reed-bed, mudflat, gravel, marsh, ice and snow all produce unique habitat beside water surfaces, utilised by very different organisms. Amongst waterfowl, the preferences for a great variety of edge is as marked as it is amongst frogs; some preferring barren spits, and others forest and mulch. Quite small ponds can provide the essential nesting and refuge places for many bird and frog species.

The surface of water itself, because of the molecular tension there, supports striding, floating, and sucking organisms and has caused peculiar adaptions e.g. the fringed legs, buoyant seeds, and suctorial mouthparts of insect, plant, and tadpole respectively. The mud generates and hides a host of rooted, tunnel-making, ciliated, and burrowing or sliding lifeforms from mussels to larval lampreys, tubifex worms to tubers. As the pond surface is critical to gaseous exchange, so the mud surface is to nutrient retention, and it is there that phosphates and nitrogenous products are stored, and humic and faecal products accumulated as mulch. Anaerobic and reducing processes can take place within the close confines of the base mulch, while aeration takes place on the water surface or by the medium of plants, wind, or flow turbulence.

## ENERGY CONSIDERATIONS

Our design strategies for aquaculture systems must hinge, as ever, on the energy costs of the system: its sustainability in terms of present and future resource costs. The actual excavation of ponds, if well planned and executed, creates a very durable resource, needing little but minor maintenance. Ponds and terraces hundreds (sometimes thousands) of years old are still in production.

Continuing costs, however, are associated with growing fish (or other aquatic organisms) and getting them to market. While both are to some extent site-dependent, the inputs of high quality food or nutrient as an integral part of planning is very much a design-dependent factor.

J. E. Bardach assesses FOOD, FERTILISER, and FUELS for water pumping as the main recurrent fish culture costs, and choice of species as critical to economic production (large carnivores being most expensive to rear). Well over 90% of the energy or monetary production costs are in the three factors mentioned. Labour and fuel energy are to some extent interchangeable, and while the utilisation of waste food is a saving, other pollutants are a cost (sometimes a terminal cost), as the water environment is very susceptible to biocides (*Proceedings of the 14th Pacific Science Congress*, USSR, 1979).

Water supply itself may become the limiting factor in many areas, and recycling of wastes, well-selected polycultures, and careful attention to distances and market are seen as strategies needing attention. Bardach gives some current production costs as:

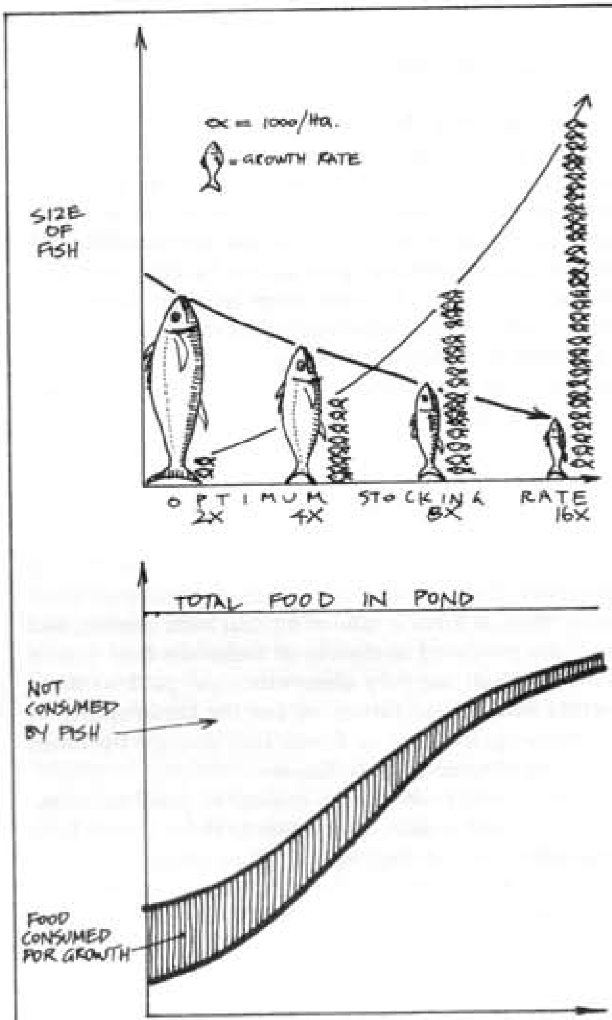



**FIGURE 13.4**
EFFECTS OF STOCKING RATES
**A.** As we increase the number of fish per unit area or edge, the size of harvest decreases; too few large fish or too many small fish indicate understocked and overstocked ponds respectively; understocking is the most common error on farms.
**B.** Only as fish grow to optimum weight are natural food sources fully used; fast-growing minnows or shrimp can hold this food as forage.

| System | Production Costs MJ/g | kcal/oz |
|---|---|---|
| Wild-caught lobster | 3.22 | 21,801 |
| Wild-caught shrimp | 2.50 | 16,953 |
| Intensive silo rearing of perch | 2.24 | 15,167 |
| Pond catfish (USA) | 0.58 | 3,941 |
| Pond polyculture of carp, mullet, *Tilapia* (Israel) | 0.027 | 184 |
| Sewage/stream culture of | | |

| | | |
|---|---|---|
| carp in cages (fast stream, no biocidal pollutants) | <0.004 | 28 |

Such analyses show why distant-water fishing is collapsing in all sensible (or oil-conserving) countries, and why aquaculture is also likely to eclipse terrestrial production of protein, especially of intensive or feedlot systems. Today, food preferences are also favouring fish and aquatic products generally in health-conscious people, and when I heard recently of an Australian sugar-cane farmer who had converted his riverside canefields to extensive prawn ponds, I was certain that he would be in business long after the sugar refineries had closed down.

As for inherent conversion efficiency, an average figure for catfish, carp, mullet and so on would be 1.5-2.3 kg of high-value invertebrate food to 1 kg of fish flesh (excluding eels and large fish carnivores). While no terrestrial species reaches this sort of efficiency, chickens and some non-domesticated stock come close, at 3.5 or a ratio of 4:1, but beef, mutton, and pork are produced at double or treble the feed cost of fish. We shall see *very* close attention paid to these factors in the near future, or see the bankrupting of western agriculture as fossil fuel energy becomes unusable in terms of its pollutants.

In this section on yields, critical to pond management, we will restrict discussion to those ponds built specifically for fish and aquatic plant culture, and thus presume that they are from 0.5-2.6 m deep, with controlled inflow and outlets, which can be drained or pumped dry if necessary.

### WATER QUALITY

All life processes, and decomposition in aerated waters, consume oxygen. A general level of 5 parts per million (ppm) is very satisfactory in ponds. At 1 ppm many fish species may die except for a select adapted group of air-breathers used in stagnant and weedy tropical still-ponds. Augusthy (1979) notes that snakeheads (*Ophiocephalus*), Singhi (*Heteropneustes*), the catfish *Clarias*, Mahi (*Notopterus*) and *Anabas* in India all have sacs, labyrinth organs, or special air chambers near the gills from which they can derive oxygen by breathing air. Other fish die in the anaerobic conditions of weedy tropical shallows where the above species, the adapted lungfishes, and many minor species survive. Even derelict swampy ponds can yield 2,400 kg protein/ha/year if a polyculture of air-breathers is stocked, as three or more of the above species, or equally hardy species.

The fish in tropical still ponds combine well with the crop plant *Euryhale ferox*, a spiny floating plant of the water-lily family whose period of yield and harvest coincide with the maturation of the fish. The ponds used are 1-1.5 m deep, and as the fish help control malarial mosquitoes, there are multiple benefits. Seeds of *Euryhale* are marketed as a "popcorn" in India.

The integration of specialised warm-water aquacultures, or the stocking of oxygen-depleted waters is also dealt with by Pullin and Shehadeh (1982). They describe the modification of rice padi to accept specialised species assemblies. Fish refuges are made in padi either as a peripheral canal or as a sump to contain fish between flooding for crop. **Figures 13.5** and **13.6**.

Temperatures in rice pond water may reach 34°C, with optimum growth at 22-28°C. In Indonesia, fish are pan size at 10-12 weeks, while in cooler areas (Japan) it may take 2-3 years of summer seasons to produce pan-size fish in padi. Weedy padi is in part cleared by using (in Thailand and Malaysia) such species as *Trichogaster pectoralis*, *Clarias macrocephalus* or *C. batrachus* for weeds, *Ophiocephalus striatus* as a predator, and *Anabas testudineus*. With such combinations, the extra crop of fish in rice reaches 70-400 kg/ha/year (water 10-34°C). Good fish mixtures, e.g. *Helostoma temmincki* (35%),

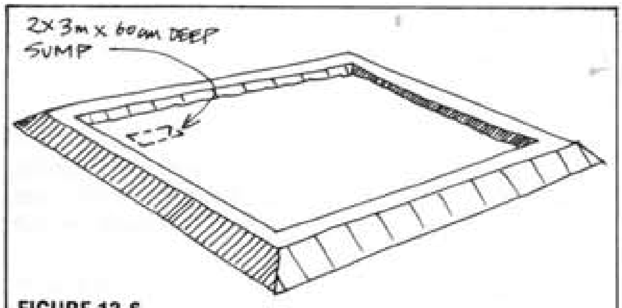
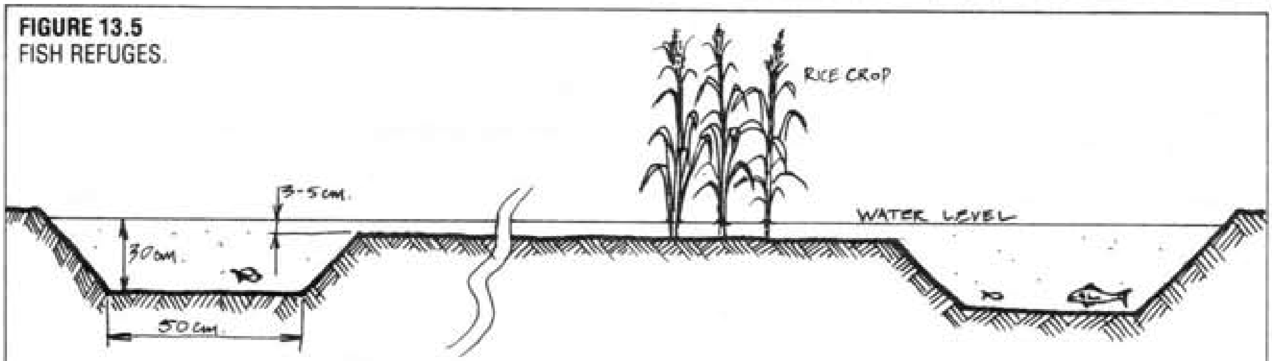



**FIGURE 13.6**
FISH REFUGES
Deep "kettles" in a shallow pond can prevent fish dying in freezes, of excessive heat, or from accidental pond water loss; they also assist capture in draw-down conditions.

**FIGURE 13.5**
FISH REFUGES.



*Osteochilus hasselti* (15%), *Cyprinus carpio* (15%) and *Puntias gonionotus* (35%) give best yields. Alternatively, *Sarotherodon mossambicus* (50%), *Helostoma* (20%), *Osteochilus* (15%), *Puntias* (15%), and *Cyprinus carpio* (10%) are satisfactory. (The percentages are those of fry or fingerlings of these species.) Such polycultures are the result of a series of trials in padi, and all use weed-eating species and predators to control small fish. Crayfish (*Cambarus clarkii*) are also stocked in rice padi, a difficult and specialised pond system, but the fish yields there may add a critical element to nutrition.

We generally classify waters (and in particular sewage lagoons) as:

• AEROBIC: where oxygen is well-supplied by wind overturn, turbulent flow, aerators, or rapids, and where there is a light load of decaying organic material.

• FACULATIVE: (many swamps and weed-clogged ponds, secondary treatment sewage ponds) where the surface may be aerated, but where sediment or sludge collects in cold periods and the pond base becomes anaerobic (sulphur-fixing bacteria then decompose the sediments).

• ANAEROBIC: primary sewage ponds and over-fertilised shallows where there is a low (1 ppm or less) oxygen status.

As less oxygen can be dissolved in warm water than in cold water, and as the plants that produce oxygen by day consume it at night, there is a danger that healthy, weed-filled shallow ponds may develop severe oxygen deficiency on warm summer nights. If valuable fish stocks are held there, care should be taken to both reduce the level of wastes in the pond, and to arrange for automatic aeration at critically low levels. Such dangers are less in clearwater, cold, and open or flowing pond systems where this factor can sometimes be ignored. However, oxygen supply becomes a limiting factor in fish stock density at levels above 5000 kg/ha or thereabouts, and then oxygen as air bubbles needs to be supplied (**Figure 13.7**).

There are several commercial aerators on the market, and many can be solar-powered. But wherever water can be led from a head of 2 m or more, fountains, showers, and "Flowforms" (**Figure 4.34**) will oxygenate ponds. A considerable energy saving is achieved if only part of the pond is aerated at critical periods; fish will gather (kettle) there in times of need. For eels, this aerated section is built with a narrow pass to the main pond to prevent aerated water escaping.

It is often ideal to combine the feeding station with the oxygenated area so that food wastes are also oxidised and waste control simplified; some such arrangement is illustrated in **Figure 13.8**.

## ACIDITY-ALKALINITY

Ponds in areas of peats, mangroves, cordgrass flats, samphires, and with water derived from heaths and granites, or siliceous soils, can be very acid in reaction (pH 4.0 or less), the acids being humic acids, tannins, and minor organic acids. In such cases, hydrogen sulphide may also be released by ponded peats or swamps to create sulphuric acid. Peat stripping, mounding, fresh-water or rain leaching, and liming are all used to bring such ponds into production. Below the peats, and especially in basaltic soils, bluish clays produced under reducing conditions may occur (anaerobic or low pH). Fish will thrive in quite acid (natural) waters if calcium is available.

If we drain peats, the organic material dries out, oxidises, and releases carbon dioxide, gradually losing bulk so that some fields in fens slowly sink below drain or even sea level. Fens are derived from alkaline waters, bogs and peats from acidic waters. Marshes, fens, and bogs contain unique plant species and are rich wildlife habitats; hopefully, the era of fen drainage is drawing to a close, as the preservation of wetland habitat is a priority of all enlightened governments and landowners.

As pond pH is ideally 6.0–8.0 or even to 8.5, and only a few fish grow well below these levels (notably salmonids, which are also one of the few satisfactory fish in monocultures), most culture ponds are routinely limed when they are made. They are also regularly checked for pH levels, which are adjusted with unburnt lime after the initial burnt lime dressing. Thus, in the matter of site selection, it is of great advantage to site ponds where run-off from limestone areas can be ponded, or where natural pH levels are already high. Lethal limits for most fish are pH 3.7 (acid) and 10.5 (alkaline).

In practice, we can aim for a pH mosaic in ponds and pond series, as many valuable food organisms prefer soft (acid) water, while fish, molluscs, and freshwater lobsters and prawns prefer hard (alkaline) waters. Crushed dolomite, marble chips, hard limestone gravels, and oyster or mussel shells give a slow release of calcium in tanks, small ponds, intake filter systems, and the upper sections of canal systems.

There is an interaction with pH, respiration, and plant density; pH may rise at night or in clogged coastal waters with *Chara* and other algal forms, or fall as peats form and anaerobic conditions develop.

Not all organisms appreciate hard water (calcium rich), and if accessory ponds are to be developed to breed soft-water fish, forages, or main crop, only organic acids are used, chiefly hydrochloric, humic, or phosphoric acids. The same effect can be sometimes produced by using a peat or dense moss/peat area to filter water, by laying peats on the pond base, and by creating a swampy condition around the culture pond.

## MUD, SILT, HUMUS, AND WASTE REMOVAL

Wastes of any nature in ponds reduce water quality if they occur in excess, or if they occur as dead material. We can in some ways distinguish rotting wastes from fertilisers, as the latter need not create excessive growth if herbivorous fish, nutria (a large aquatic rodent), or shrimp are available to eat the detritus or weeds that would otherwise die and create anaerobic conditions.

There is little or no problem in flowing canals or well-aerated ponds, but still ponds need regular monitoring for waste removal. This is most handily achieved by draining and liming the pond and taking off a season of dryland crop (clover, fenugreek) before flooding.

Where ponds cannot be drained, care should be taken to keep at least one bank clear of trees for dredging or bucket removal of muck, which is traditionally layered with green crop for compost in Asia. In padi and terrace, 2–5 cm of mulch is retained over the clay base for cropping. All terrace can be drained to a dryland cycle.

In deeper non-draining resevoirs, recourse must be

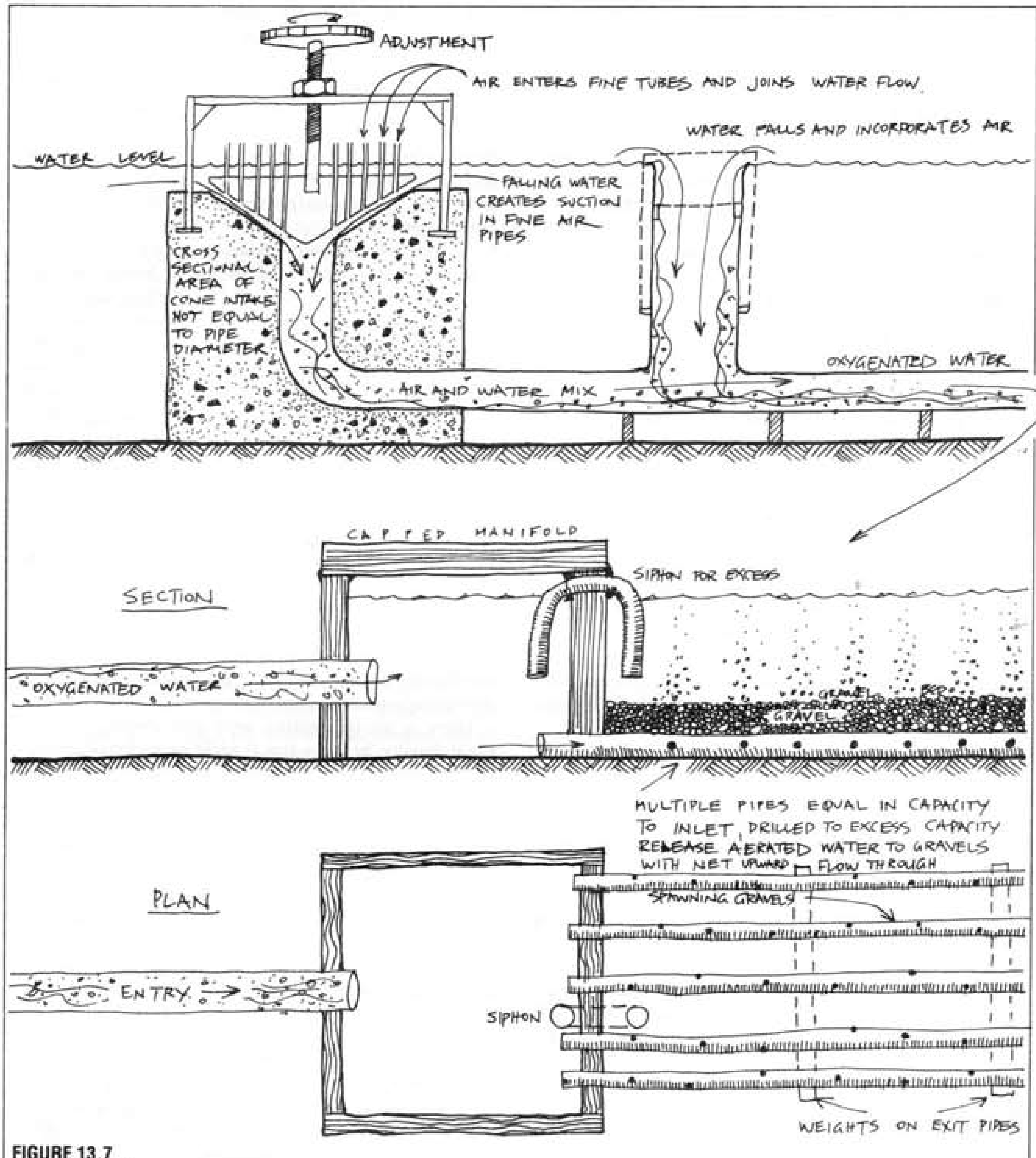



**FIGURE 13.7**
CONE AERATOR
A simple "trompe" or cone aerator in flow, with oxygenated water piped to refuges in ponds prevents fish losses due to anoxic conditions, or assists hatching of trout eggs in gravels.

made to a jet pump, which can be used as a vacuum cleaner to pump detritus out of the resevoir (and which will remove soils up to gravel size). This can be deposited near the pond as adjacent retaining walls or as low islands and causeways so that silt settles out, and the water flows back to the pond free of detritus. The pumps are typically raft-mounted and liquid fuel powered (**Figure 13.9**).

FERTILISERS

After testing waters, it is likely that minor elements and phosphates may be needed. Caution should be observed in adding nitrates to waters where natural manures are used, or in desert basins where water nitrate levels can be high. Be careful also in using boron-containing detergents, or any biocides not recommended for fish. (Salt, copper sulphate, weak formalin and some antibiotics are used to control diseases or parasites without lasting harm.)

Pig, duck, and second-stage sewage are all used in fish ponds, and any bird or animal manures are useful. We can distinguish between heavily fertilised ponds intended for intensive algal growth to feed milkfish or prawns, ponds where higher vegetation is encouraged to feed grass carp or *Tilapia*, and almost clear-water ponds for bass, perch, and salmonids (trout). That is, we adjust fertiliser to fish food preferences, and in any polyculture a larger proportion of fish can be algal or plant feeders (5:1 herbivore: predator is a usual ratio).

Phosphatic rock and granite dust can be used to supply lime once selected nutrient levels have been achieved. The stocking of waterfowl, the erection of perches for gulls, ducks, and land birds, the siting of pigeon lofts, pig pens, or chicken roosts over water, the erection of martin and swift nest sites in water (or bat roosts in Holland) are all devices to bring in complex plant nutrients to ponds (**Figure 13.10**).

Phosphates, potash, and minor elements are fixed and held in water in a matter of 12–14 hours, or 3–4

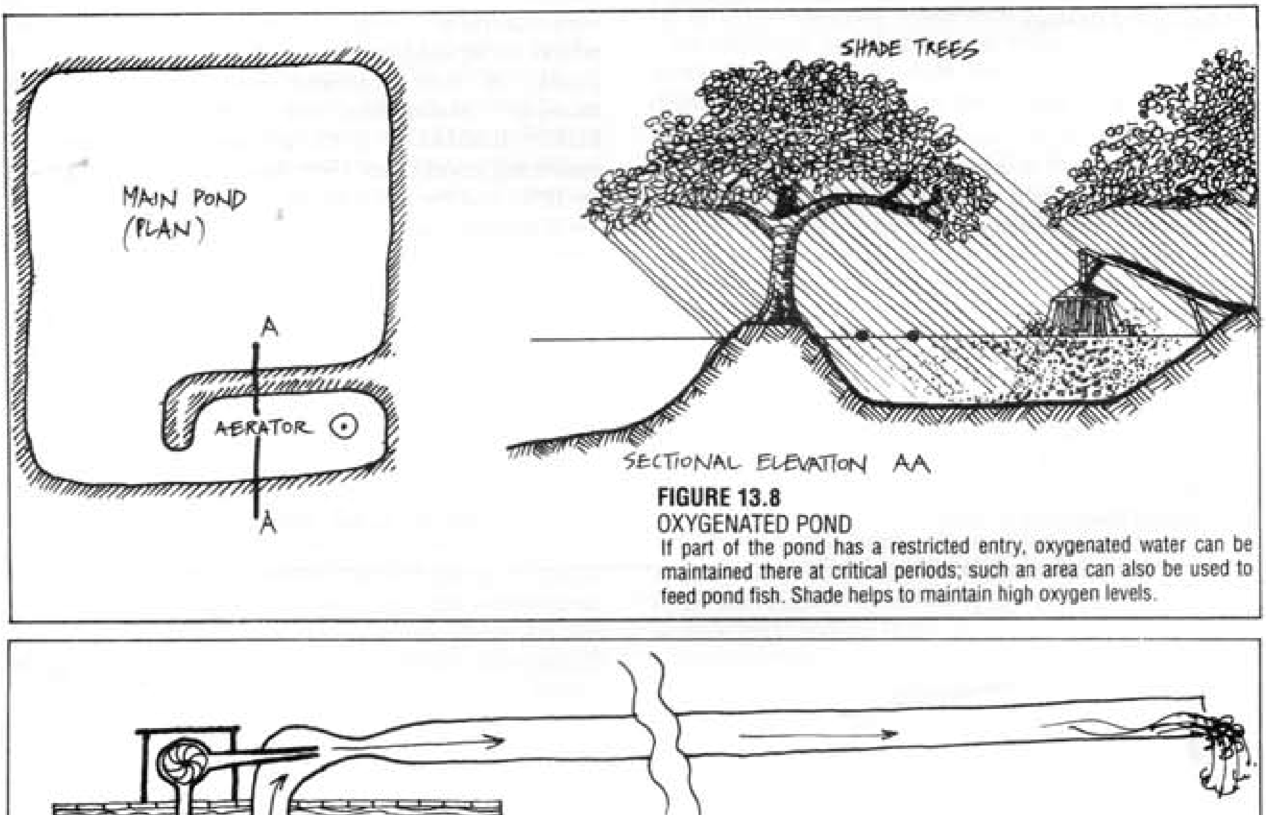



**FIGURE 13.8**
OXYGENATED POND
If part of the pond has a restricted entry, oxygenated water can be maintained there at critical periods; such an area can also be used to feed pond fish. Shade helps to maintain high oxygen levels.

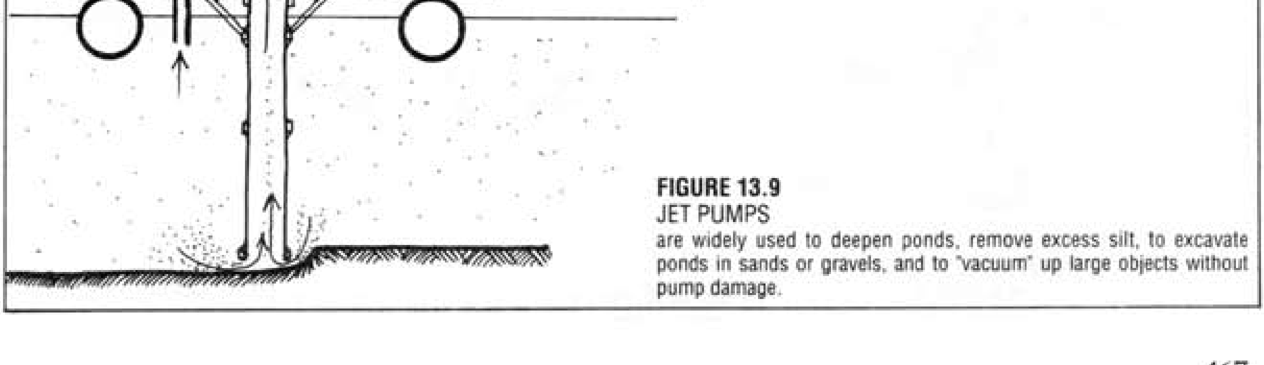


**FIGURE 13.9**
JET PUMPS
are widely used to deepen ponds, remove excess silt, to excavate ponds in sands or gravels, and to 'vacuum' up large objects without pump damage.

days (in oceans), and can be added to quiet marine bays as well as to ponds. Mussels in particular convey phosphates to the mud via their anal siphons, and are the major phosphate resevoir of ponds or rivers. As even modestly fertilised ponds can alter the yield by factors of from 2 to 10 times, attention to nutrient supply is a critical strategy.

As fertiliser uptake is so rapid, we need to stock fertile ponds with shrimp or large numbers of small forage fish while our fingerling pan fish are growing, or we lose yields. Too-high nitrate status can be filtered via a forage food pond of crustaceans, or through reed beds. We rely on land crop downstream to remove excess nutrient from pond overflow. In flow-on of ponds, we can usually achieve a doubling in yield of species such as melons, tomatoes, or fuel forests, so that fish ponds are a key feature in raising land-based yields. Swingle (1966) records a difference in yield for mussels (in the same pond) of from 52.8 kg unfertilised to 1,012 kg fertilised (whole weight; meats are 35% of total) so that the fertiliser factor, well-managed, is a critical yield strategy.

SHELTER AND REFUGES

Stacks of pots, pipes, tyres, and bundles of rope, reeds, or brush can have a decisive yield effect on predation losses of young fish, crayfish, and species subject to predation by their fellows. Crab and crayfish culture, in particular, benefits from such refuges. Similarly, forage species in ponds need breeding refuges to persist. Figures are hard to come by, but yield increases of 10–30% are recorded for crustaceans, and 20–100% for forage fish protected by shallows or weedy areas. Mortality of young and fry are always greater in ponds of simple design and without escapements. Cage culture is not only in itself a high-yield system, but enables the strategic separation of predator and prey (or adults and juveniles).

TEMPERATURES

Within water, surfaces and gradients develop from the effects of heat, solutes, particles, or stream flow. These are utilised differently by different species, so that a river or lagoon opening by a shallow bar to the sea may have saltwater fish at depth and freshwater species on the upper section, and either colder forms at depth or (in icy winters), warm refuges at depth for fish to kettle (crowd in until warmer conditions develop).

The interface between cold and hot water is termed a THERMOCLINE and between salt and freshwater a HALOCLINE; such boundaries can be abrupt transitions if no turbulent flow exists. Where no pronounced surface separation occurs between hot and cold or salt and fresh, gradients develop, especially where wind overturn or current flow is a factor. Fish, molluscs, and plants have specific niches in such gradients, and may move with tide or current to adjust to their specific needs.

At or about 21°C (70°F) we make a categorical difference between *coldwater* fish, to which such temperatures are lethal or debilatory; and *tropical* fish, which suffer cold stress or will not breed below this point. A few common fish (*Gambusia*, the mosquito-eating fish) are temperate tolerant or EURYTHERMAL (1–36°C), but optimum feeding and spawning conditions for coldwater fish are around 15–18°C, and for tropicals 20–25°C. Rainbow trout will die if kept for long periods above 14°C, while *Tilapia* die below 12°C.

Higher temperatures certainly stimulate plant growth and algae production, or general turnover, and it is advantageous to be able to keep winter temperatures at optimum for the species mix selected. We may achieve this in any of a number of ways:

• By including a solar pond (heater) in any other pond (**Figure 13.10**), or as an accessory to a pond.

• Using waste-heated water from industries such as power stations, salt works, or food processing plants.

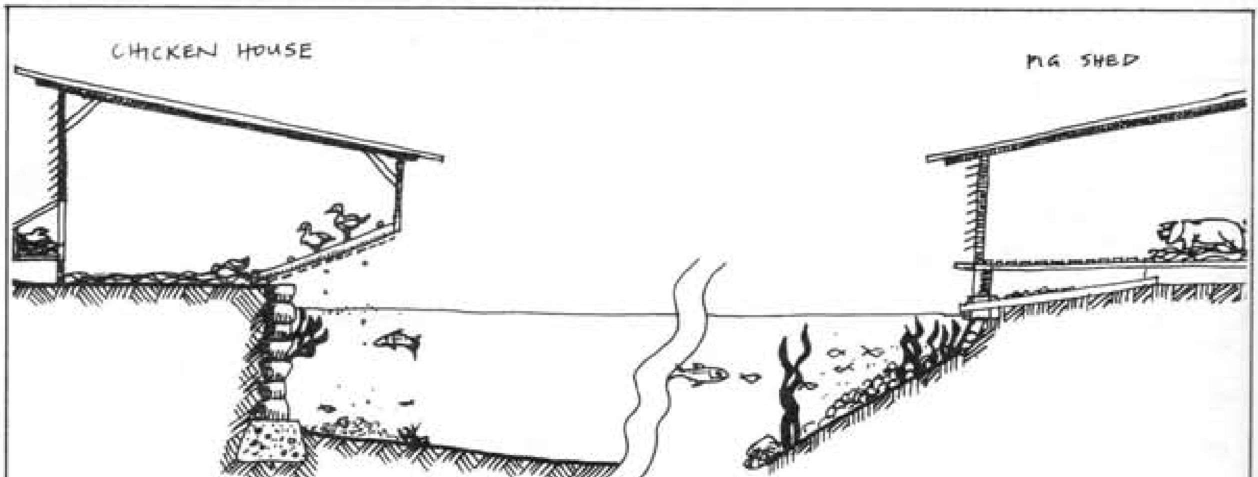



**FIGURE 13.10**
DEVICES TO BRING MANURE TO PONDS.
Widely used in Asia, land nutrient is returned to ponds, and pond water to land crop; each part of this cycle gives a yield.

• Glazing over canals, refuges, or building raft columns insulated from the earth and colder waters, as heat refuges for cold-tender fish (**Figure 13.27**).

• Providing heat refuges as earth-covered pipes, shaded canals, or kettles of 5 m or so deep in shallow ponds.

Adapted local fish generally need little assistance to survive, but selected stock or exotic fish can require refuges for a week or more of extreme weather. Where no local heat sources are found, pond water pumped over a dark roof, rocks, or cement areas very efficiently extracts solar heat at close to 100% efficiency. Sections of bitumen road can be used in this way, or can have pipes buried under them at 1-5 cm depth as thermal siphoning systems for pond heating in winter. Glasshouses to hold small ponds, compost heat, collectors and trough reflectors are all strategies to maintain heat for higher production. Gains in yields of from 2 to 5 times are common where ponds are regulated to optimise feeding activity and food growth.

Heating devices can raise water levels 3°C or more (glasshouses), and although this doesn't sound spectacular, it can extend the growing periods of fish by 30–40% (*New Scientist*, 30 June, 1977). Collectors, of course, depend on the area of collection relative to the pond. Heat pumps from canals can deliver heat to ponds in the same way, shortening maturation times of fish or plants to about one-third that of cool, open pond areas. Passive collector systems are ideal, and cheap to run by a system of thermosiphon and non-return valves if heat sources are placed below the pond to be heated, as in **Figure 13.11**.

SALINITY

Fresh water contains very little salt. Coastal lagoons usually contain 7–9 parts per thousand (ppt); few frogs can breed above this concentration. Seven ppt is the safe upper limit for human consumption. Brackish water is detectably salty at 11–12 ppt, and oysters may be found from this concentration on. These are the salinities of estuaries and brackish waters. At about 27 ppt many shellfish and marine organisms are found, and the sea itself is at 33–35 ppt.

In areas of high evaporation and restricted tide flow, hyper-saline conditions can develop. Marine organisms seldom spawn above 40–50 ppt, and if fish and crabs do occur there, it is often as one-sex populations, one-age groups, or gigantic forms. Many desert organisms and some desert fish can live to 60 ppt salt.

Fish which live all their lives in freshwater rarely do well above 8 ppt. A great many fish and shrimp, however, migrate fresh to salt and vice versa, some spawning in rivers (trout), some in the sea (eels). Because of their wide range of tolerances, these groups are called *euryhaline*. Many mullet, salmonids, and some oysters and shrimp can be kept in fresh to saline waters. Saltwater fish rarely tolerate salinity below 28 ppt.

Changes in salinity may kill pond fish not adapted to estuaries; salt or freshwater is also used to kill external parasites and disease in fish. Estuaries and brackish waters generally contain more fish species than the river itself, or the sea offshore, although the sea is far richer in molluscs and crustaceans.

In estuaries and lagoons, a halocline (salt-fresh surface) can develop, with the denser salt water at depth, or pushing up under the surface of an estuary as a tidal wedge below the fresh water. Haloclines are common in deep lagoons or rivers with barways. Marine forms live at depth, and freshwater fish at the surface, sometimes for many miles inland. As tides push into and recede from large river estuaries, extreme changes in temperature (especially in winter) and salinity can occur, so that at low tide a mud-living shellfish can be in fresh water at 4°C, and at high tide in seawater at 20°C. Many species in this zone burrow, migrate with the tide, or return to the river at high tide.

Thus, salinity is a species-specific factor rather like temperature, and salinity regulation just as much a matter of concern as temperature regulation. We seldom get sudden increases in salts in ponds, but a hazard of marine pond culture of the inshore tropics is torrential rain. Even with flood diversion drains, the sea itself may become so dilute as to kill lobsters, prawns, or milkfish in marine impoundments.

Very rich brackish-water polycultures of algae, crabs, mullet, sea bass, milkfish, eels, and trout are possible in

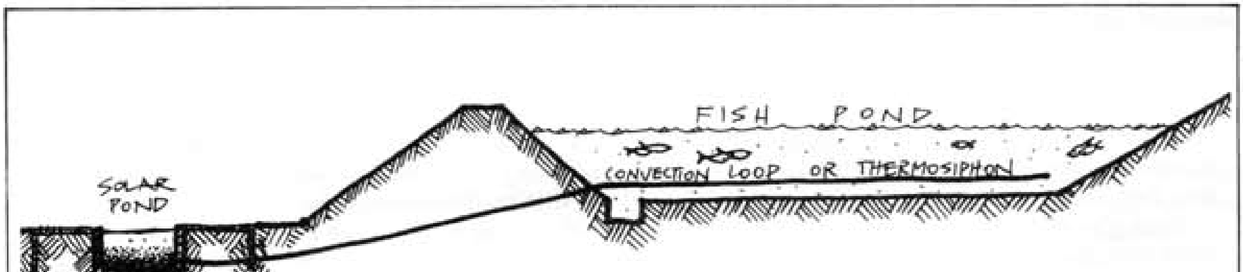



**FIGURE 13.11**
SOLAR POND BELOW FISH POND.
Any type of solar collector below pond level will thermosiphon heat to the pond itself in winter.

estuarine (and desert or atoll) impoundments. Salinity is controlled by flood by-pass canals and sea weirs or locks. Fish are graded to suit pond conditions, or a salinity mosaic is established to mix species as diverse as carp and mullet. Where tide and streams interact, as in some Hawaiian fish ponds, both freshwater and marine species can be cultivated in one pond series.

Brief immersion in salt water is an old remedy for reducing fungal disease in freshwater fish.

FLOW

Even very modest flow stimulates gaseous exchange, photosynthesis, and therefore growth in plants up to a level where mechanical damage by turbulence can occur. Flow in food-rich waters increases yields far beyond that possible in still ponds, but most streams do not have heavy natural food yields unless they are fertilised or manured, and then a problem of stream clogging with aquatic weeds can occur, necessitating control by nutria, grass carp (White Amur carp) or another efficient herbivore. The other great advantage of flow is in the oxygenation of water, either via a "Flowform", aerator (**Figure 13.7**), or series of rippled falls or weirs in the stream bed.

The balance we would like to achieve in flow is to maintain sufficient flow for aeration and vigorous plant growth, but to restrict flow to a level where we do not suffer rapid leaching of soluble nutrients and calcium. For this reason we often pipe or channel flow to fish and terrace areas rather than working in the stream itself, where floods can affect us in several obviously deleterious ways ranging from fish losses to physical damage to structures, and a wipe-out of balanced fertiliser in waters. In ponds, we may hold back flow for a few days to allow fertiliser uptake, then resume flow for aeration.

## 13.4
## CHOICE OF FISH SPECIES (VARIETIES, FOOD, HEALTH) AND FACTORS IN YIELD

SELECTION FOR EFFICIENT FOOD CONVERSION

Fish low on the trophic scale, those eating plankton, algae, or vegetation, are produced at higher yields. For example (if ponds used are fertilised) we can reasonably expect a maximum production/ha/year of:

Bass (a predator) ................................196 kg
Catfish (an omnivore) .......................370 kg
Bluegill (an insectivore) ....................560 kg
Java *Tilapia* (a plankton feeder)....1,612 kg
(Swingle, 1966)

Obviously, if our choice was for one species, it would be for *Tilapia*. However, real-life tests must be carried out, as some of these neat orders of yield can be reversed if forage is supplied or pelleted food provided. Each trial must be made under the food management schedule proposed, because fish can harvest different foods more or less efficiently. For example, if we add *pelleted food*, the yields are:

Catfish................................................2,688 kg
Bluegill.................................................896 kg

(Reversing the order found in fertilised ponds only.) Yields in this case depend on the food type.

Having selected a set of *species* in this way, what can we do about variation within species?

If we stock a high density of fingerlings of one size (5000-10,000/ha), and feed these fish, then we can net out the pond after a few weeks or months and select only the larger fish as brood stock, or as an "efficient" variety. After only one year of selection, bass fingerlings from such fast-growing strains converted food at an efficiency of 3.4:1, whereas unselected fish converted at from 7.3:1 average, and the worst cases at 24.2:1—a range of metabolic efficiency greater than the differences *between* species! (Swingle, 1966).

In ponds, and particularly where we raise fish in hatcheries, or where the water supply is free of fish and their diseases, we can both select and ensure stock free of external parasites and internal pathogens, by close attention to cleansing eggs and fry.

The results in ponds can be to double the number of fish growing to maturity or marketable size. Thus, the three factors above give guidelines to raising fish yields by several orders of magnitude. Eels are usually caught at sea (as elvers) for this reason.

Yield increase of from 40-200% are achieved in a pond by the judicious admixture of species. Some examples from Swingle (1966) are given here, and more will be given as examples of traditional systems later. However, it is a sensible initial approach to try to work out what sort of functions any species in a polyculture should serve. Some of these are:

RAPID UPTAKE OF NUTRIENTS

This serves two purposes: the first to fix any fertilisers we may add, and the second to convert wastes produced by dense stocking of other fish. Ideal species are those that breed in ponds, grow fast, and convert decomposers to food. Better still if they form a group which doesn't fly off (as insects do) or migrate out of the pond (like frogs). They then remain as fish food for the young pan fish which are slowly growing up.

Ideal selections are:

• SHRIMP, especially if provided with vegetation or brush bundles for cover; also small crabs, scuds (amphipods), and molluscs.

• MINNOWS or small free-breeding fish; again, provided with cover and screens as the large fish grow, or with shallow water refuges.

Examples (kg/ha/year) Ponds fertilised:

• Bluegill on their own (at 3,900/ha). ......186.4 kg

• Bluegill with *Gambusia* fish ..................3,449.4 kg
(yield increase of 18 times).

OR

• Bluegill and bass (a polyculture; at 3,750 and 134 fish/ha respectively).............................................282.6 kg

• Bluegill, bass, *and* fathead minnows.........470.6 kg (a 66% increase on the above).

Swingle hypothsizes that 50% of a pond devoted to cover or special habitat for small forage species would not reduce the total yield of pan fish, much as 30% tree shelter in fields does not reduce the weight yield of livestock. It is therefore important to plan the shallows of such ponds.

Minnows have increased yields for trout, salmon, *Tilapia*, bass, bluegill, mullet and so on. Our trials should resolve *which* minnows, and how we provide cover or escapement for them. Prawns benefit from brine-shrimp (*Artemia*) mixtures, and most fish benefit from shrimp in ponds. A second reason for adding a pond species is:

WATER QUALITY

This refers mainly to food waste uptake. Species successfully used are fresh or brackish-water mussels, and plants. As plants also add to the daytime oxygenation, and mussels also actively circulate water, both have a dual effect. Their yields are additive to the fish yields, and increase fish yields while they allow higher stocking rates, e.g.

Fish alone.......................................................316.6 kg

Fish plus mussels..........................................464.4 kg

(plus 864 kg of mussel meat. We could add 600 kg of water chestnut if plants were also used. Algae activates bacteria and improves the oxygen content of water, as do higher plants).

CULLING OF EXCESS SMALL STOCK (PREDATION)

Small numbers of predators (at any level: fish, turtles, or mammals that eat some of the smaller fish) to prevent over-stocking are essential for a well-maintained growth to market size. Cormorants, otters, or other efficient predators serve this function in large lakes and rivers, but we need better-regulated systems in ponds. Bass, soft-shelled tortoises, snakeheads and pike are just some of the species used to control breeding in carp and bluegill. For example (per ha/year or cycle);

Bluegill alone..................................................316.6 kg

Bluegill plus bass...........................................484.4 kg.

Increase in yields are modest, of the order of 30-50%, but the predators often fetch higher prices than the prey species, so that the fiscal economics of yields are greater than the figures of weight increase may suggest.

UTILISATION OF DIFFERENT FOODS

This is where a greater potential lies. It is not atypical to find carp ponds with any of the above species mixes, plus 3-7 varieties of carp, all chosen for their distinct food preferences. Even a few additional species help. Examples are (yields per hectare):

Common carp alone (2,500/ha) ............314 kg

Buffalo fish alone (2,500/ha) .................896 kg

Buffalo fish (2,500) plus 250 carp/ha ...925 kg

(300% increase on carp alone)

OR

Channel catfish alone (4,400) ....1,400 kg/ha

Channel catfish (4,400) plus

1,250 *Tilapia* 1,834 kg/ha

Yields are greater for more species added. In the latter case, the food conversion efficiency of catfish (1.7:1) was unaffected by the *Tilapia*; there was no stunting of one of the species by the addition of another. Similarly, the addition of pangas (*Pangasia*) to ponds rich in molluscs does not affect yields of carp or *Tilapia*, nor their feeding efficiency, but adds to yield. It is important to choose fish of different food preferences for maximum yield from polycultures.

THE CONTROL OF BREEDING IN FISH PONDS

We can only talk about optimum stocking rates if we can count on the number of fish in the pond remaining fairly constant. This is not the case where fast- growing pond fish kept beyond 3-7 months can breed in the pond itself. Fish culturalists avoid this sort of overstocking by a variety of methods suited to species, technology, and site. Some of the systems used are:

• by stocking one sex or sterile hybrid fish. Hybridisation in *Tilapia* species give sterile males or one-sex stock fish. "Counts in" are "counts out" less mortality (allow fry losses of 30-40%).

• by crowding fish. Brown bullhead cease to breed above 7,500 fish per hectare (Swingle, 1966). Other species are also inhibited, probably by crowding stress or waste accumulation.

• timing. Fish added and harvested in spring-summer fast-growing conditions can be taken before, or at the point of, breeding, and the pond then restocked.

• predation. Predators with, or screened off from, the breeding fish can reduce their numbers to an optimum level; predator fish yields are a bonus.

• lack of substrate. Ponds lacking the right substrate or niche for breeders will thereby prevent eggs being laid or surviving. Fish will often not spawn if substrate is not provided.

• lack of habitat. Fish that breed in fresh, saline, or seawater will not breed if kept in (or transferred to) a different habitat. This applies to mullet, eels, trout, milkfish, prawns, and shrimp. A lesser effect is that of suitable water temperature. A rise or fall in water level is crucial to carp and mullet species that breed on flooded grasses or reeds.

• hormonal manipulation. Pituitary extract is widely used to induce spawning, and trials of other hormones are being made to inhibit sprawning (*Puntius* is a fish used for pituitary extract).

FISH LOSSES FROM OTHER CAUSES

Losses in ponds can occur from theft, very efficient predation by numerous or large predators, by diseases or parasites carried in by stream water, as a result of extreme heat or cold, and by accidental draining of the pond. There are obvious precautions to take, involving fences, locks, automatic signalling or pumping systems, and predator control. The fish culturalist needs to live close to or overlooking the pond area for all these reasons.

Losses due to sudden heavy rains in estuarine ponds may be unavoidable in shrimp culture, but flood by-passes are a normal precaution in freshwater pond culture. As fish density increases, the upper limits to yield may be determined by pond water quality and a set of pathogens encouraged by crowding. This latter factor may be the ultimate barrier to yields, as it is in land livestock.

### STOCKING RATES

This is a critical factor. Some of the stocking rates are given in the above examples, and they range from 200-300 fish/ha for a predator to 5,000-10,000 fish/ ha for plankton eaters and detritus feeders like *Tilapia* or carp. That is, rates depend on the ability of the fish to stand crowding, find food, and use food efficiently.

Very low stocking rates produce low yields of large fish; thus beware of early trials which show a low yield if fish were stocked (alone) at less than 1000/ ha. Too dense a rate will result in a larger proportion of unmarketable small fish. We can tolerate some 5-10% of stunted fish, but no more than that. Examples of such factors are:

| RATE/HA | YIELD (KG) | MARKETABLE (%) |
|---|---|---|
| TILAPIA (allowing a 200 g fish as marketable) | | |
| 5,000 | 316.2 | 97.5 |
| 10,000 | 403.2 | 50.4 |
| BUFFALOFISH (allowing an average of 250 grams as marketable) | | |
| 300 | 152 averaging 636 g /fish. | |
| 600 | 273.5 averaging 603 g/fish. | |
| 1,080 | 656.5 averaging 590 g /fish. | |

From the above data, we have *exceeded* the sensible stocking rate for *Tilapia*, and not yet reached the rate that would reduce "marketable size" for buffalofish. Incidentally, *Tilapia* at below market size took 7 months more to reach the limit of 200 g achieved by the fast growers in 6 months! (Swingle, 1966). There is a selection factor involved here, and we can select from the fast growers for future brood fish.

Management helps, in that one heavy stocking can be sold off as they reach market size, or a predator can be added to cull the smaller fish. However, we need a good measure of *optimum* stocking rate for every species used, and this can only be achieved by experiment. Similarly, we need to decide the rates at which polycultures of fish are stocked by assessing the proportion of too-small fish in any one species in the polyculture at harvest time.

In Fertilised Ponds

Fish stocked as fingerlings lose a lot of food unless a fast-breeding forage fish utilises it. Fingerling numbers fall off rapidly as they grow (in predatory fish, by cannibalism), but with supplementary food, much larger numbers can be stocked, saved, and therefore can use the natural foods better. Also, they reach market size much faster, e.g. with brown bullhead (all fish fed while water was above 16°C). See **Table 13.2**.

**TABLE 13.2**
STOCKING RATES IN FERTILISED PONDS

| NO. STOCKED (per hectare) | FISH PRODUCED kilograms |
|---|---|
| **Tilapia alone** | |
| 2,500 | 631.7 |
| 5,000 | 840.1 |
| 7,500 | 1,011.8* |
| 15,000 | 1,387.0 |
| **Tilapia with catfish** (all fish fed at 16°C plus) | |
| 560 | 302 |
| 2,500 | 1,076.7 |
| 5,000 | 1,709.7 |
| 7,500 | 2,646.6 |

*Above this rate no spawning occurred in thepond

## 13.5
## FISH POND CONFIGURATIONS AND FOOD SUPPLY

### POND CONSTRUCTION

Pond or terrace construction on the small scale (to 0.2 ha) can be hand-tuned for drainage, levelling, and spillways, but larger constructions arise either as a result of many years of hand labour, and are then built to suit the landscape, or are built in modern times by survey and machine. Still-ponds have an essential need for a compact clay base, while tidal and diversion ponds can tolerate some losses from seepage.

New ponds need careful assessment and survey for factors of evaporation, seepage, water sources, sealing, and stability. As few fish ponds exceed 2-3 m in depth, earth, clay, and stone-faced earth walls suffice to hold water (**Figure 13.12**). Many trout ponds and fast-flow channels are concrete-sealed in intensive systems, but by far the most productive, common and economical ponds are clay-based. Ponds can evolve from low-walled padi to deeper permanent or seasonal fish systems, or have a dry cycle in summer seasons.

The chapter on water deals with the essentials of construction of dams. The clay core or seal is effective in miniature in fish ponds. A build-up of organic mulch and algae in ponds assists sealing, so that even ponds in sandy loams may gradually evolve to reduce water losses. Long uncompacted canals, however, need good clay bases to prevent water loss in transit, although seepages are not necessarily lost to production if land crop and trees can be planted to utilise seepage water.

It is of great value to elucidate the uses of ponds from very small to commercial sizes, as a proportion of very small ponds have valuable uses in home gardens and for domestic food supply in both urban and rural areas. What we are talking about here, in general pattern terms, is the *order of size*, and therefore appropriate use.

Ponds from 1 – 10 square metres

Very small garden ponds of from 2 to 60 cm deep can be made from old baths, stock watering tanks, plastic-lined holes with protective clay or earth covers, and so on. Pre-cast ponds in plastic, fibreglass, and concrete are sold in most areas.

In shallow ponds, Chinese water chestnut (*Eleocharis dulcis*), kangkong (*Ipomoea aquatica*), watercress (*Rorippa (Nasturtium) aquatica*), taro (*Colocasia esculentus*), frogs, and small fish thrive. Frogs are excellent predators in the garden (as are lizards), and *Hylid* (tree) frogs inhabit the leaves of plants, feeding on insects by day and night.

A square metre of taro gives 20–30 kg of starchy food, while deeper ponds will grow Indian water chestnut (*Trapa natans*), lotus (*Nelumbo*), and arrowhead (*Sagittaria*). Boiled taro, cassava, or plantain can be added to fish food. Stocks of small forage fish for larger ponds can be kept in house ponds, together with mussels and useful molluscs, basic plant stocks, and shrimp.

At 10 square metres, and about 2 m deep, clear fibreglass or Kalwall® ponds, as used at the New Alchemy Institute (NAI—Cape Cod, USA), produce fish and products valued at from $4.50 to $17 per square foot (1984), and amortise costs in 3–5 years, yielding fish, shrimp, and enriched water for semi-hydroponic crops. These ponds provide useful heat storages for night and winter heating, and can be used in greenhouses, or outdoors for much of the year. Outdoor ponds at the NAI are placed in front of reflective (white) walls on white gravels to maximise solar input, increase yields, and lengthen seasons of growth. The Rodale organisation in the USA has also made extensive trials on small tank production of fish.

In glasshouses, such ponds give good yields and moderate temperature extremes, while providing algae-rich waters for terrestrial plant beds, so that fish wastes (and nitrates) are reduced in the water and routed to plants.

It has long been clear that there is a business opening for standard-sized ponds, equipment, and fish stocks for domestic pond culture. This is a field in which there are few suppliers (and most of these have concentrated on decorative plants). I expect that we will see productive pond kits for home owners in the near future. Subsidiary uses are as water stores for fire, tank supplies for gardens in dry periods, productive disposal systems for food wastes fed to omnivorous fish, and sources of recreational interest such as aquariums (fish tanks are very peaceful to contemplate and are recommended for workaholics as a relaxing hobby).

Ponds from 10 – 100 square metres

Ponds of this size are very useful to rear fish fry for sale or stocking, breed forage fish, produce large quantities of vegetable crop, supply aquaculture nurseries and aquariums with plant and animal stocks, and to create significant fire-breaks, water reserves, and heat moderation. One special pond of this size can supply house heating and hot water (the solar pond); it can be built just to heat a larger pond.

For a family, an intensively-managed fish pond of 100 square metres comes close to providing a full protein and vegetable resource if carefully designed and stocked, and if a beneficial polyculture is maintained. Aeration via a photovoltaic cell and air pump may be necessary for high yields, but the modest yields of 300–2,000 kg of protein that can be realistically expected are a significant contribution to food

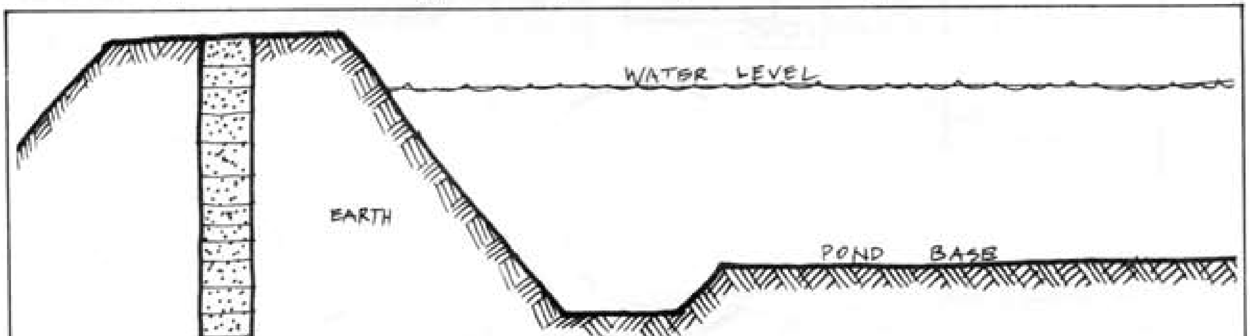



**FIGURE 13.12**
POND WALLS
Where clay is in short supply, a tamped clay cut-off core is an economical sealer for pond walls.

self-reliance.

In a sense, these are specialty ponds, with a need for very careful planning and subsequent modification (like the home garden, and part of it). Ponds of this size can be an important part of waste food disposal, and can form part of a total wastewater system. In line with a biogas or septic tank unit, they will grow a fairly constant mass of green manures that can be reaped or gathered for garden mulch or biogas recycling.

Ponds 100 – 500 square metres

Chakroff (1982) and others regard ponds of this size (alone or in series) as ideal for fish culture. Easily harvested, netted, or drained, and capable of holding specific age, size, or species assemblies, such ponds give flexibility in management. Devoted to special crop, even one 500 square metres (or five 100 square metres) pond can provide an income from baitfish, aquarium fish, special plant crops, and intensively managed fish (e.g. prawns) of high value. A nursery of any sort, providing eggs, seeds, fry, or fingerlings to growers need not exceed this size. In 1983, incomes of about $30,000 were possible from open-air ponds of this size stocked with prawns (Hawaii).

Ponds 500 square metres – 5 hectares

About 5 ha is estimated to provide a full (affluent) family income in high-value product. Ten to twenty prawn ponds (with ducks, mussels, and edge plants) is a full-time job akin to (but more easily managed than) a

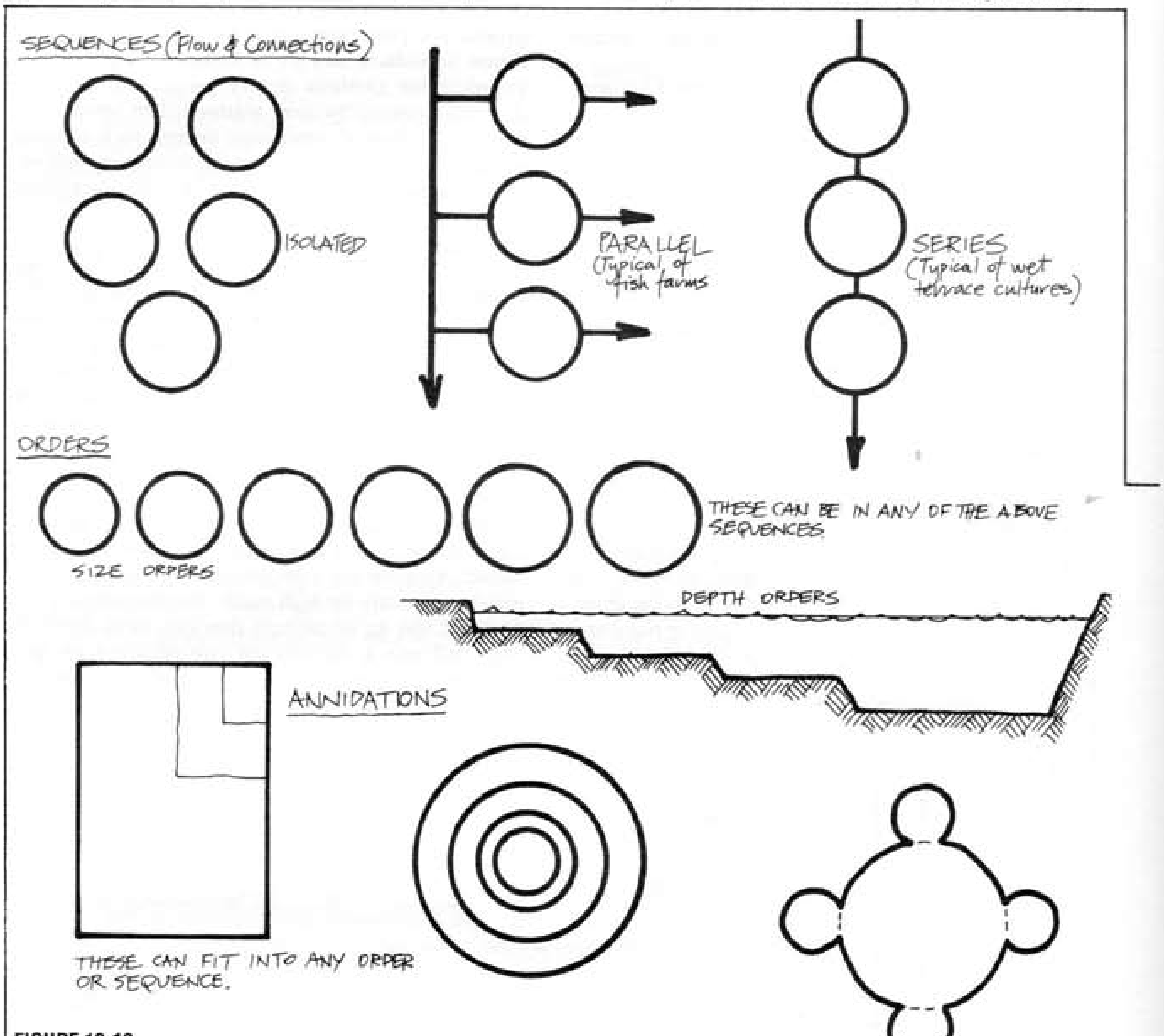



**FIGURE 13.13**
FACTORS IN POND LAYOUTS.
Ponds can be arranged as isolated, in parallel, in series, or annidated one within another; they can be the same or different sizes, and all these factors must be selected for in particular landscapes, or for a specific fish species or polyculture. Depths too may need to be varied for forages, breeding, or predator protection.

market garden. Many successful enterprises never exceed this size (a family farm). The scale permits multiple use and perhaps leaseholds of other activities, will supply a relatively large area of land crop, and form a complete fire–break for homesteads and fuel forests. We can characterise these as semi– intensive; many eel–rearing establishments operate at about this size. Sewage ponds little in excess of 5 ha will provide safe disposal for small towns.

Ponds greater than 5 hectares

Impoundments of 50–500 hectares are now not uncommon as extensive farms. Even a single impoundment of this size, designed for easy management, gives a living to a family or families. At 10–20 ha, given that the design is fairly adequate, harvest and occasional re–stocking is the main activity. Companies and investors may try to run such systems intensively, and are often limited by cost–benefit, food supply, or disease control ceilings. Innovative leaseholds, recreational fishing, and new scales of planning (including village or shoreline residence development and holiday homes, boating, and sales of water itself) may become feasible.

Every size order can include specialty ponds of the previous order, devoted to specific functions. Some functions may in one or other way serve all orders while themselves remaining small. This is true of an intensive hatchery for trout, carp, or perch.

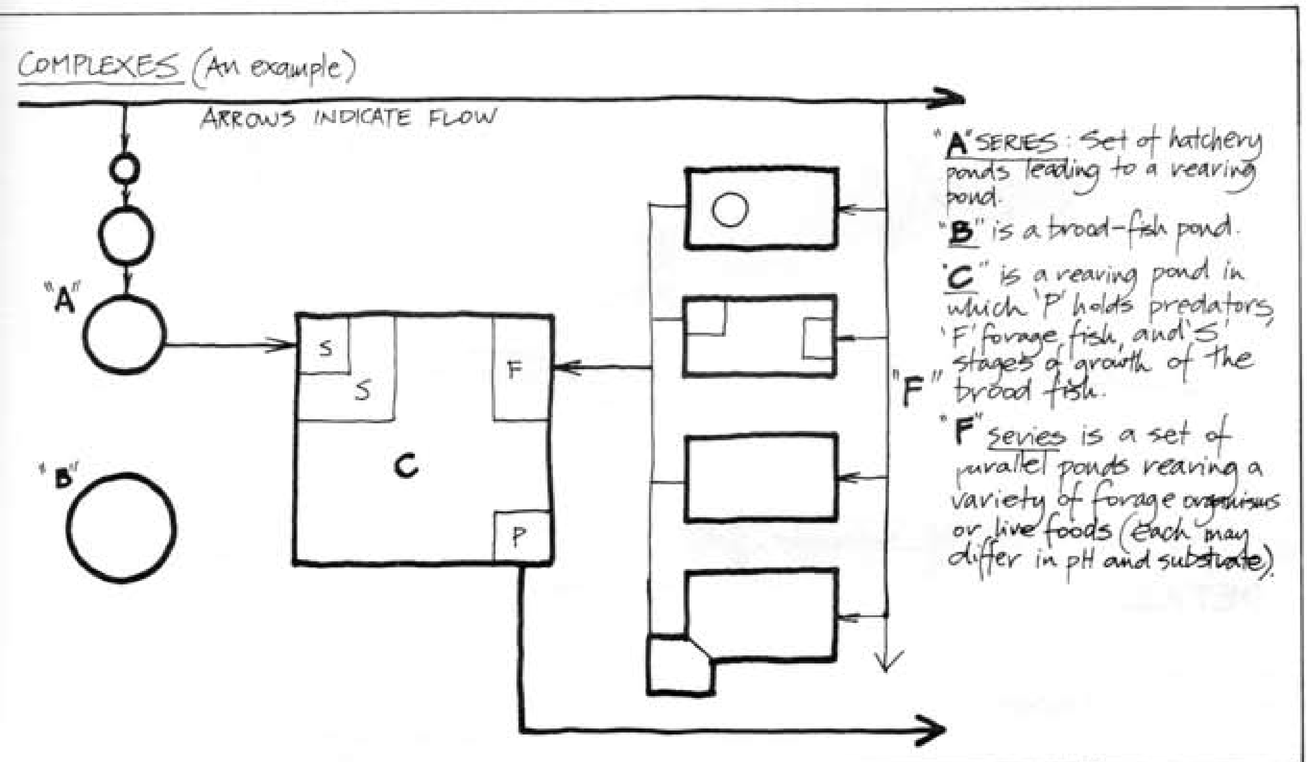
Given that we have some ideas about the best uses for size or volume of water, what are the best arrangements for series of ponds, and what shapes might ponds take? What order of ponds in total landscape can we define, and what specific constraints or freedoms are permitted or imposed by site selection?

ORDERS OF DEPTH

Depth, as for surface area and volume, has its orders and effects. Mere films of water, or wet mud patches, suffice to grow most productive green salad and root crop, to allow bees to safely drink, revive frogs, and breed a few mosquitoes. Soil at field capacity is effectively a "pond in hiding". From 2 to 6 cm depth, some of the smaller floating plants take root and form mats, and scuds and small crustaceans flourish. From 10–100 cms depth, true floating and anchored plants can separate out their niches, and we can grow Indian water chestnut or almost any fish species covered by the water. Even in rich algal ponds, some light will penetrate.

The maximum commonly used depth to rear fish in culture is 2 m, and at this depth no unstable thermoclines develop to create sudden overturns of oxygen and temperatures; the ponds are easily wind–aerated and yet deep enough to buffer air temperature changes.

From 2–15 m, lakes of clear water are potentially productive. Below this depth, less biological cycling takes place, and less still in the cold, deep, sometimes anaerobic depths of V–shaped lakes with leaf–fall on the margins. Deeps of 4–5 m do have a limited use to fish escaping high surface temperatures, or ice. Caves under water serve the same purpose, and it is common to find trout huddled in drainage pipes under the dam wall on hot clear days (they are then easy to catch if the drainage valve is suddenly opened!)



Depth and plants together serve as a set of breeding refuges for the food organisms of omnivores and carnivores. As we will later see, the configuration of levels at different depth may have a profound effect on the total yield or availability of such food organisms.

Thermoclines may develop above 15 m depth, and are fairly typical of lakes subject to sudden seasonal changes in their temperature. Overturns in temperature typically occur in autumn and spring. While in summer the surface waters remain consistently warmer than those at depth, in winter we can get surface ice, then warmer water at depth, and finally ice again deep in the lake, where very cold streams pool up and freeze. Fish may live in a sort of icy sandwich, or tucked away kettled in a modest cave or hollow in shallower water.

## PONDS IN SERIES AND FLOW

Ponds can be built isolated from, in parallel with, in consecutive series with, in order sequences with other ponds, or as any combination of these. They can also be annidated (nested) one within each other, and in fact have some features which permit linear arrangements (the pond as canal or waterway).

Isolated Ponds and "Isolation" Ponds are familiar to every aquarium keeper. New stock, diseased stock, trial polycultures, and an insurance against general loss may dictate a set of still–water ponds in quite separate situations (not sharing any flow of water). A set of tanks above grade, or still–ponds filled one at a time can be effectively isolated. Even if treated the same, they will still manage to be different, which is one of the fascinations of aquaculture. Water systems are more connected within themselves, and convey small differences more rapidly than land systems.

Ponds in parallel are perhaps the common fish–culture system, and are analagous to irrigation bays on land in that they possess a head canal (inflow system), an individual flow–through, and a tail canal (drainage system) which also works for surplus water in rains. They are effectively isolated *unless* a disease, pollutant, or qualitative change occurs in the common water supply, when all may fail together, unless (as is also common) flow regimes are staggered so that some flow, others are still.

The parallel series is ideal for valley floor ponds where water at head has been diverted along contour, for single feeder pipes, and for some narrow tidal benches. There are many advantages, and some basic disadvantages in that one cannot "feed the other". That is, we cannot set up a controlled trophic ladder in

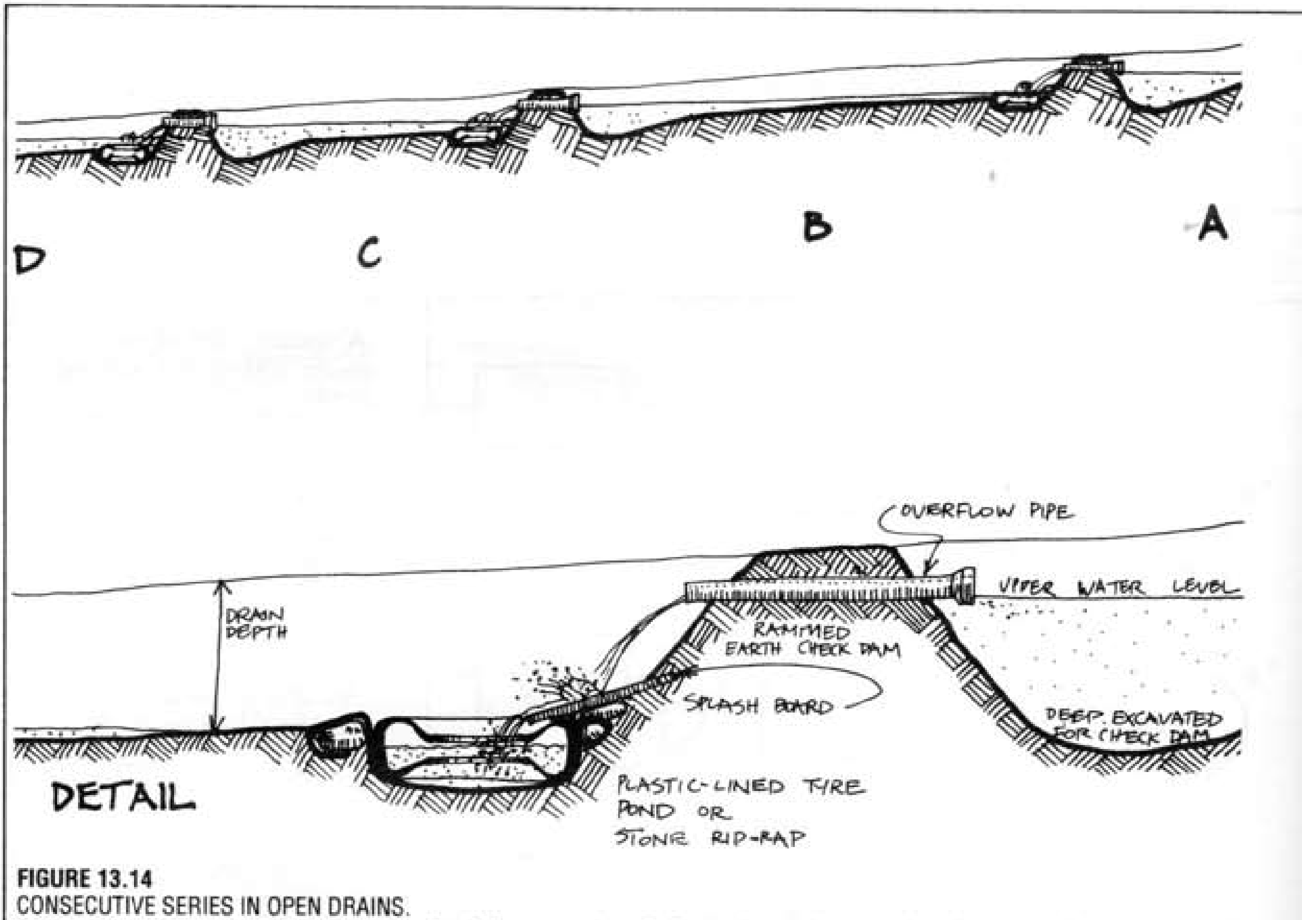
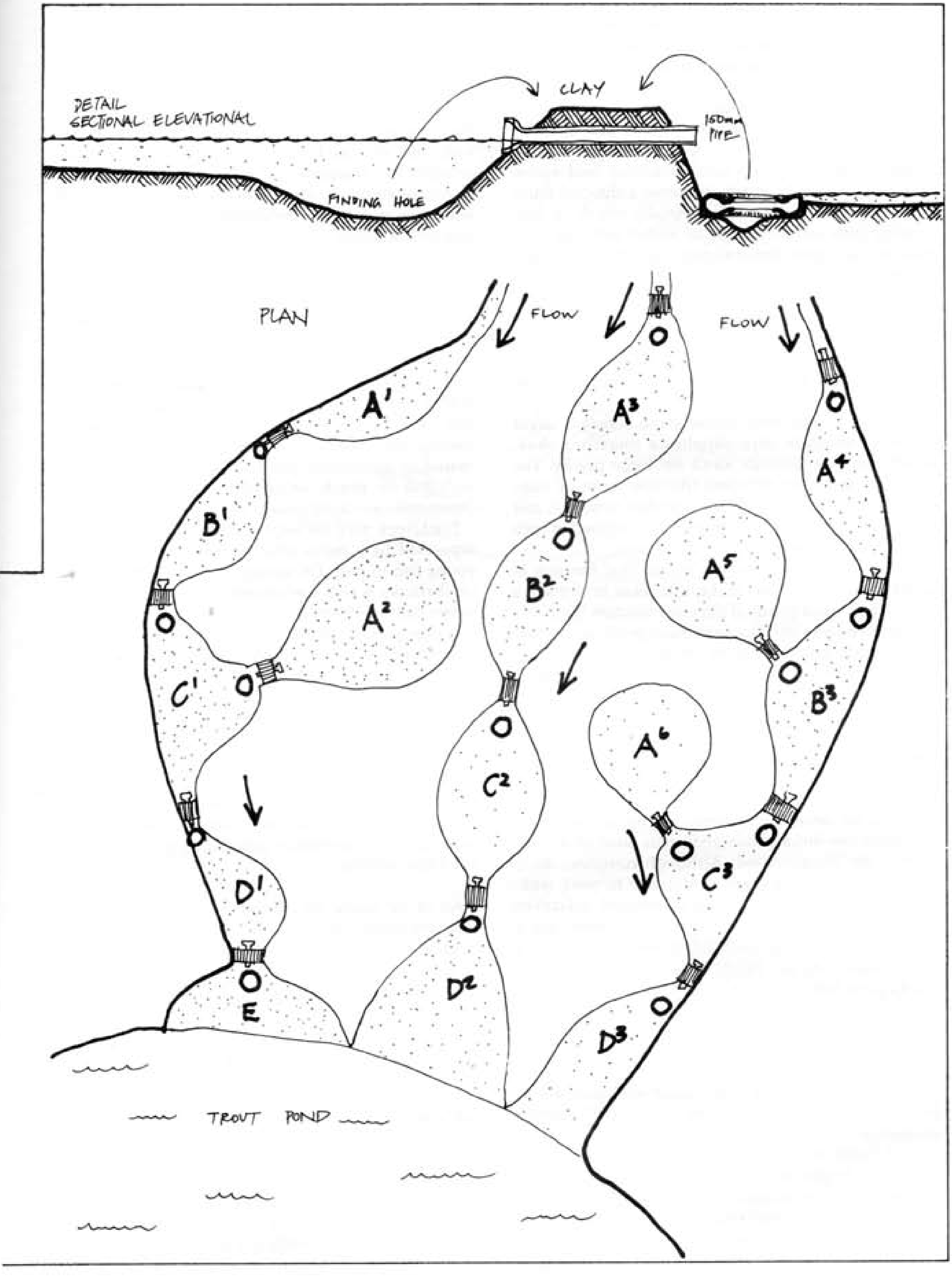



**FIGURE 13.14**
CONSECUTIVE SERIES IN OPEN DRAINS.
**A**. Oversized drains, stopped at intervals, give drainage, swale function, and small permanent ponds in landscape.
**B**. Pond series can be arranged as above to permit one–way travel of forage animals to a rearing pond (see text).



DETAIL SECTIONAL ELEVATIONAL
CLAY
150mm PIPE
FINDING HOLE
PLAN
FLOW
FLOW
A¹
A²
A³
A⁴
A⁵
A⁶
B¹
B²
B³
C¹
C²
C³
D¹
D²
D³
E
TROUT POND

parallel ponds, where food is cultured and allowed to flow down to higher trophic levels (minnows to trout).

Consecutive Series can be arranged in trophic levels, with orders of ponds breeding forage fish or shrimp spilling over to ponds containing carnivorous fish; or with marshy ponds of tadpoles, scuds, and Daphnia flowing into ponds of omnivores. Even more handily, primary sewage lagoons (anaerobic) can feed secondary lagoons rich in insect and other arthropod fauna and zooplankton (faculative ponds) which in turn cascade into aerobic ponds of useful fish, mussels, shrimp, or green vegetable crop, which in turn...etc. **Figure 13.14**.

Moreover, as quite small ponds (about one-seventh or one-ninth of the size of the next) deal with the anaerobic phase, and as these are best constructed as tunnels or canals from which gas (methane) can be collected, the order of size in this sort of series can be suited to function.

Similarly, a very small hatchery can supply a larger fry pool, which in turn supplies a fingerling tank, which can now provide stock for large ponds. The orders of size here are more like one-tenth or one-twentieth of the next, and their aeration, structure, and therefore construction will differ. Eels are reared in such increasing size order of ponds, as are trout.

Thus, consecutive series has an essential function in terms of orders, but may make little sense in terms of a set of equal-sized ponds of the same function (such as a consecutive series of 500 square metre ponds all stocked with fingerlings). Consecutive series may also be forced on us by valley configuration or other site limitations, and then the risks of change in water quality compels close monitoring.

Evolutionary Pond Systems

Every evolutionary (old) fish culture system or terrace complex has an intricate set of ponds and flows. Elements are added on as needed, as money and time permit, as new information and needs arise, or as new species are incorporated. Although complex, these systems work well and are comfortable to work with. Successful modifications are preserved, mistakes rectified, and catastrophes remedied. However, many such systems are never intended for easy reading, and a novice inheriting one might spend weeks or months working out how to control and manage the system. All are quite unique, and often subtle in operation, with complex water control.

Ruled-up Pond System

In contrast, the flatland rice farmer who converts to catfish may evolve a simple, standardised, all-pervasive and often monocultural rectilinear farm visible from an airliner as a network of precise regularity imposed on the landscape. Anyone can understand it; the system is probably easy to control, but it costs in food, and tends to be a bit boring. The plan may very well have been drawn up by a Euclidean geometry student determined to force an unnatural rigidity on nature. All that is needed to manage is power (energy). But then power, as Mr. Kissinger remarked, is the ultimate aphrodisiac, and there may be some murky compensations hidden in the pattern.

While all of the above evolutions have their admirers, there are potentially a set of quite different approaches, only one of which may be to consider the pond complex as a component of total landscape, and others of which refer more directly to energy (or food) supply and have to do with configurations, or the shaping of ponds themselves.

ANNIDATIONS

We can nest any sort of smaller pond in a larger pond in a variety of ways:

Cages and ring nets in large bodies of water allow control of feeding, harvesting, and disease in caged, netted, or fenced-off fish. They are in (and may benefit from) the larger body of water, but are concentrated for management. Similarly, eggs and fry can be separately reared in partitioned ponds or in aquariums. Their survival is much enhanced, as many fish and crustaceans are cannabalistic (or rather non-selective).

Predators may be kept to thin out populations, separated by a mesh which permits any stunted or young fish to pass. Or, shrimp may live out their lives in shallows which nevertheless adjoin a deep area where their predators lurk.

A solar pond, yielding heat, can be nested in or below a frozen pond, and thaw it in winter. A shaded, chilled, or aerated pond may act as a refuge in hot weather. Part of any pond can be glassed over, even insulated (on shore and in the water) for a heat refuge, while remaining open below or via a base slot for fish to use as a refuge in chilly weather.

Floating basins or mini-nets of live food can be placed in larger ponds, as can a single gravid (pregnant) crayfish, whose young fall free into the larger pond to commence growing without predatory adult competition.

All of the above are operating and valid, although some are energy-storage rather than integrated aquaculture annidations intended to aid fish or plant production. Listing them helps us to decide on how we may use such accessory systems in any pond, but there is no doubt that if we plan them to start with, we can make the original pond much more easy to fit than if we tack them on later, or as afterthoughts. As an after-thought, many "ponds in ponds" are made either to hold wild fish trying to enter a cultured pond, or to hold migrating escapees from a cultured pond. Both are illustrated in **Figure13.15** as one integrated system (upstream and downstream fish traps or sorting cages).

PONDS AS PART OF THE LANDSCAPE MOSAIC

I believe that when creating ponds in barren (or agricultural) landscapes, we must plan for a beneficial

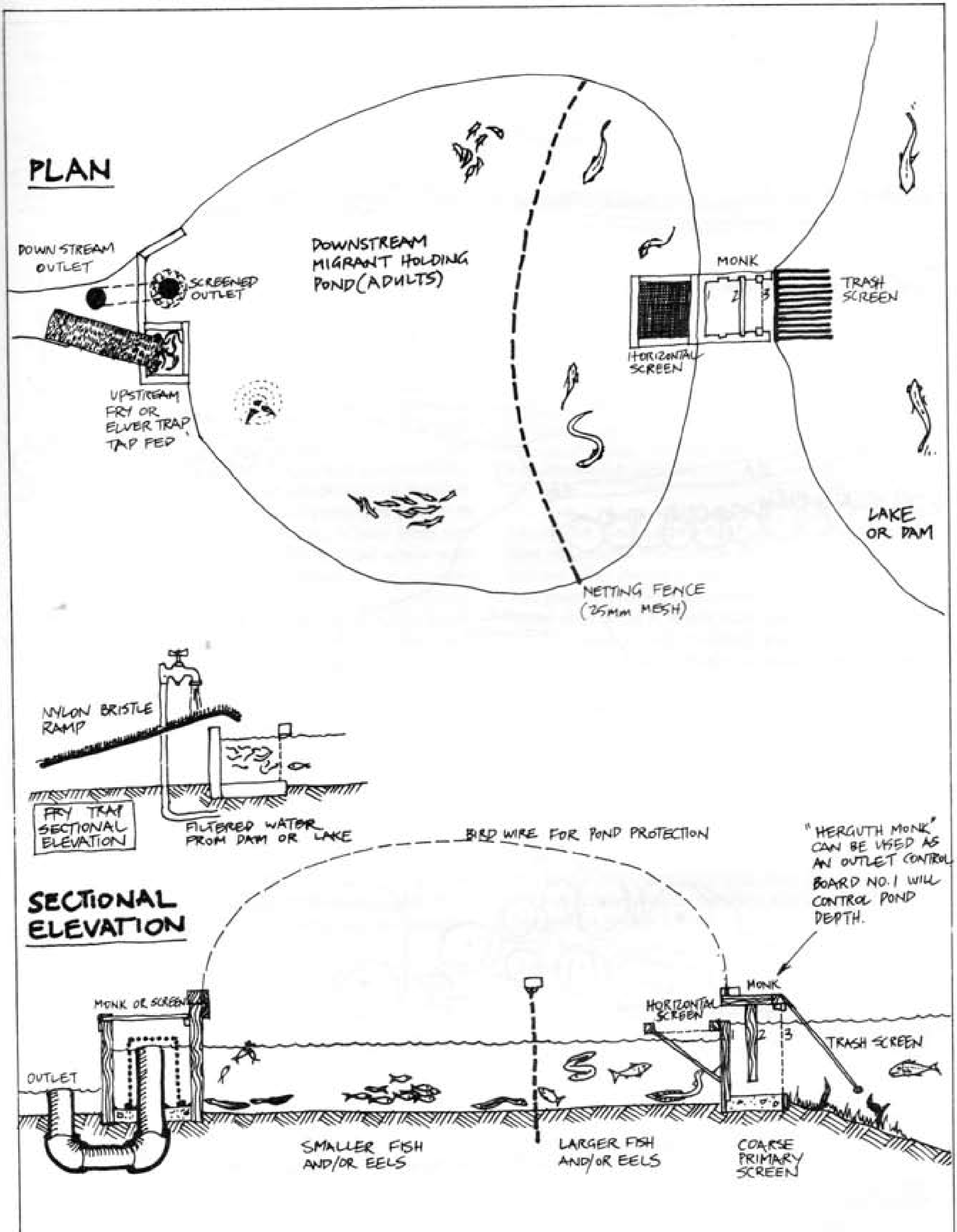



**FIGURE 13.15**

DOWNSTREAM AND UPSTREAM TRAPS.

Both of these may be essential, e.g. in eel or mullet culture, or to harvest extensive swamps. Adults are held in a capture cage, fry ascending the stream *via* a nylon mat are trapped for stock ponds or sales.

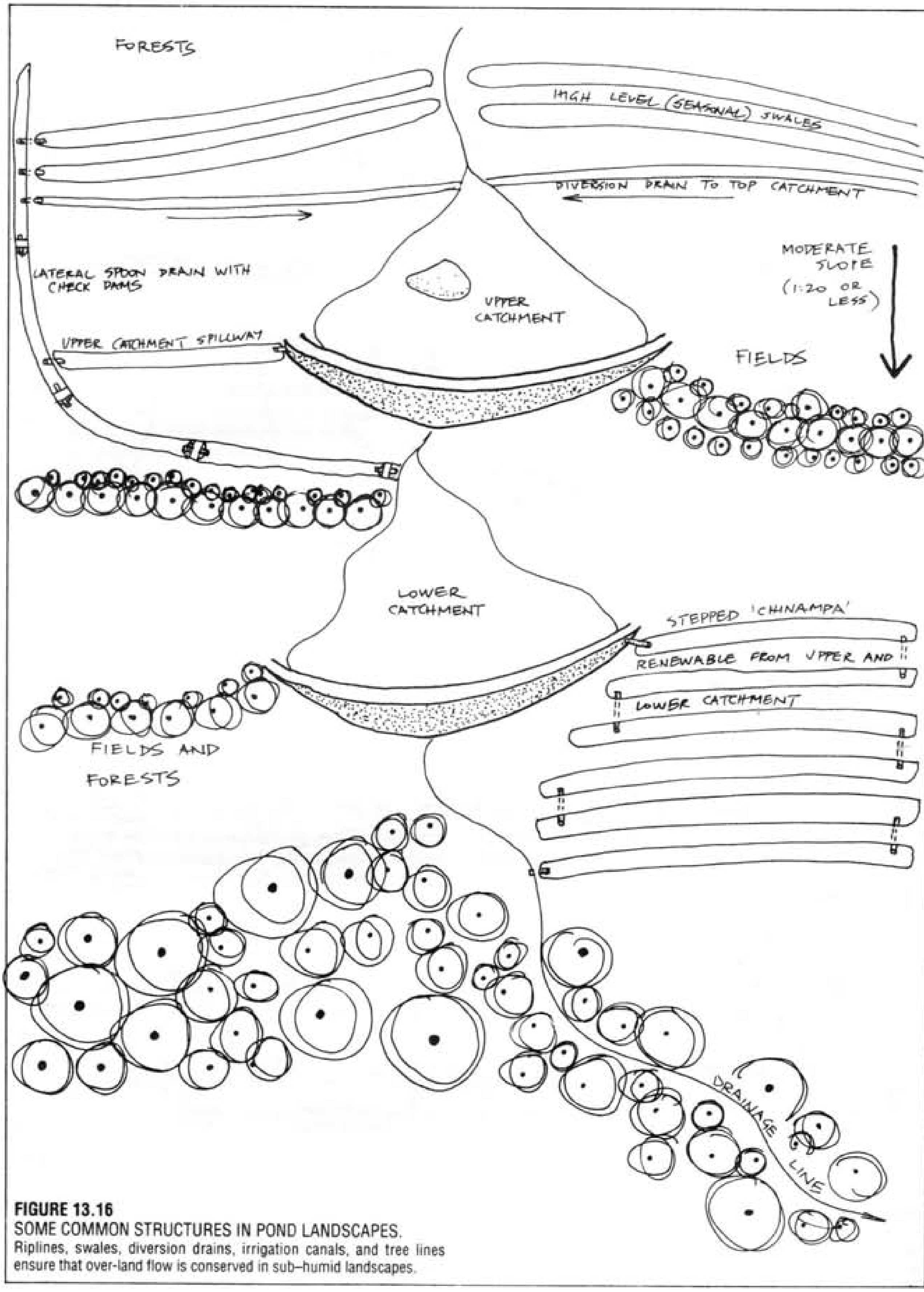



**FIGURE 13.16**
SOME COMMON STRUCTURES IN POND LANDSCAPES.
Riplines, swales, diversion drains, irrigation canals, and tree lines ensure that over-land flow is conserved in sub-humid landscapes.

mosaic of forest, pond, marsh, and prairie or rangeland. The role of the forest (correctly chosen) is to produce clean water of good nutrient quality, to absorb wastes from fish and their plant associates, and to provide a variety of foods either directly (as fruit) or indirectly (as insect bodies and frass) to the pond in return.

The role of the marsh is to provide a rich habitat for birds and crustacea so that ponds and the forest collect phosphates, and that of the meadow to provide for some mammals and plants that interact with both forest and water. Given that we distinguish four sections or component assemblies (open water, marsh, prairie, forest) in our mosaic, we can have both simple edge effects and other complex edges involving more than two junctions.

As a round figure for sub-humid or humid areas, perhaps we need something like 15% pond, plus 15% marsh (contiguous), plus 30–60% forest, and a remainder in meadow, crop, or pasture (10–40% of the total). Moreover, we need the forest upstream of, downstream from, and between our ponds, the marshes upstream of and in the ponds, and pasture or prairie as downstream and random patches, where trees are difficult to grow. We could perhaps link the whole with a complex of permanent or intermittent drains, streams, canals, and swales (**Figure 13.16**).

We can even define some ideal forests, partly in terms of site and climate, and partly in relation to the pond component. River red gums, some other eucalypts, and some leguminous trees provide an enhanced phosphate drip from rain throughfall. They belong close to the waterways and water edges. Many fibrous-rooted willow and *Casuarina* species either need, or "fix", phosphates. They belong in the downstream forests. So do freshwater mussels; they belong in and are confined to the pond.

We can see many opportunities for sensible local design, encouraged by past successes (mulberries, duck, and silkworms in the Chinese carp-pond complex). Having discussed the series, orders, annidations, and layouts of ponds, we can consider how to shape our ponds.

## POND CONFIGURATION FOR EDGE EFFECTS

**Figure 13.17** shows the plan of some ponds of 75 square metres (surface area). They have equal depth, contain the same volume of water (and the same quality of water), and differ mainly in their configuration or ground plan. Pond A (5 m radius) has about 32 m of edge, or margin. Pond B, which is 37.5 m long and 2 m wide has 81 m of margin, and pond C is 1 m wide and 75 m long with 153 m of margin. All are made below grade, or with wide banks, indicated by the thin lines; this "halo" we will call the ZONE OF EDGE EFFECT. Note that B and C differ profoundly in that this zone occupies only some of the field in which B lies, but all of the field enclosed by the folds of C.

Let us consider that a large proportion of the plants

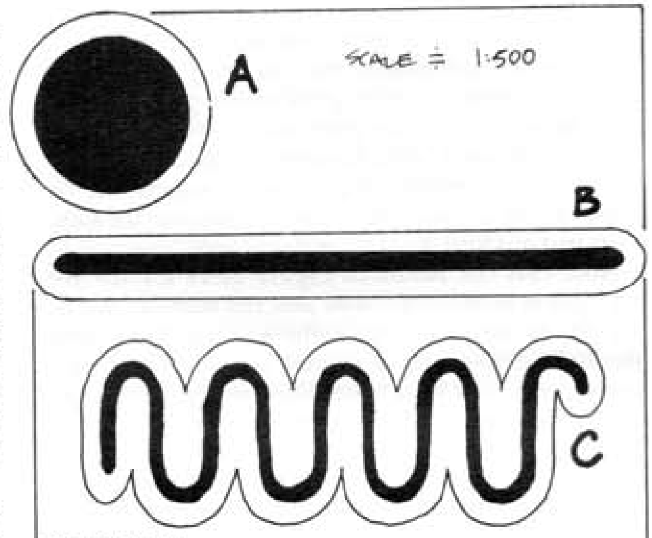



**FIGURE 13.17**
75-SQUARE-METRE PONDS
Three possible shapes; the "edge effect" of forage greens is maximised in **C.**, adequate in **B.**, poor in **A.**

around all these ponds can be either eaten by, or will host organisms that can be eaten by, the omnivorous fish we have placed in the ponds. It is at once obvious that pond B provides 2.6 times, and C provides 5 times the food of pond A to our omnivores, and that the land around pond C will do much better at this than the fields around A or B. Moreover, while pond A is rather self-contained and inflexible, pond B is easily partitioned, and pond C easily compartmentalised for parallel flow. Pond C is indeed a very flexible pond in every way.

Further, if our pondside vegetation grows over the pond edge for a modest 0.5 m, then it affects only some 25 square metres of pond A, but reaches half way across pond B and clear across pond C. Thus, if this is of benefit (and we can design it to be so), pond C benefits by a factor of 3 times more than does pond A.

Again, if we wish to partition any or all of the ponds using a set of two 1 metre square sieves, we get only 1 m of bank in pond A in our new enclosure, but any amount of bank in pond B (with 2 partitions) and the same in pond C (with 3 partitions) depending on our desired ends (see **Figure 13.18**).

Given modern machinery, or even pick and shovel, all are equally easy to construct. However, as up to 15 or more times the natural food is available in pond C, our decision is a simple one. There is one last consideration: long narrow ponds can fit easily on slopes, and as troughs they can be stepped and stacked. While circular ponds can be stacked, they become more inaccessible, and as slopes steepen, more expensive to build. So why are most fish ponds we see round or square? Probably because we used a compass and ruler to design them, rather than spend a little time on the consideration of some more basic and life-related implications.

There are serious drawbacks to linear ponds on leaky sites, as they may lose more water than circular ponds. However, on well-sealed and clay sites, this is not a factor and sealing a linear pond with a plastic liner is also simple. Evaporation from both is equal, or less in shaded narrow ponds. Channel-shaped ponds are appropriate for establishing a modest aquaculture on slopes fed by a spring, where clay is present in the soils, or as part of a total canal connector system.

Note that the ponds in **Figure 13.19** are (or are intended to be) all of the same area and volume. That is, all ponds lie in a 2 ha field and are 1 ha area themselves. The field is planted to tamarack, which grows very well near water, but poorly away from water. Between the tamaracks and the pond edge, blueberries thrive, arching over the water and reaching a metre or two from the pond edge to the trees. They benfit both from the water and the acid tamarack mulch. Through them and above them, grape hybrids climb in the conifers. At the edge of the lake rainbow trout feed, eating both the blueberries that are knocked down by birds and the insects coming to the plants. In addition, the manure of the blackbirds coming to the blueberries encourages a bloom of phytoplankton much appreciated by rainbow trout. At a glance, which field and pond of the four in **Figure 13.19** will produce the best?

There are many potential pond configurations, and many alternative species assemblies to that of trout, grape, blueberry, and tamarack, but wherever we spend a few hours analysing a more efficient or benign configuration before we call in the bucket and dredge, our return may be many times that of the Euclidean or "straight" designer. The yield goes on for years and years, while the digging of the pond is a single event.

Circular ponds and tanks are most appropriate to intensive fish rearing with a water flow at head, or pumped. The usual arrangement is to set water intake jets at an angle, and by this means contrive both to aerate and to induce current flow in a round tank. Most of these intensive rearing tanks, suited also to fry and any active swimmers, have a central water regulating and drainage system to facilitate harvest.

Heat-welded or rivet-silicone tanks of clear plastic or fibreglass (as used at the NAI) have the multiple advantages of growing dense algal food, storing heat, and as well as rearing fish (*Tilapia* is popular), serving as a hydroponic and eventually a terrestrial nutrient source for plants, whose roots are pruned by fish. These indoor tanks are integrated with glasshouse and crop to give multiple benefits; most are still-ponds (aerated but not in continuous flow).

In the earth, the configuration of a round pond has little benefit, giving the least edge for area. Most existing ponds are rectangular (to aid fish-out by netting), and in large series. They are usually built without shallows or bays for forage, often lack drainage, and (as in tank culture) the majority of food has to be supplied from purchase. It is in these essentially simple or factory systems that pumping, food supply, and maintenance of water quality become the major costs of production.

**Figure 13.20** suggests that we can set up a separate but interconnected mini-system, rather like a pond with shallows, or a pond with different sizes of boulders and gravels. How could we stock this pond?

We have some 16 possible environments. Ponds A1

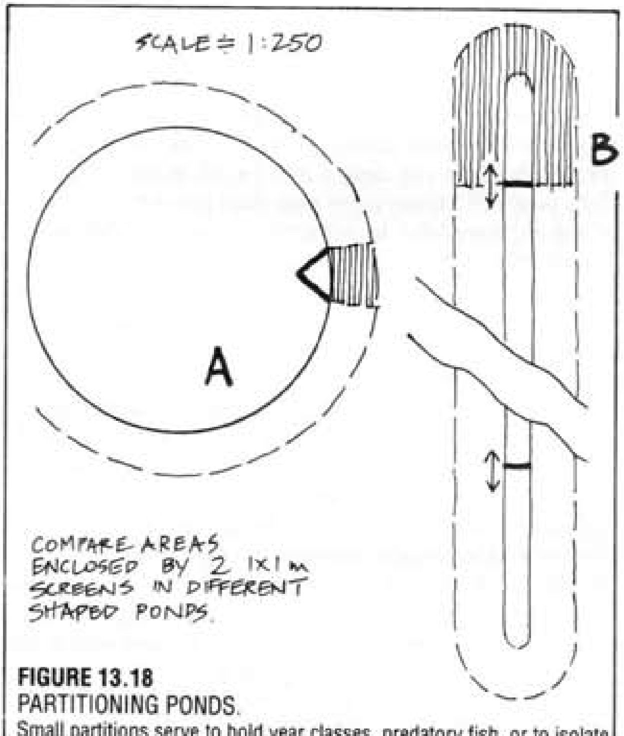



**FIGURE 13.18**
PARTITIONING PONDS.
Small partitions serve to hold year classes, predatory fish, or to isolate manure-rich water to a smaller anaerobic area for culture of fish foods.

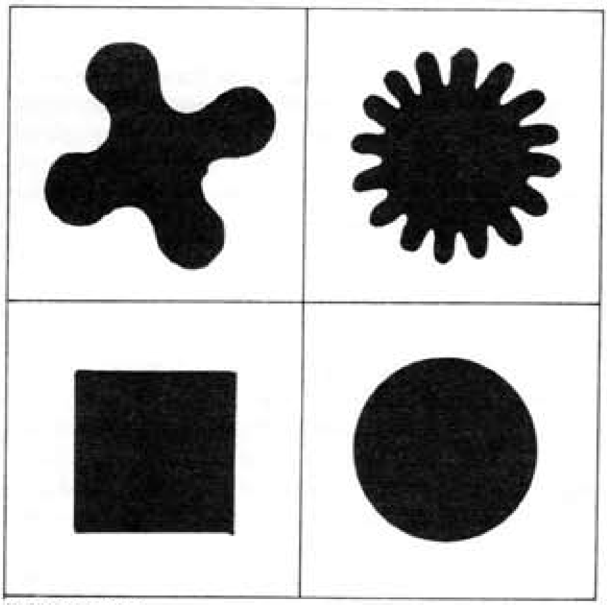


**FIGURE 13.19**
4 PONDSOF SAME AREA,
but differing widely in their capacity to provide for edge plants such as blueberries, to feed fish from edge vegetation, and to irrigate nearby tree roots.

and B1, are for frogs, scuds, marsh plants, and peaty organisms. Ponds A2 and B2 are good bait fish ponds, some needing alkali, some acid, some muddy/humic water. Pond B3 can be our pan fish—or a *predator* species of that pan fish, e.g. A3 can be top minnows, B3 sunfish, and C largemouth bass, so that B3 and C eat A3, and C eats small B3. All these fish species breed in ponds and are carnivores. They (in effect) supply each other with food. All eat tadpoles, frogs, scuds, and water fleas at different life stages. All screens are one way. Even more simply, we could build a single pond and arrange screens as for **Figure 13. 21**.

Thus, we have several choices of configurations, and a pond series of different volumes, areas, aspects, orientations, perimeters, depths, nutrient states, and even handiness for servicing. **Figure 13.21** also gives us good orientation potential, and increases the perimeter of the whole pond. Our "screens" can be as simple as graded gravel or boulder mounds separating the pond into areas. The boulders themselves then become a complex edge and refuge.

When we consider pond margins, we have choices of weedy, woody, mown, or flowering plants. The life forms of woods, flowers, herbage, and lawn can fall in the ponds.

As well, we can *attract* insects in with light, colour, scent, or sound. Some aquatic invertebrate species may take up residence in the boulder screens. I have never seen a pond just like this, although I know of some natural ponds with some of each of these characteristics. But I feel as though we would learn a lot from planning and constructing a pond of this nature.

## THE CLIMATIC ORIENTATION OF PONDS: COLD, HEAT, AND WIND

When we have the opportunity to orient ponds, as we do in marshes or flatlands, our concerns are to do so for the benefit of the water environment. The criteria are very like those governing house orientation.

Some conditions are:

- climate basically cold: oxygenation less important than heating (**Figure 13.22**).
- cold winter winds, warm to hot summers: oxygenation in summer, protected in winter (**Figure 13.23**).
- hot at most seasons: oxygenation a primary need, shade necessary for shallow pond (**Figure 13. 24**).
- variable (continental) climate: different needs in any of four seasons (**Figure 13.25**).

## POND USES DETERMINED BY SITE

Huet (1975) and some others give a few sensible

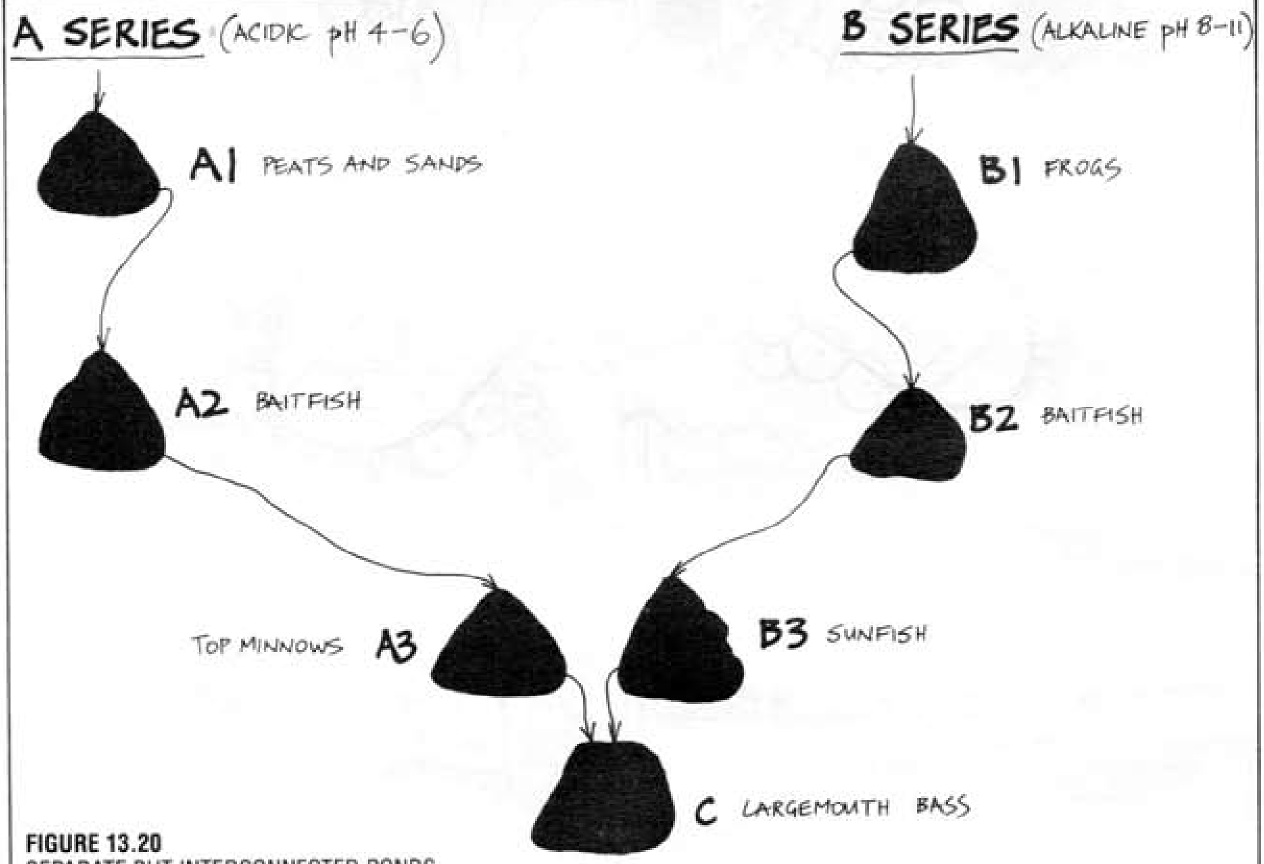



**FIGURE 13.20**
SEPARATE BUT INTERCONNECTED PONDS.
"Flow down" of food to successive trophic levels; both acid and alkaline waters can feed into rearing ponds in a "self-forage" sequence.

site-related pond arrays for valley sites. While it seems obvious that near-flat sites give greater freedom, these also lack the potential for vigorous through-flow and aeration provided by hill streams directed to valley ponds. It is the width of valleys or estuarine flood plains that may in the end determine a parallel or consecutive flow sequence from river or tide at head.

A second site restriction is that of soil type. Although artificially sealed ponds can be established in any location, stable clay and clay-loam soils are needed for cheap extensive pond systems. Clay is expensive to dig and transport. There are sites obviously subject to soil slump where no ponds at all should be established, as water from even small refuges lubricates the shear planes of soils in slip-off areas, and can trigger earth or mud slides. District inspection, a soil survey, and some simple tests at a soil laboratory will reveal such delicate sites; some are specifically mapped as soil types, or as unstable slopes on land-use plans.

Resevoirs of great size have very similar effects on

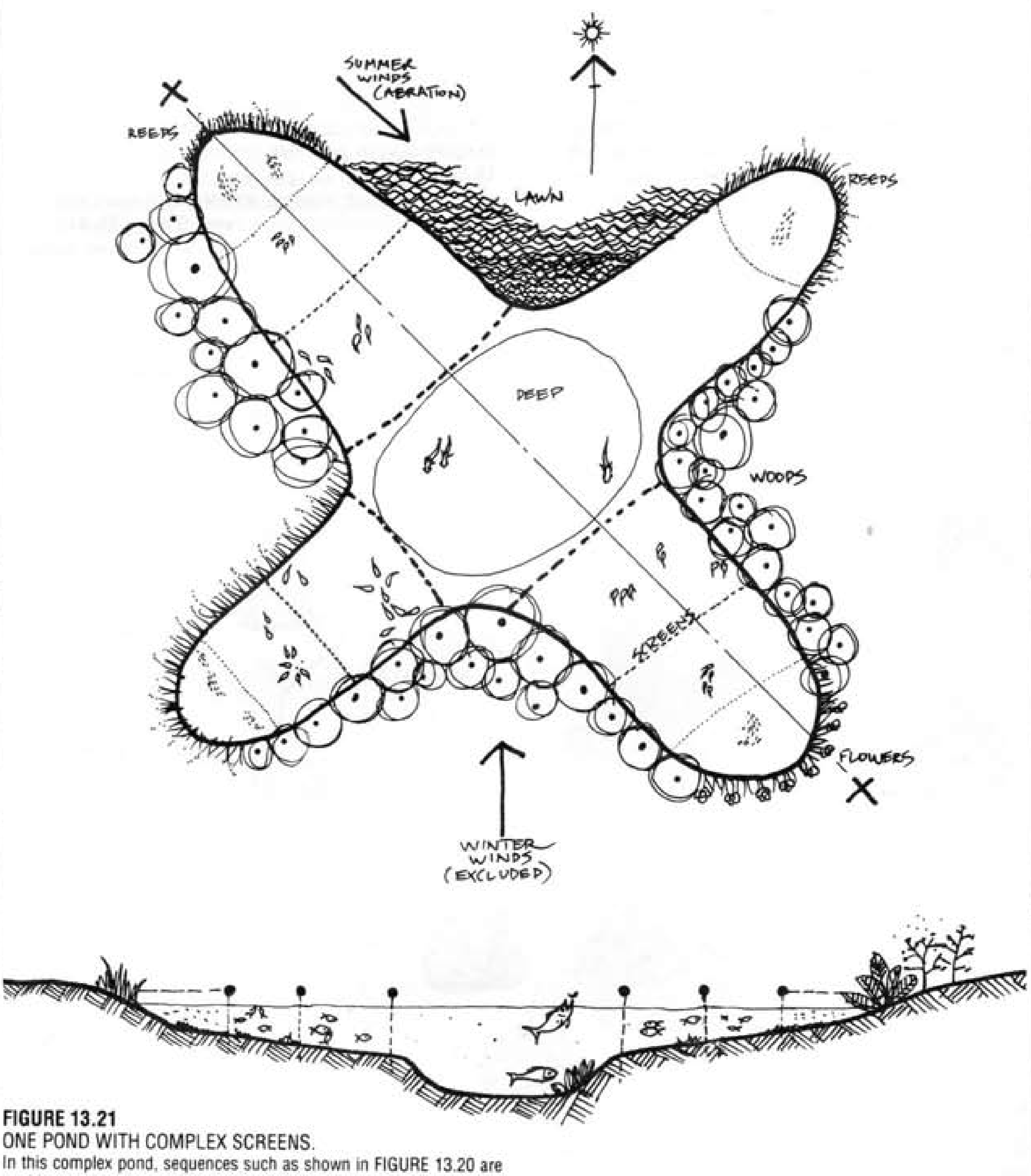



**FIGURE 13.21**
ONE POND WITH COMPLEX SCREENS.
In this complex pond, sequences such as shown in FIGURE 13.20 are annidated (nested) in one body of water divided by screens or walls.

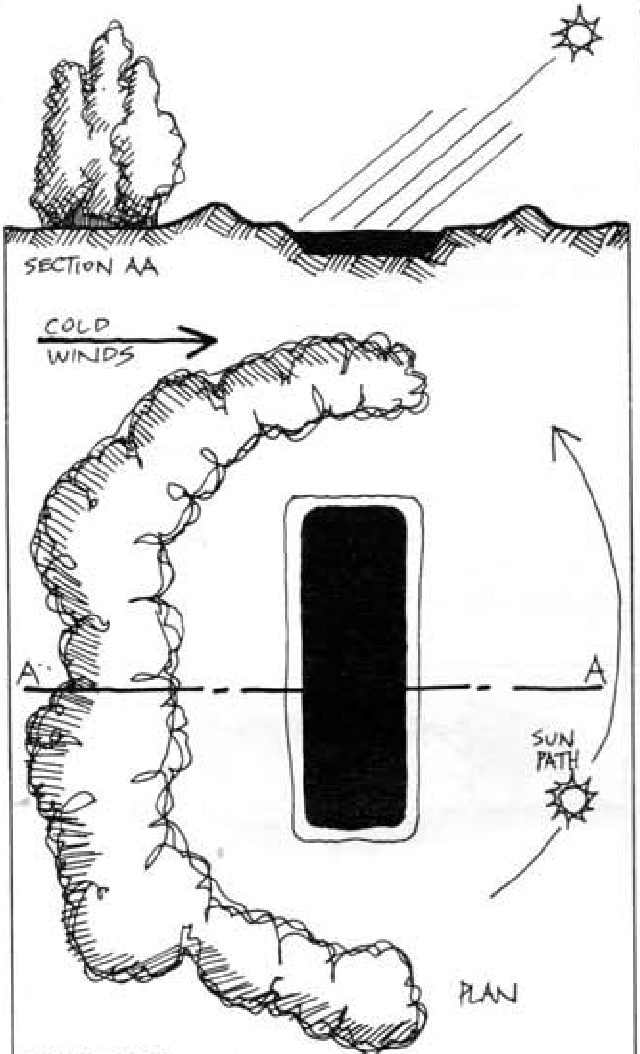



**FIGURE 13.22**
OXYGEN LESS IMPORTANT THAN HEATING.
In cold climates, pond shelter, orientation, depth, and configuration is critical for extending warmth in cool periods, hence fish and plant growth.

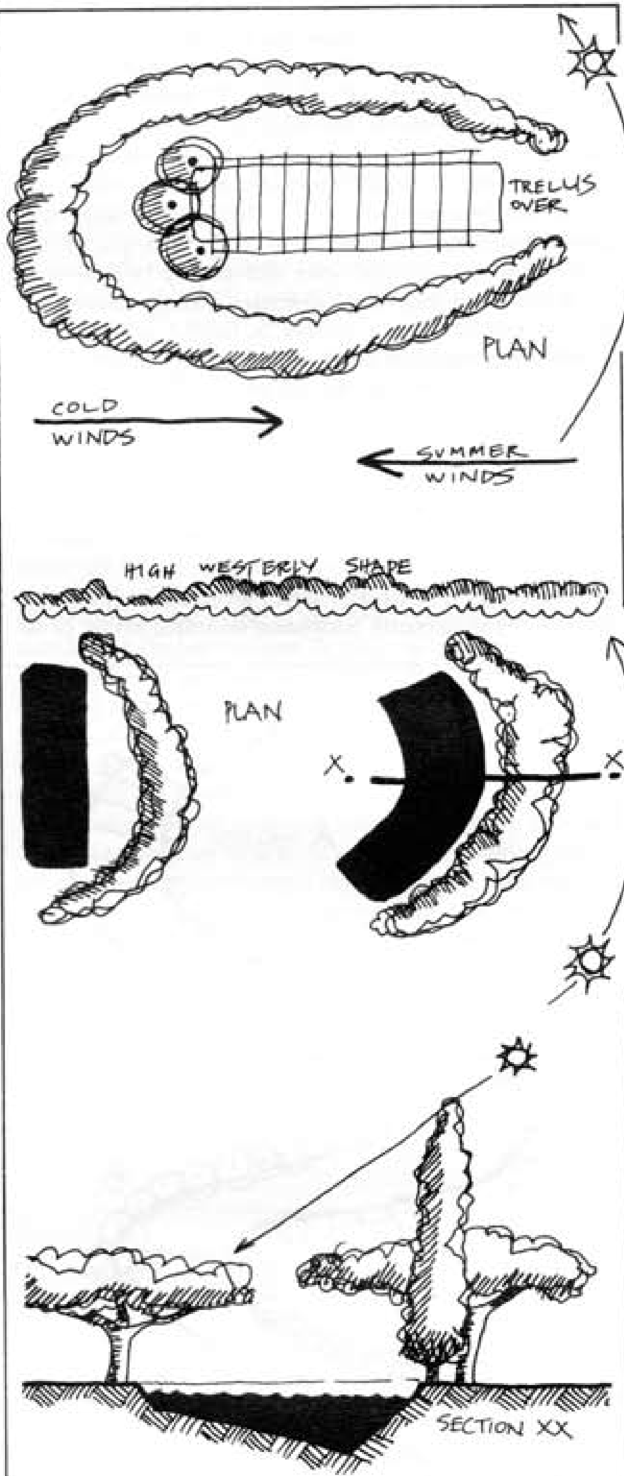



**FIGURE 13.24**
HOT MOST SEASONS
Overheating of pond is reduced by trellis and high shade hedgerow, wind tunnel below hedges as per section, deeps on shaded edges.

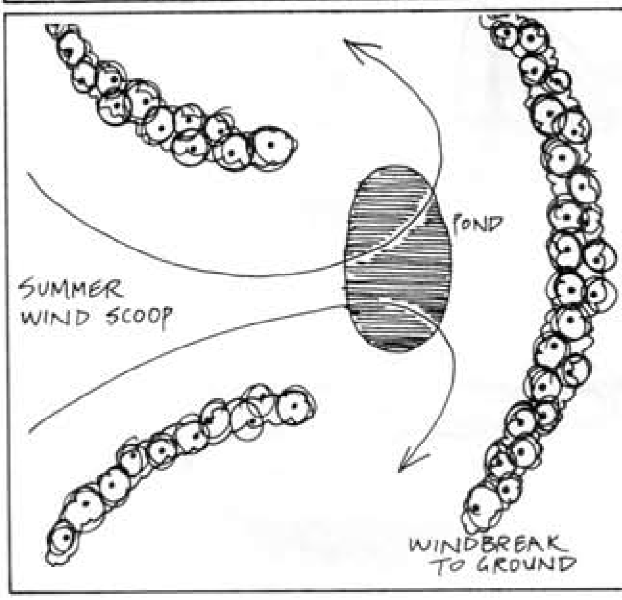



**FIGURE 13.23**
COLD WINTER WINDS, OXYGEN IN SUMMER.

incipient earthquakes, and water seeping through rock cleavages may either stabilise or destabilise faults, with potentially beneficial or catastrophic effects. For the building of large dams above human settlements, busy roads, or populated valleys, we modest pond-workers need make way for the more heroic aptitude of the civil hydraulics engineer, and even then with a lingering doubt that their structures will, in the end, persist, or that the potential catastrophe will merely be deferred. As a safe limit, ponds in restricted valleys should be limited to one or two metres in height, while those above broad flats can safely disperse a greater volume of water. Fish ponds, however, rarely cause civil catastrophes, and there is almost always good advisory or regulatory services available.

Rarely, we can find a property with a natural constriction between hills that enables us to flood 50–200 ha with one small dam wall. Our capital costs in such a situation can be very small in terms of the total production potential, and a little accessory earth-moving to create peripheral swamps, jetties, or to create islands is all that is needed apart from the small retaining dam and spillway.

Aquaculture must be as seriously designed as any other important production system. If a system is so planned, yields should exceed terrestrial crop in the same region by factors of 10–20 (more in arid areas), and there is no better use of land than as pond-and-forest systems. Of all endeavours, aquaculture (and its polyculture accessories) show greatest promise for the reduction of land areas in present use, and the repair of damage caused by badly-managed pastoralism and monocrop systems.

## THE FURNITURE OF PONDS AND MARSHES

Any wetland habitat can be increased in yield and use by the addition of some basic facilities which provide special habitat. Some of these are configurations or earth structures, others are constructs or technological additions. They cover such areas as:

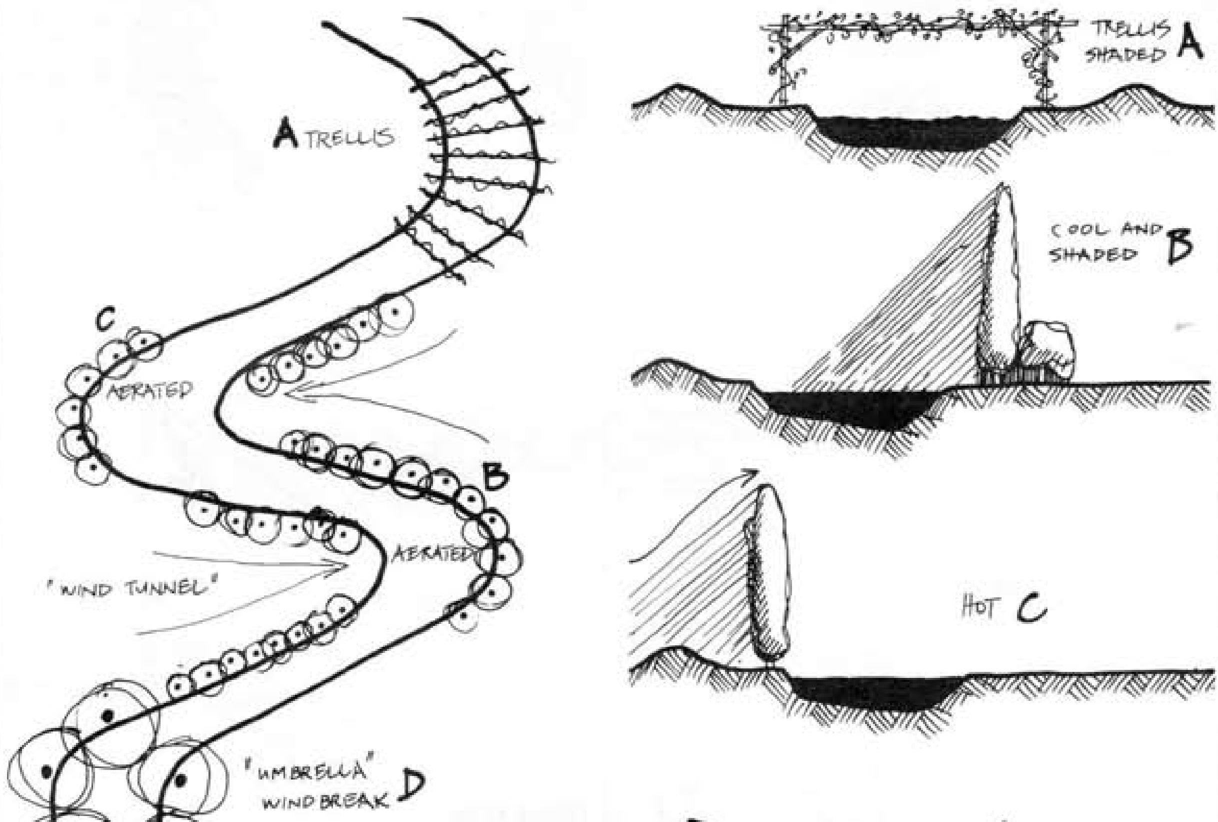



**FIGURE 13.25**
VARIABLE CLIMATE ON STREAMS.
On streams, wind aeration and shade can reduce direct sun, hence heated water; logging often causes streams to overheat.

A. Configuration

• *Islands and Hummocks:* Although the construction of quite small islands are excellent wildfowl habitat (quickly occupied by nesting birds), islands have other uses, such as the isolation of useful but invasive plants (runner bamboos), and as a strategy to increase edge for fish. Islands also create sheltered bays in windy areas, or can streamline the winds to better oxygenate water.

Swan and other hummock-nesters may be limited by available (defended) nest sites, and can expand their numbers with small hummocks in shallows. Many territorial waterfowl find these of use for night-roosts, and a good many useful tree species are hummock-dependant. Alligators are the natural hummock architects of Florida swamps.

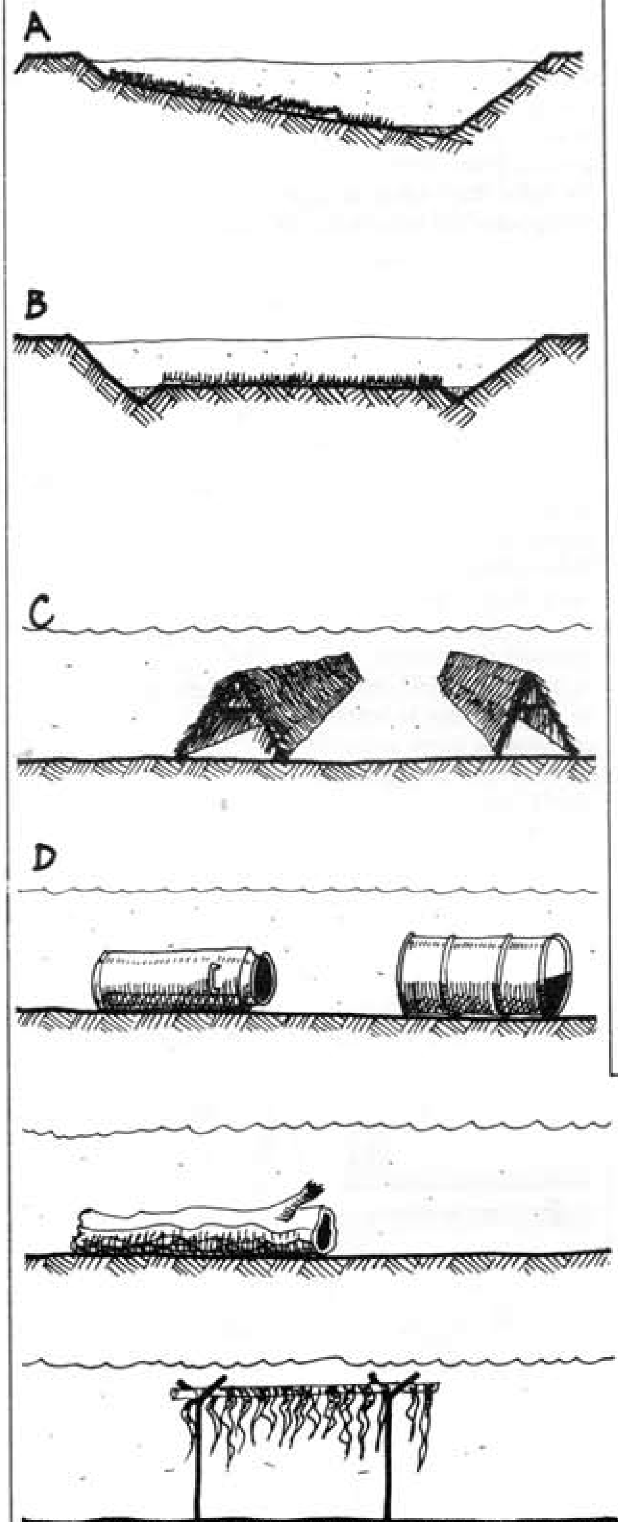
• *Peninsulas* (islands with narrow causeways) are safe house sites in areas of high fire frequency. They also elaborate the edge effect, increasing the area of shoreline for plants and fishermen.

• *Deeps*. The fish species of shallow waters and marshes may be decided in their composition by the number of deeper refuges in times of extreme cold or heat. Several species occupy such kettles in both tropical and temperate or cold lakes. **Figure 13.33**, in fact, is a series of continuous or extensive deeps in marsh, which is probably the highest-production water of any natural system.

With several carp, galaxiid, catfish, and perch species, deeps flooding out over mud and grass spawning beds are essential to their natural breeding cycle, and we can arrange a "flood" cycle by water regulation, to induce spawning. Many waterfowl also respond to this stimulus.

B. Structures

• *Breeding Substrates*. Depending on species, we can place a series of substrates on which fish will deposit



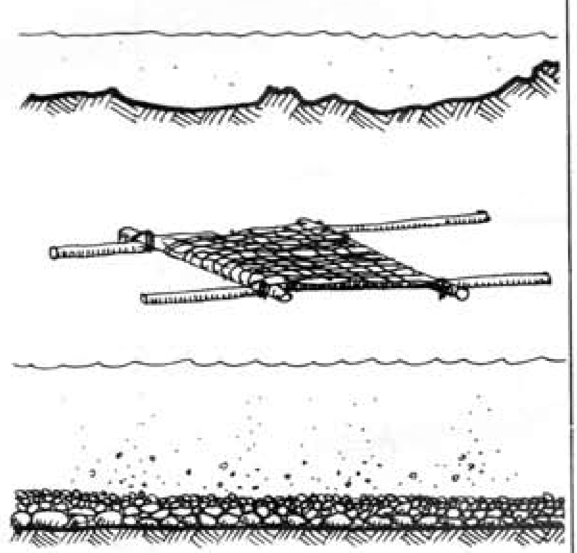



**FIGURE 13.26**
BREEDING SUBSTRATE.
**A**. Grassy slopes flooded for carp; **B**. alternative flood system; **C**. thatched shelters for "cave breeders"; **D**. logs or drums for large perch caves (Murray River cod). Gravels, sands, rock piles, mud caves, floating weed, and bundles of reeds or twigs provide other egg sites.

eggs. Some of these are figured (**Figure 13.26**). Others are in the form of earth material, gravels, subsurface aerators, and hollow breeding refuges such as logs, pipes, milk churns or drums and tanks. Many cannabalistic crayfish and territorial fish species defend such homes, and their population density depends on these refuges. Tyre heaps or piles of broken pipe provide condominiums for such species.

For small species such as shrimp, snail, notonectids, and some small fish, bundles of brush perform two functions: that of a breeding substrate, and as a refuge from larger predators. All such refuges can be arranged to be hauled out, and then they operate as "traps" for the species (octopus, eels, and crayfish stay in their holes or in old tyres; shrimp and freshwater crab cling to brush piles), or to collect their eggs and fry.

• *Rafts*: Rafts serve as floating docks in tidal waters, as supports for houseboats or pumps, as walkways to

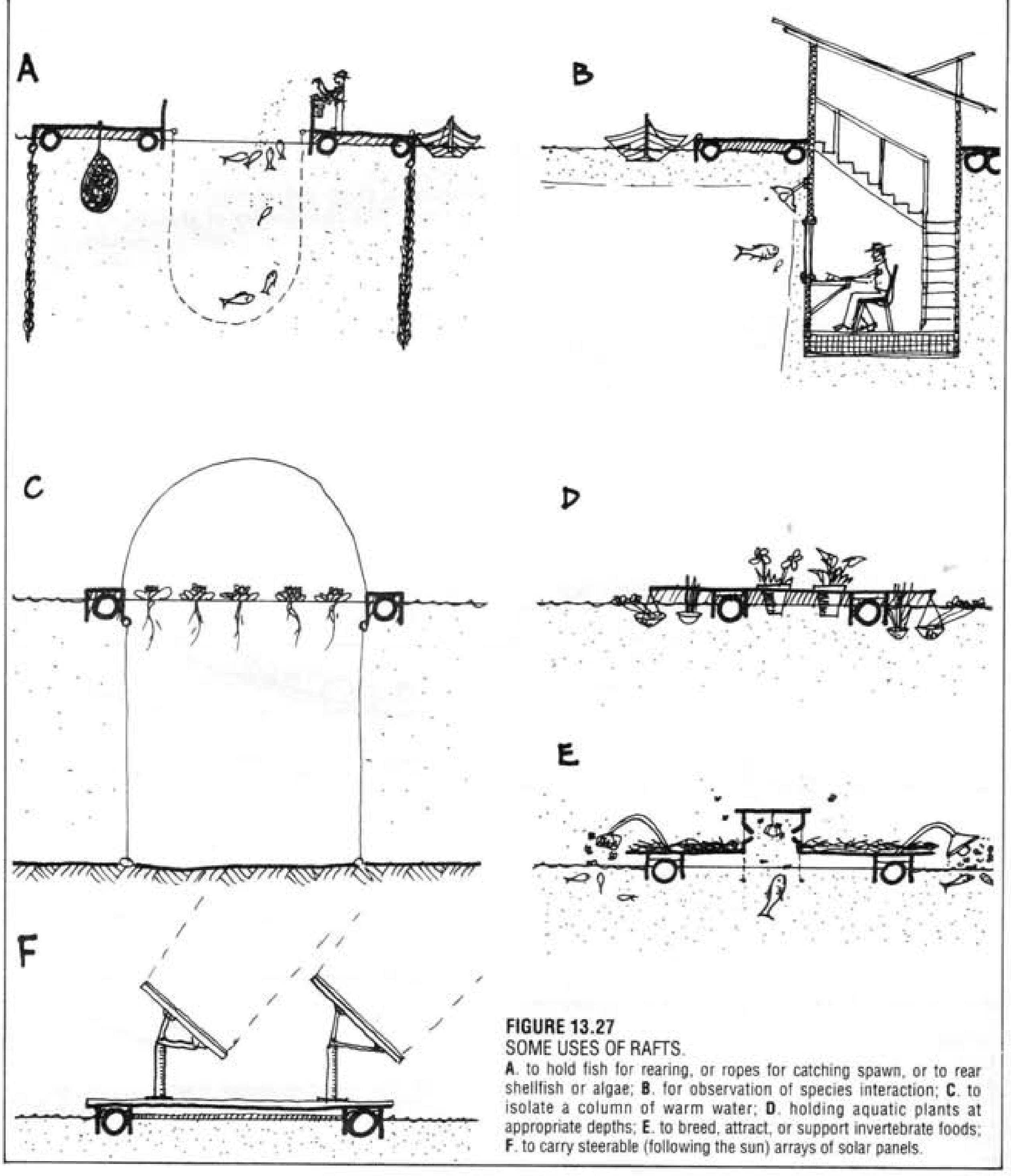



**FIGURE 13.27**
SOME USES OF RAFTS.
**A**. to hold fish for rearing, or ropes for catching spawn, or to rear shellfish or algae; **B**. for observation of species interaction; **C**. to isolate a column of warm water; **D**. holding aquatic plants at appropriate depths; **E**. to breed, attract, or support invertebrate foods; **F**. to carry steerable (following the sun) arrays of solar panels.

fish cages and ring-nets, as surface floats for organisms cultured on ropes, brush, and in mesh bags, and as observation platforms. Some of these uses are figured (**Figure 13.27**). With fluctuating surface levels induced by tides or the draw-down of dam storages, only a raft arrangement can cope with the steady level of water needed by certain water plants and nesting birds.

Cultures *on* rafts range from light and lure traps for insect foods to insect incubators of leaf litter or animal wastes. In many cases, multiple uses of rafts are feasible. Rudolf Doernach, a German architect, has actually built raft houses in cistern ponds, and was in this way able to "follow the sun with the house". Heavy arrays of solar cells and solar collectors are most economically oriented to the sun on raft structures of this type. Rafts also hold self-feeders for fish and waterfowl.

• *Screens and fences.* Shallow-water fences and screens are useful in polycultural stocking to keep predators from cultures of forage fish, or to allow stunted fish to be culled by predators. Outlet and inlet screens either prevent or regulate the migration of species (**Figure 13.28**).

Screens (**Figure 13.29**) can be horizontal, sloping, vertical, or as cylinders and cones. The configuration enables, in each case, some degree of self-clearing or deflection of solid particles. Rotating drum screens can be made to be entirely self-cleaning and self-turning, providing a small head of water is available. Drum screens are particularly useful for skimming ponds or collecting floating plants and algae for use as manures or forages.

Fences are a cheap way to screen shallow areas, or to separate the area between deeps. Again, they separate predator-prey or cage populations of carnivorous fish. For a small grower, they enable brood fish to be kept in the same ponds as immatures, and two antagonistic species to be reared in a pond. Screen fences beside deeps in marshes prevent fish escaping from them (extending predation to shallow waters), or permit frogs to breed in shallows without excessive predation

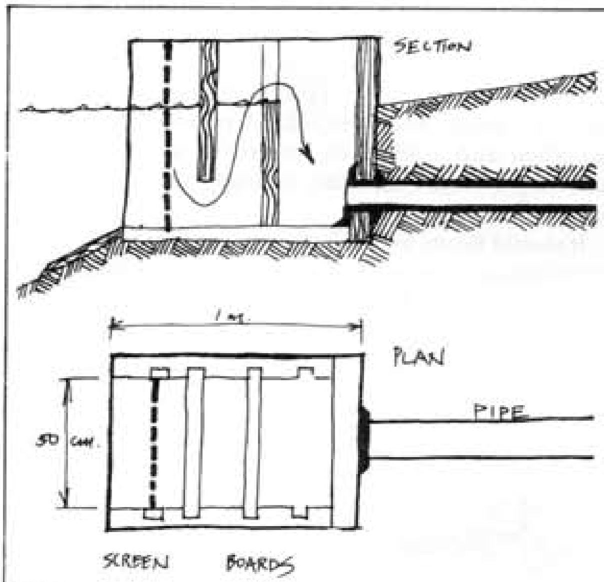



**FIGURE 13.28**
SCREENS AND BOARDS.
Classical "Herguth monk" outlet incorporates a screen and a level control board.

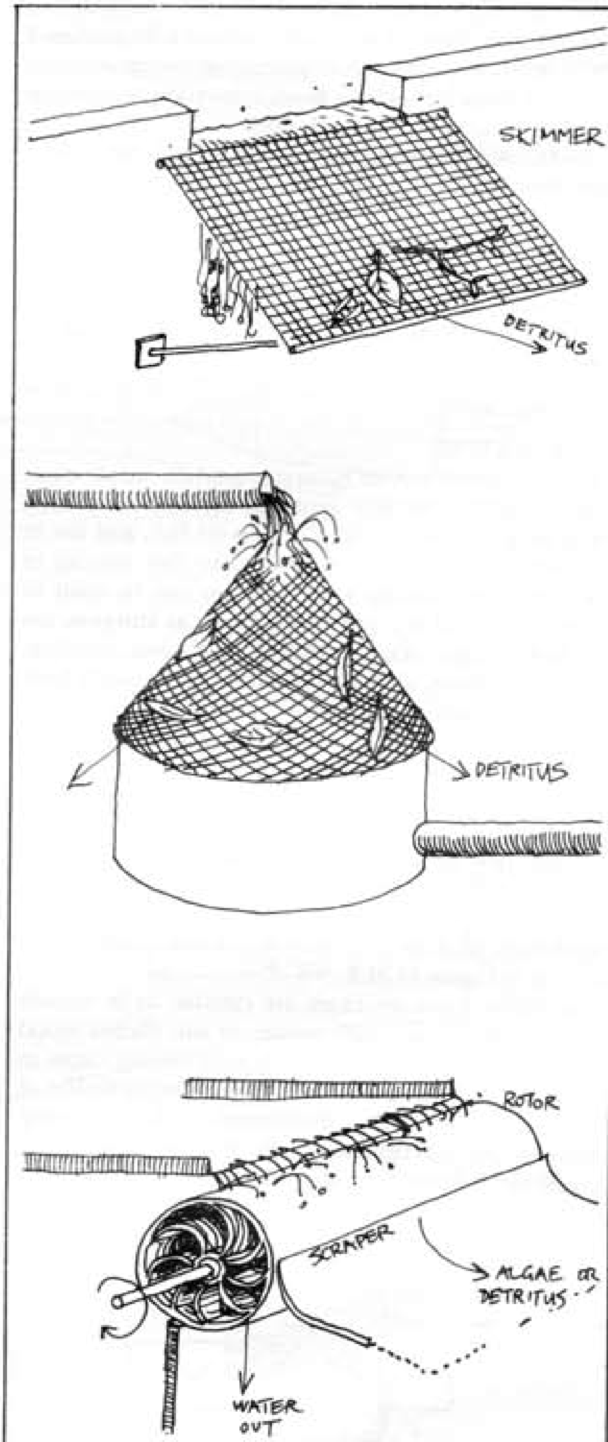



**FIGURE 13.29**
VARIOUS TYPES OF SCREENS
to remove leaves, algae, or to self-clean.

from trout.

• *Outlets and Inlets.* For ponds, the types of water level controls are a critical factor. Modern production of reliable and flexible pipe has made very simple level control possible, either as an elbow or upturned flexible pipe.

Outlets can also be a harvest system, as baskets into which water falls, or as smaller ponds with screened spillways that gather fish migrating downstream. Both are used to gather eels or trout from complex swamp systems difficult to harvest by nets.

Inlets are likewise regulated and screened, but greater attention must be paid to prevent the entry of silt, weeds, or unwanted organisms into the pond itself. Consequently, inlets can be complex systems of filters and screens where water quality is poor, or very simple pipes where unpolluted and fish-free water is drawn from springs. Some inlet systems are given in **Figure 13.30**.

## CAGE CULTURE

Cages of wood, woven natural materials, metal mesh (and nowadays modern synthetic meshes) have been used since antiquity to trap or harvest fish, and are in current widespread use for intensive fish rearing in both still and flowing waters. Cages can be used to protect eggs and fry, and species such as sturgeon are hatched in cages (**Figure 13.31.A**). Live fish, crayfish, prawns, molluscs, and eels have been traditionally held in cages or *caufs* (pronounced corfs), floating barges, and wet wells in boats for the fresh fish market. They are also used to hold eels, oysters, crayfish, carp, and weed or algae eaters to reduce algal taints in fish flesh (**Figure 13.31.C**).

Where flow is rapid, cage mesh large, or wave motion exists, oxygenation in cages is no great problem. There is some advantage, however, in shaping cages subject to rapid tidal flow, or to induce water circulation in the cage, as in **Figure 13.31.B**.

Normally, however, cages are circular, as in salmon ring-net culture, or plain square to suit slatted wood construction (**Figure 13.31.D**). Typical rearing cages in which fish are fed, and which float in larger bodies of water, have a water flow maintained by the swimming action of the fish themselves. Such cages produce the largest yields known to aquaculture.

Mooring cages can be effected by individual anchors, as sets of cages attached to floating docks or walkways, or as gangs of cages fastened to lines, and (allowing a boat-width between cage pairs), the gangs can be stretched across bays, or anchored to float-lines in open water not subject to violent wave action (**Figure 13.31.E**). Old tyres serve well as spacers between cage units. I used caufs for years in sheltered bays to hold shellfish and net fish for market, and rarely suffered losses, but all cages need an annual inspection and watchful maintenance. Predators such as octopus and seals can cause large mortalities in cage fish, whereas pond fish can avoid such losses by evasion. On rare occasions, large shark attack caged fish and destroy cages, a loss not experienced in pond cultures!

## NUTRITION AND FOOD SUPPLY

The same care must be paid to the nutrition of fish and shellfish as to that of land species. Vitamin supply from fresh greens, fruits, and algae are essential. High-protein foods, with a modest admixture of starchy foods (and all of these in fresh condition) is a requisite for healthy growth, as fertiliser is for plants. There is no substitute for fresh live food to produce high quality fish. Some strategies for better fish nutrition are given here; they are *the* critical strategies for cost savings (or energy conservation).

Fish maintain growth by eating about 1% of their body-weight daily, and gain most weight (at the least waste of food) when fed at 3% of body-weight daily. Again, trials of feeding are needed for specific species and size groups, but it is a good rule of thumb to feed out as much food as will be completely eaten in 15 minutes, to check on food wasted, and to establish a growth curve from samples taken as the fish grow.

Demand feeding, where the fish themselves trigger a food supply when hungry has its advantages, but may necessitate pelleted foods purchased at some 60–70% of total expense. Sub-samples of netted fish can be weighed and a weighed ration fed at 3% of total, allowing a 10–12% mortality in fingerlings, and 40–60% in fry.

It should be obvious that whatever food we can grow or collect as "wastes" is a critical factor in energy and cost conservation. For some of these strategies we must look to systems within the boundaries of the pond

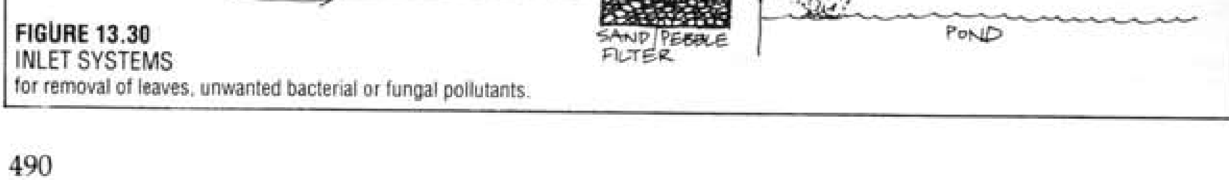



**FIGURE 13.30**
INLET SYSTEMS
for removal of leaves, unwanted bacterial or fungal pollutants.

(shrimp, minnows, algae) but for others we must closely design the pond margin and create accessory food systems outside the pond itself. While this section completes a summary of the factors that we can manipulate to increase yields, we will follow with a set of food provision strategies, which I believe will have a profound effect on yields, although it is not a factor identified by others unless with respect to breeding or pond management for harvest.

## 13.6

## FARMING INVERTEBRATES FOR FISH FOOD

Dried insects and other invertebrates are high in protein value, thus forming a very important fish food, e.g. if we take the "food quotient" (F.Q.) formula as given in Augusthy (1979):

F.Q. = <u>wt. of food given</u> (e.g. 200 kg of minced fish waste) divided by the <u>wt. of fish gained</u> (e.g. 100 kg of fish gain)

Then: F.Q. = 2 for fish waste in this example.

In these terms, insect larvae are 1.8, compared with guinea grass at 48. Obviously, we do well to encourage

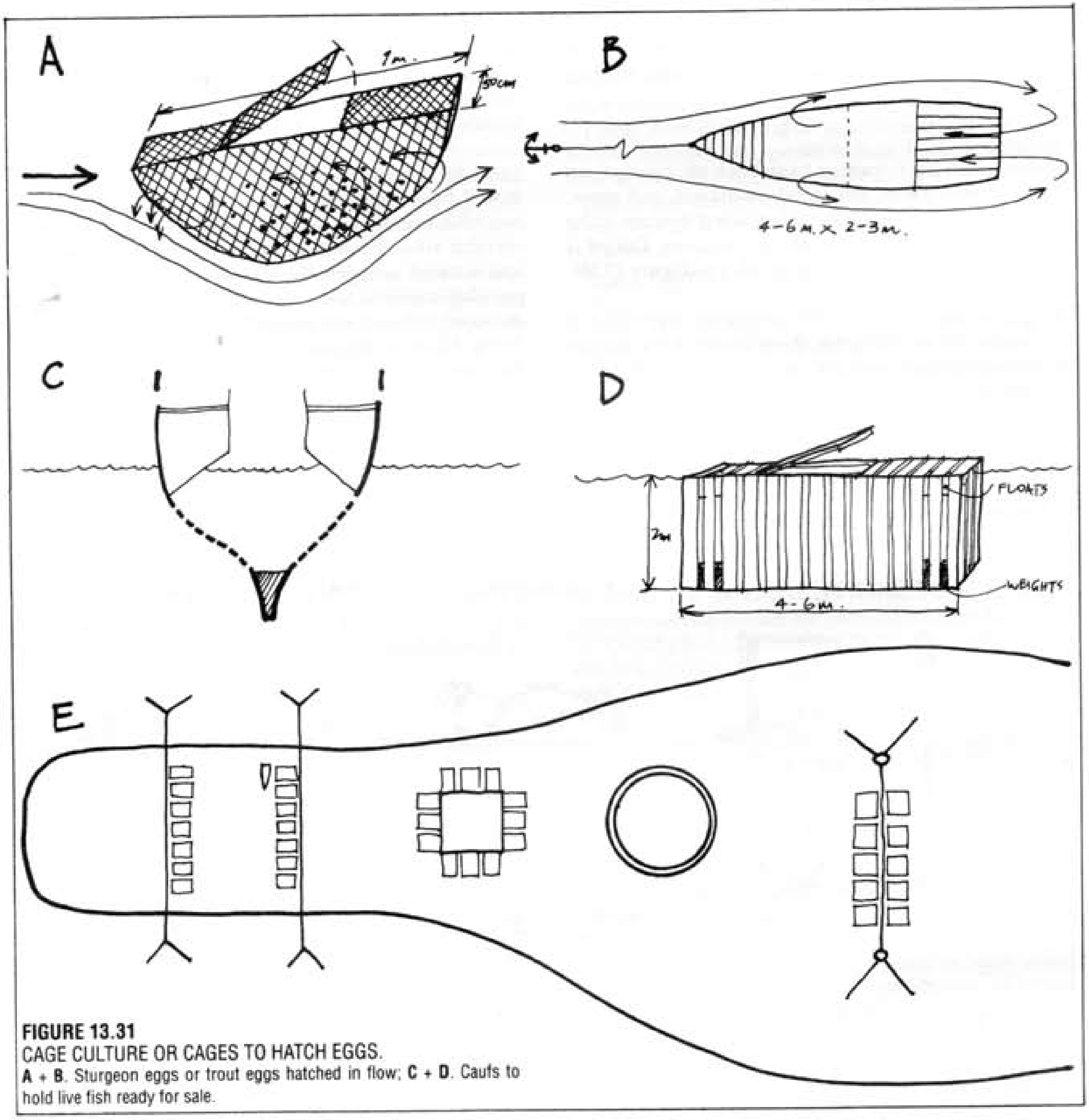



**FIGURE 13.31**
CAGE CULTURE OR CAGES TO HATCH EGGS.
**A + B**. Sturgeon eggs or trout eggs hatched in flow; **C + D**. Caufs to hold live fish ready for sale.

insects. There are several ways to do this, and some are:

Cockroaches, mealworms, and sowbugs:
Scatter food waste or flour, cover with leaves, and "seed" with cockroaches or sowbugs. Add to this pile some leaves and starches from time to time. Millipedes and cockroaches build up in tropical areas, and can be used to feed ducks or fish. Dano Gorsich on Moloka'i Hawaii, has a successful cockroach mulch heap of *Hibiscus* leaves which produces cockroaches for his ducks; if the pile is half-turned every few days, cockroaches are taken by the ducks. The duck manure then stimulates plankton growth in ponds.

Similarly, a "sandwich" mound of boards, paper, leaves, and so on breeds sowbugs (woodlice) and houses earwigs. These can be sieved and shaken out, or the mound demolished and rebuilt with ducks or chickens present. *Zostera* (eel grass) is a good sowbug base.

Termites:
A perforated 200 l drum or loose brick pit, covered can be filled with paper, old wood, cardboard, and straw, and then watered. Termites will invade if they are in the area, or sowbugs can be seeded in cool areas. The pit is periodically dug or sieved out for insects (**Figure 13.32**).

Plague locusts:
Up to the 4th or 5th instar, these insects form ground swarms (flightless), and can be vacuumed, brushed up, or "trawled" in grasslands using a side-towed bar and net. Frozen or dried, they are ideal protein food (people in many cultures eat the singed or dried bodies). They are largely overlooked as a high protein fish food resource. Fermented and dried they can be dry-stored.

Standard light-and-fan floats are available to attract night-flying insects and blow them down to the water surface. Yellow floats attract grasshoppers to ponds, where many fall short of their goal and are consumed.

Pasture grubs:
These are the larvae of *Aphodius, Phyllophaga* and other beetles or moths. They occur at high densities (10 t/ha is not uncommon) in the top 3 cm of soil. Strips of field can be skimmed, sieved, and the grubs "floated" out of the dust with salt solution, dried, or frozen. At an F.Q. of 2–3, every hectare should grow 2–3 t of trout or other high value fish! Also, the adult beetles will cluster around bright lights and can be trapped in funnel-and-drum systems, and also frozen or dried. This is a good way to raise turkeys, when a daily disc-plough line can turn up 100 kg or so of grubs: all this on pasture carrying less than 0.5 t of sheep/ha.

In general, any dense collection of insects can be cultivated, harvested, and converted to fish food; food wastes can be converted to insect food in many cases.

Snails for fish and duck food:
A well-limed area planted to arum lily, *Nasturtium*, root sets of horseradish, *Brassica* seed, broad beans, and cucurbit vines if "seeded" with a few buckets of snails and watered occasionally, will build up a dense snail population over a few years. These can be "fed off" to ducks or gathered and minced for fish food as needed. Every 10 or so square metres, a clump of arum or *Agapanthus* will form permanent snail harbours; *Nasturtium* and horseradish provide food, as do cucurbits and annual *Brassica* species or globe artichokes. Snails can reach high densities under these conditions.

The large tropical snail *Achatina* likes a mixture of papaya, over a ground cover of cucurbits, *Nasturtium*,

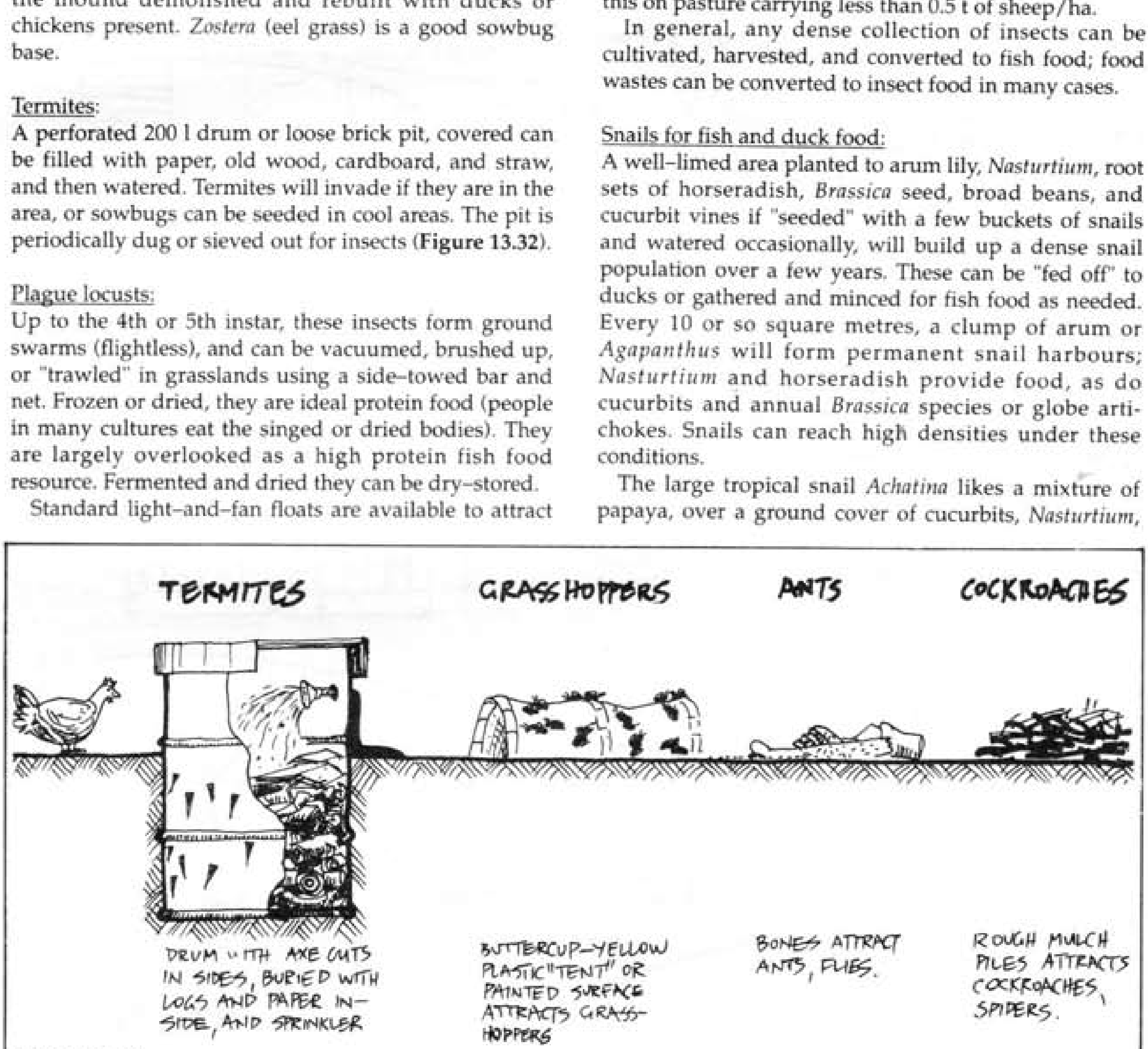



**FIGURE 13.32**
TERMITE BREEDER + OTHERS.
Many high-protein invertebrates can be cultivated in field situations to add to forage systems.

and fleshy or mucilaginous harbours. Desert snails can be collected from post tops in swales or grasses, where they gather to avoid soil heat.

Zooplankton:
Water fleas, cyclops, ostracods, rotifers, and so on can be cultured in small ponds or tanks supplied with lettuce, potato slices, crushed sugar cane, manioc (cassava) or legume leaves. A shallow bay off the fry ponds can be screened off for this purpose, and the plankton will swim out into the fry ponds. Conditions in the enriched area may not suit fish, but produce ample food.

Midge larvae and tubifex worm cultures in rich, shallow, organic ponds supply essential fry food, as do the brine shrimps (*Artemia*) of salt pans. *Artemia* culture is one of the very few productive uses of saline inland ponds.

Larval flies:
Carrion flies will "blow" waste meats or carcasses suspended over ponds, and near-putrid shallows supplied with kitchen sink water will breed "gentles" (larvae of *Tubifera tenax* flies) in the muddy base (depth of water 1-2 cm).

It is in the development of such high-protein foods as accessory to fish ponds that we save the greatest continuing cost of fish culture—food. In our site planning such areas are as important as the ponds themselves. For herbivorous species, semi-rampageous plants such as *Nasturtium, Tradescantia, Dolichos*, and comfrey supply hardy and palatable foods to fish such as *Tilapia*. In channel cultures, the banks themselves (when planted to such species) are a complete food supply.

Aquatic molluscs:
Species of the genera *Physa, Limnaea, Bythnia, Vivipara, Pisidium, Sphaerium* and so on occupy most alkaline waters. They form a large part of the food of fish, and are easily cultivated on vegetation in organic ooze in shallows and on stream banks, or in pools.

Worms:
Small or large-scale worm beds are invaluable sources of food for fish; worms are collected by flooding the beds at intervals. With a source of hay, food scraps, or manure, worm-growing can be a major fish food producer. The hessian (burlap) cover of worm beds can be immersed in or suspended over ponds after flooding the beds.

## FODDER POND SEQUENCES

As each small pond falls through a pipe to the next, upstream migration is prevented while downstream migration is possible or even aided. Ponds I have built were organised as per **Figure 13.33**.

The criteria for upstream species are simple. In plants, it is that they be non-invasive, and in animals, low on the trophic ladder. If such ponds are arranged along spoon or V-drains, several origins and destinations can be achieved, with forage fish or invertebrates migrating always downstream, and even then a perched pond above the trout or predator system can make a trout-free forage-fish polyculture.

From the intake: Ducks add manure; shrimp eat algae produced by the manure. Some shrimp larvae escape to the next pond where a small fish breeds (*Gambusia* for example). These fall again to trout or perch in the last (outlet) pond. Snails can be part of this downflow *if* a separate intake is arranged. Species suitable to each stage are:

**A.** ORIGIN:
Animals. Manurial species such as ducks, freshwater mussels, amphipods and phreatocids (mud shrimp), small freshwater crabs (*Halicarcinus*), snails, shrimp (*Atya, Macrobrachium*), frog larvae (*Hyla, Rana, Crinea*).

Plants. Non-flowering or non-invasive species such as taro, and manurial species such as *Azolla*. Insects and their larvae will also be represented, like it or not.

Structures. Rotted logs, reed beds, brush and small cover. Taro or other useful crop can also be planted in any pond downstream.

Edges. Comfrey, vining legumes, fruit.

**B.** NEXT POND DOWN:
Animals. Any of the above plus more predatory invertebrates and very small fish working at planktonic level, e.g. surface-feeding fish such as minnows, *Paragalaxids, Saxilaga* in the mud.

Plants. Useful edible species (kangkong) on mounds.

Structures. Reed bed, small pipes and logs.

Edges. Mulberry, berry fruit, legumes, comfrey.

C and D follow much the same sequences as given in B. Products or yields can be taken off at any level as shrimp, snail, ducks, frogs, taro, *Tilapia*, perch, or trout. Even pH can be altered in some chains to allow different species to enter the chain, and niches arranged for special plant or animal groups, so that high oxygen and low oxygen demand species are accommodated. Such systems can accept water polluted by phosphates and nitrates as part of their intake, providing plants and organisms can be found to cope with that level of pollutant (**Figure 13.33**).

There are at least three strategies to increase the diversity of the waters; all apply to relatively small still-ponds, marshes, or perched ponds. We can:

- Locate ponds at headwater and ridge locations, thus creating small ecological islands;
- Salt small ponds for the development of semi-estuarine species; and
- Manure small ponds and marshes with trace elements, animal manures, and phosphatic or nitrogenous fertilisers in order to produce large quantities of forage fish, algae, or crustaceans which will feed trout.

Swingle (1966) proposes that up to 50% of a catfish pond can be in shallows; these are to provide food for the main fish (as shrimp), not at a cost of reducing fish

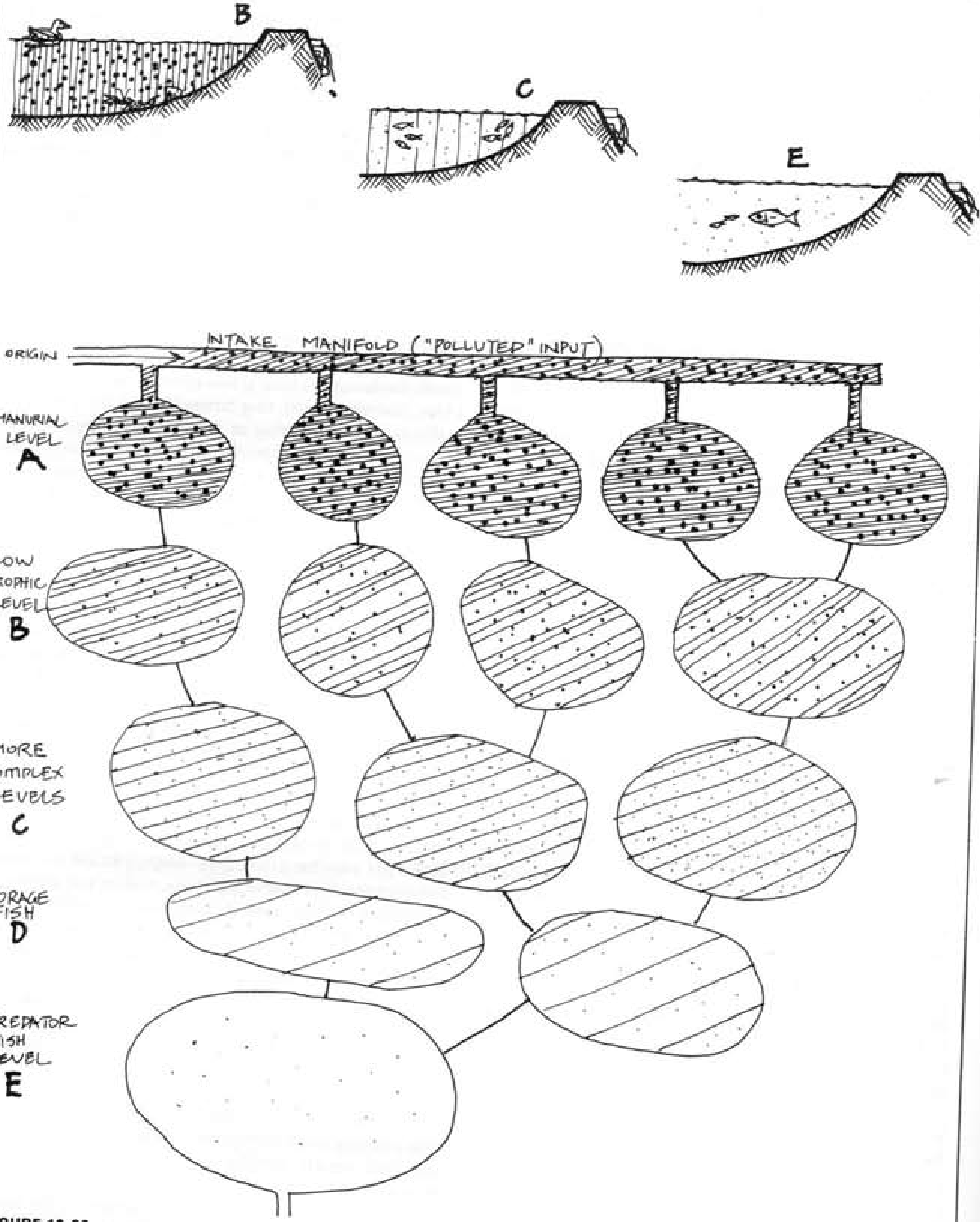



**FIGURE 13.33**
LEVELS OF POLLUTANTS IN PONDS.
Pollutants, here as manures, are successfully reduced by **A**. algae and zooplankton; **B**. invertebrates such as shrimp and shellfish; **C**. minnows; **D**. baitfish; and **E**. a polyculture of predatory fish. Water plants and margin plants greatly assist this process.

**TABLE 13.3**
ORDERS OF YIELDS GIVEN SPECIFIED CONDITIONS.

| kg/ha/year protein | CONDITIONS |
|---|---|
| 10 – 50 | Deep, cold; rocks around lakes with few shallows. |
| 30 – 60 | Deep artificial resevoirs |
| 60 – 90 | Artificial resevoirs modified for fish and forage culture. |
| 80 – 150 | Natural shallow lakes, unfertilized, e.g. glacial outwash areas, natural shrimp yields in coastal lagoons of low pH. |
| 200 – 500 | Basic "standing crop" of fish in fertile (but not fed) fish ponds, e.g. bass, trout, bluegill; extensive fertilized waters of one to three species. |
| 500 – 1,000 | Unfertilized brackish lagoon cultures of milkfish; modified rice padi crop of carp or *richoseras*; central padi "plateau" cropped, and plants cut for water manure. This is the upper range of totally natural systems. |
| 1,000 – 2,000 | Fertilized, extensive carp, milkfish, and mullet cultures, including a dry cycle. About the limit of extensive systems. *Puntius* in padi culture; intensive prawn culture. Fertilizer now 25–50% of costs. Well–chosen and unfed ploycultures can also achieve these yields. |
| 2,000 – 5,000 | Intensively fertilized and fed pond polycultures of selected species; water quality monitored. Some feeding or crop residues supplied. Optimum conditions. Food is 60+% of total costs. |
| 5,000 – 20,000 | Intensive cage and cauf cultures or small aerated ponds of carp, catfish, tilapia; fertilizer and food now 96% of total costs, and waste products may limit production; disease control is critical. land cycle of wastes essential, to reduce nitrates. |
| 20,000 – 150,000+ | Cage culture in oxygenated food–rich streams or with accessory foods. Vigorous flow or waste removal essential and achieved by channel flow. Hardy and disease–free fish stocks essential. |

numbers, but at a gain in energy needed to feed them.

Fish such as *Tilapia* and carp are commonly fed on starchy foods from adjacent crop (pumpkin, banana, sweet potato, yam, taro, beans and bean flours, grains and doughs), but also eagerly eat the fallen insects, seed, and fruit from fringing vegetation, along with selected water weeds.

*Tilapia*, in particular, eat many fruits and edible leaves from garden weeds and vines. For this reason, market gardens and fish ponds belong together, but as fish-pond water is also of good nutrient value to gardens, the relationship is enhanced. Crop production from well-fertilised ponds may be as much as twice that from resevoir irrigation.

Grass carp neatly trim fringing vegetation such as *Dolichos* species, and save encroachment of weeds into taro, while not only mixing quite well with *Macrobrachium* prawns but actually increasing prawn yields without feeding them artificial food. Like *Tilapia*, they appreciate garden waste, plants, and fruits. Barry Costa-Pierce (pers. comm.) has a variety of polycultures under test in Hawaii, and the ponds in which he keeps grass carp with prawns have neatly-trimmed edges (bitten by the fish, not lawn mowers), while the prawns grow as well on grass carp fecal detritus as they do on chicken pellets in nearby monoculture ponds. Even if they grow less, or if we increased pond margins as an edge effect, or planted comfrey and clover, *Dolichos*, *Tradescantia*, and lucerne along the pond edges for fodder, it is preferable to create the conditions for yield at the pond than to import them from elsewhere at great cost in energy.

## 13.7
## CHANNEL, CANAL, AND CHINAMPA

Next to cages (and sometimes integrated with them) channels of 0.5–2.0 m deep are widely used in fish culture; they are the only economic way to develop "ponds" on slopes of more than 8° unless we develop water terraces. Channels maximise edge effects, and natural foods can be substantially more available in channel culture. The chinampa is probably *the* most efficient culture configuration for natural feeding of fish, and many rice padis have now been modified for this effect.

"The chinampas... of the Valley of Mexico... date back more than 2000 years and were the main source of foodstuff for the inhabitants of the entire valley, producing as many as seven different crops in a year, two of which were maize." (Tompkins, P. 1976, *Mysteries of the Mexican Pyramids*, Harper and Row.) Properly maintained, chinampas could remain fertile for centuries without having to lie fallow. Rafts of water vegetation were cut from the surface of the canals and towed to mounded banks where they were built up in layers and covered with rich mud scooped up from the canal bottom.

I have extended the use of the word chinampa to include any system in which a sequence of canals and banks in approximate parallels are developed for growing fish and marginal plants. Given a body of standing water such as a lake or swamp, or a humid landscape with a clay base that will retain water all year, or a water table close to the land surface, it is possible to create a cross–section harmonic of land and water whose uses are bounded only by the limits set by climate, the imagination, and the harvest capacity of the designer. Chinampa systems combine the best of both worlds in soil and water culture, and are in use in deltaic regions of Thailand to grow fish and truck crop, ducks and fruit trees (**Figure 13.34**).

There is one other strategic benefit of chinampa systems, in that useful but potentially rampant species such as runner bamboo, vine blackberry, hops, horse-radish and like crops can be water–isolated from other land systems. Small moated islands have the same facility, and waterfowl can nest or rest on these without interference from foxes and feral cats.

We can cheaply create chinampa swamps with a few compacted retaining walls where water levels are regulated to back up over chinampa systems. The ratio of channel to dryland culture is normally about 1:1–3, but if we reverse this ratio, herbivorous fish, plankton eaters, and crayfish are self–foraging.

Crayfish and grass carp in channels 2 m wide, ranging over a swamp strip of 5–10 m wide have a rich forage supply, *plus* land edges. The terrace or swamp can be drained, and in 3–4 weeks harvested or cropped, and the vegetation of terrace and shelf act as fish food and manure. With the right selection of species (ducks, mussels, weed–eating fish, crayfish, or eels) such systems give yields in excess of 1000 kg/ha of water surface, as many food organisms and plants are intimately available to the canal fish.

On slopes, Huet (1964) reports good yields from trout canals in Switzerland (fed or unfed) at 40–60% greater than broad–pond culture. For hill canals, a reliable water intake and clay soils are essential to permanence The vegetation of the edges, shallows, and margins are a critical factor in nutrient supply.

## 13.8

## YIELDS OUTSIDE THE POND

<u>Flow down</u>

We have dealt with "in pond" yields as factors of water quality and fish selection. This does not take into account upstream, incorporated, or downstream yields not directly related to fish flesh. For instance, if we feed industrial fish food pellets to ducks or pigs, and let the manures of these animals fertilise the ponds, we get about the same yield (or even more) of such plankton and detritus feeders as prawns, carp, *tilapia*, and mullet, plus the duck or pig products. This is a question of the correct routing of the food supplied, and involves land yields.

Further, if we use fertiliser on land crop, feed that to pigs and ducks, and use their manures for fish, we get an even greater yield. Beyond that, we can grow permanent low–fertiliser crop for pigs (banana, papaya, acorns), use sparing fertiliser, and get even greater total yields.

Alcohol recovery and the subsequent biogas digestion of green feed, tubers or starchy food, manures, and wastes produces a flow–on slurry not one whit less fertile than the original substances, so that we are now arriving at an integrated flow–down system of tree forage > animal protein > manures > alcohol > biogas > water crop (plants) > forage–fish. Even within this flow, side cycles to worms, notonectids, or *Daphnia* give better utilisation and a yield at every step. The problem that we begin to strike here is that no one family or person can manage a very complex integrated system. We need a higher order of social organisation in order manage these maximum yields (**Figure 13.35**).

<u>Margins</u>

Ponds, depending on their shape, give a new and productive edge in landscape. Trees and vines grow better there, and selected marginal plants drop leaves, insects, insect wastes, fruits, and extend roots into ponds as fish foods. They also shelter ponds or direct winds over them, prevent over–heating and chilling of waters, and provide cover for forage species. Thus, a whole set of yields are available from pond margins.

<u>Ponds</u>

We know that weedy shallows, brush piles, fences, rocks or pipes, and rafts provide additional shelter, escapement, or forage in ponds. There is a rich field here for increasing yields. We could devote 50% of the pond to such cover or forage systems.

<u>Downstream</u>

Water from densely–stocked fish ponds is a rich source of irrigation water for land plants. Yields from sewage or fish–pond water are 2–5 times that from intake water. These land crops, as fuels, food, forage, or structural product, must be integral to pond development if we are to realise the full value of fish ponds, and utilise the

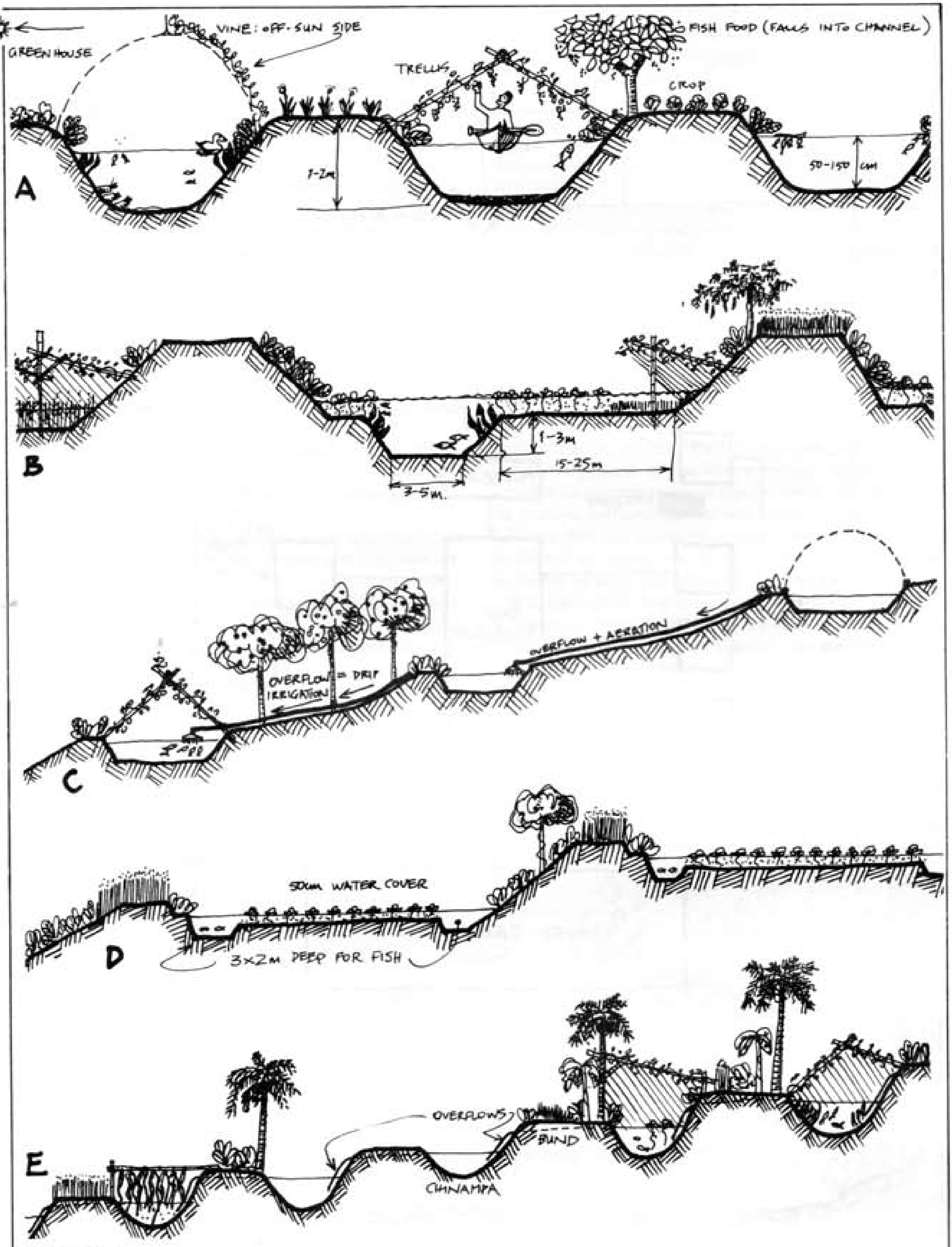



**FIGURE 13.34**
CHINAMPAS.
Some variations on the earth–water harmonic: **A**. in flatlands; **B**. in swamps; **C**. on hillsides; **D**. at terrace edges; and **E**. as canals on clay-based hillsides with top-up stream water at highest level.

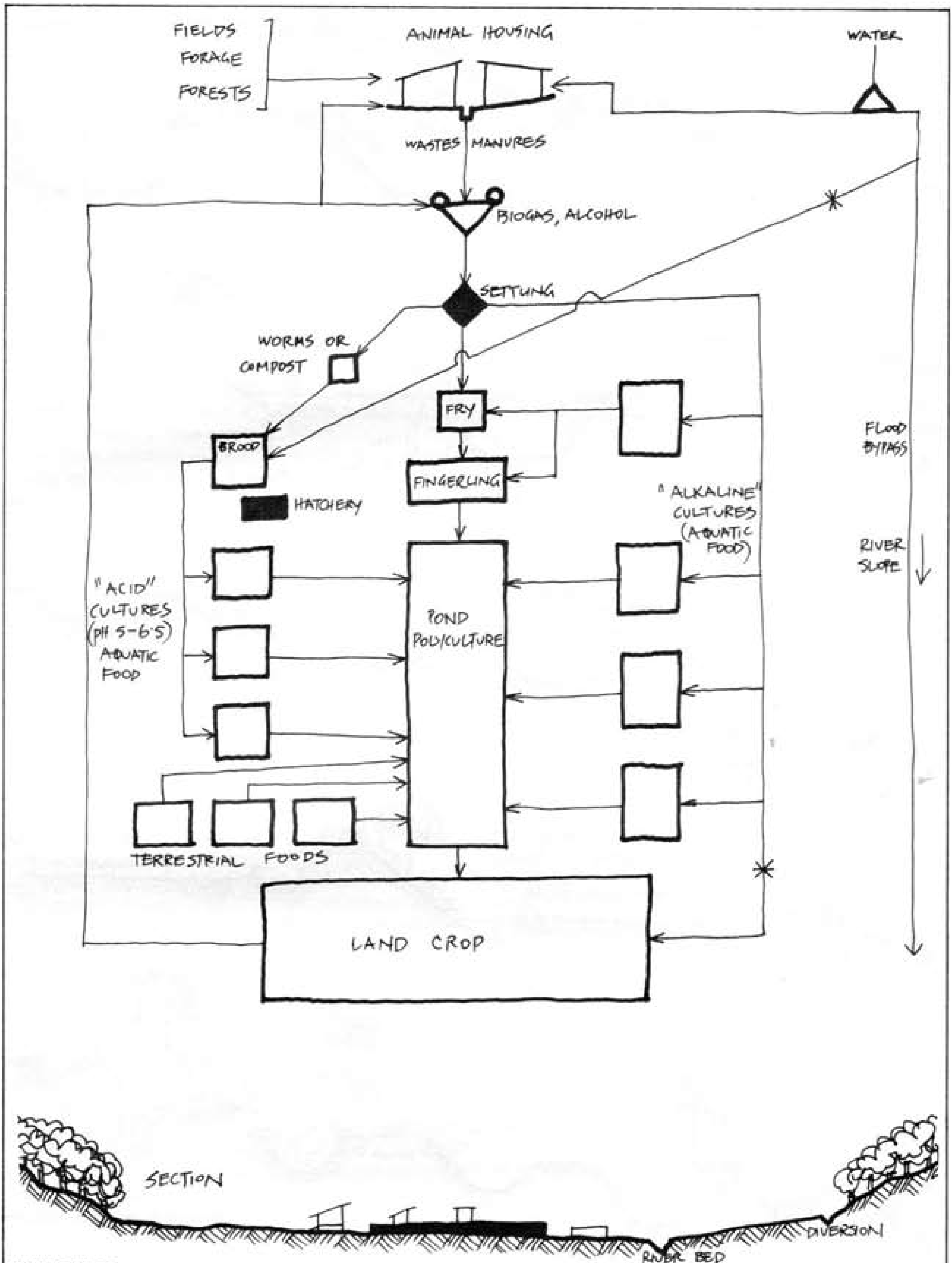



**FIGURE 13.35**
SCHEMATIC OF INTEGRATED POND SYSTEM.
Intended to self-provide for food and energy; forage for land animals is assumed.

wastes and algae flowing downstream.

PLANTS OF THE MARGINS

There is a curious lack of data on marginal plants in most literature, even if their value is sometimes noted in passing. What can marginal plants achieve?

- Cover for fish, shrimp, waterfowl, and hence predator protection.
- Spawning and nesting sites for fish and waterfowl.
- Fruits and flowers which manure or directly feed organisms in and on the water.
- Leaves, bark, limbs, and detritus for decomposers in the water such as diatoms, phreatocids, algae, sponges.
- Hence a feeding base for fish and low-trophic feeders or browsers such as shrimp, mullet, and molluscs.
- Insects attracted to blossoms, or falling as larval and pupal forms into the pond.
- pH modification from mulch and leaves, buffering of extreme pH levels.
- Materials to control mosquito larvae and snails, to stupify fish, to make traps and screens, and for conduits and pipes.
- Prevention of bank erosion by mat roots and leaf buffering of wave and flow energy.
- Wind, shelter, shade, and hence evaporation and temperature modification.
- Beautiful reflections.... what more could one ask?

Marginal plants live in a milieu of fairly constant moisture and buffered temperature changes, hence tend to be reliable producers of fruit, nectar, and flowers, tubers and foliage. Many are either very resistant, or very susceptible, to water rot and attack from aquatic organisms, hence making excellent wharf and boat timbers, or rotted mulch in water. Others contain air cells which make them light and buoyant, or conversely are very dense and sink like stones (*lignum vitae*), so that marginal or aquatic timbers have unique values in specific usages.

In crop, those honey-producers of ditches and ponds are very reliable in yield, while tubers are consist-ently produced, and drought is an unknown restraint on yield (**Figure 13.36**).

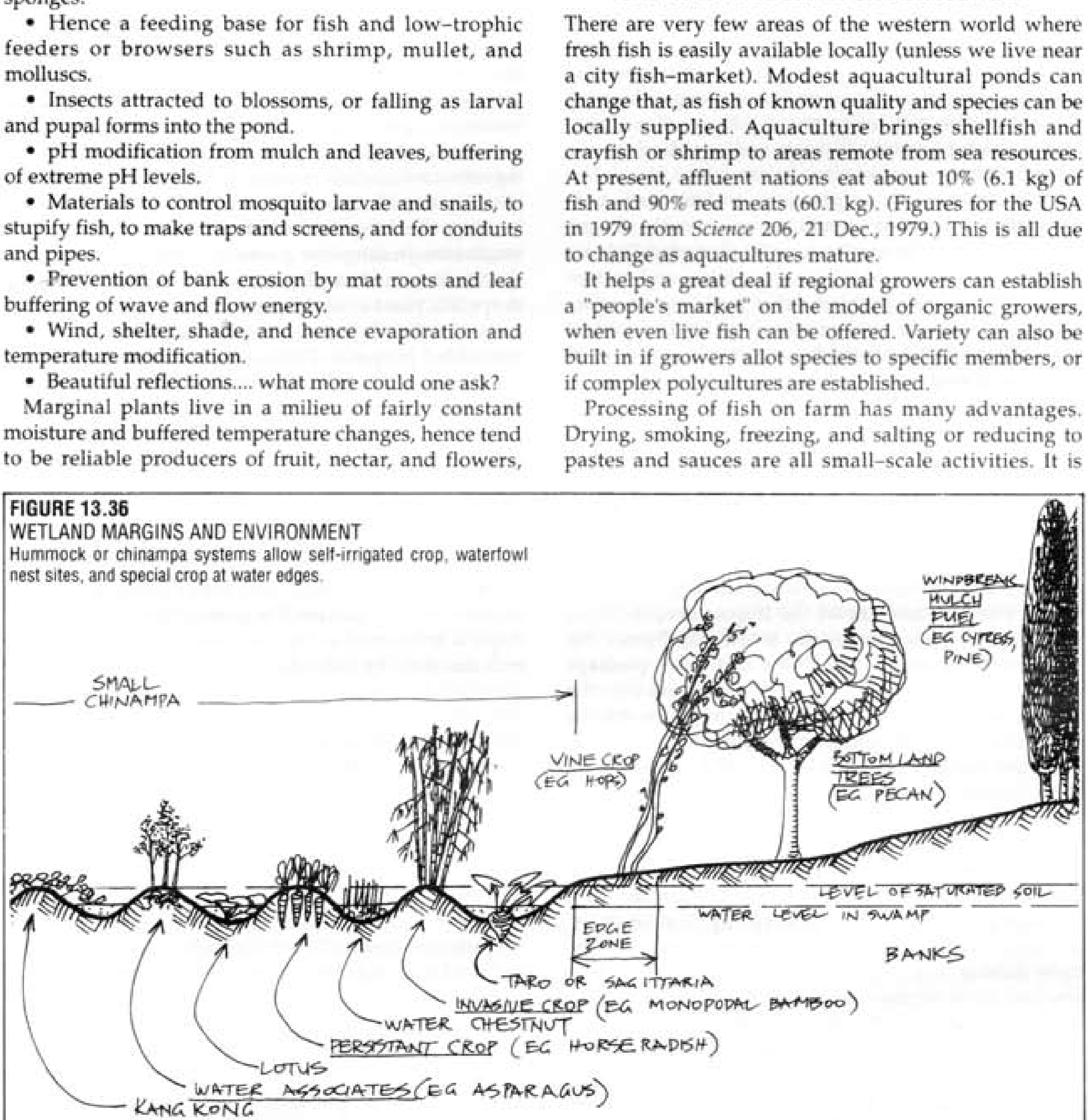
## 13.9 BRINGING IN THE HARVEST

There are very few areas of the western world where fresh fish is easily available locally (unless we live near a city fish-market). Modest aquacultural ponds can change that, as fish of known quality and species can be locally supplied. Aquaculture brings shellfish and crayfish or shrimp to areas remote from sea resources. At present, affluent nations eat about 10% (6.1 kg) of fish and 90% red meats (60.1 kg). (Figures for the USA in 1979 from *Science* 206, 21 Dec., 1979.) This is all due to change as aquacultures mature.

It helps a great deal if regional growers can establish a "people's market" on the model of organic growers, when even live fish can be offered. Variety can also be built in if growers allot species to specific members, or if complex polycultures are established.

Processing of fish on farm has many advantages. Drying, smoking, freezing, and salting or reducing to pastes and sauces are all small-scale activities. It is

**FIGURE 13.36**
WETLAND MARGINS AND ENVIRONMENT
Hummock or chinampa systems allow self-irrigated crop, waterfowl nest sites, and special crop at water edges.



critical to protein production in the tropics that rapid processing of fish is achieved in view of the potential for spoilage. More everyday manufacture of clear plastic drying tents or boxes is needed rather than emphasis on increasing fishing efficiency or production, as up to 40% of a catch can be lost to spoilage and damage by rodents and birds.

Ferment of fish wastes (as practiced in Indonesia) produces a protein-rich, salt-stabilised liquid sauce of great value to people on rice diets, and such techniques are an essential part of salvaging fish wastes for market dispersal. Processing also increases on-farm economics and rural employment potential.

For non-carnivorous species, catch-and-restock systems can greatly increase yields over batch or total removal of the species. Many permanent ponds are run on this basis, or that of natural breeding in the case of crayfish (when a *maximum* size limit is used to return large, fast-growing breeders to the pond or breeding area). It is always wise to consider returning or keeping the largest fish, and eating the slightly smaller grades (unfortunately not a strategy well-applied in sea fisheries).

Although a great emphasis is put on fish, true aquacultural planning should always include diverse plant products, with emphasis on local staples. Fish are then accessory to a broad product base, and to tree crops. The disease problems that build up in aquacultures are due to over-emphasis on one species or class of food and high yields, and also to a neglect of shade, wild foods, and the beneficial effects of plants on water quality.

## 13.10
## TRADITIONAL AND NEW WATER POLYCULTURES

The very antiquity of some terrace and riverside cultures demonstrates their sustainability in human terms. The wet terraces of the Ifugao people of the Philippines have been in use for at least 3,000 years; the flood cultures of the Nile (now sadly but perhaps temporarily ended) is probably 17,000 years old; the chinampa system of Mexico is also antique, as are the flood-plain, lakeside, and river cultures of Asia.

Harold Conklin in "Ethnographic Cities of Ifugao", *Scientific American (Review)* February 1982, calculates that 1000 years of toil created these terrace cultures. He makes a commentary on water cultures that Fox (1977) makes on the Indonesian palm cultures—that these peoples recognise no external authority. Not only is it an inappropriate and interfering concept in self-sustained systems, but the creators of such systems have learned a self- governance never developed by any central authority in history. The construction of common canal systems and shared irrigation necessitates community organisation and self-control. Hydraulic despotism, as found in colonised areas, predisposes societies to exploitation and centralised government. Water is, in all sane or democratic societies, regarded as a *public* resource.

Growing 0.5 hectares of padi rice, and 0.25 ha of sweet potato as staples, with 1 ha of woodlot and grove crop, domestic pigs and chickens fed from gleanings and crop, the Ifugao family of 5 spend 400 person days of productive labour per year, or 80 days per able individual. Rainfall is an incredible 3 to 6 m/year, necessitating constant terrace maintenance. The terraces have 2 cm of soil, and half the mass of the bunds is in stone. Canal and ditch maintenance necessitate annual earth and stone repairs; the equivalent value or objective cost is one day of rice for one hour of work.

There are a good many useful plant species of the marine and aquatic environment; only some 20-30 species of water plants are in constant culture or have been subject to varietal selection. Many species are still wild-gathered or (if cultured) are derived from unselected wild stock. Yet there is an obvious potential for wetland forestry, craft product, and specialised forage crop assembles for species such as bees, ducks or waterfowl, and fish. Pigs utilise seasonal swamps and water margins for a variety of fodders. Cattle enter lagoons and shallow waters to browse, while species like the Soay sheep, turtles, and the Galapagos iguana browse the large seaweeds of the seashore, and seagrasses. In samphire pastures geese, swan, and fish species browse at varying tide levels. Anyone interested in specific plant assemblies can evolve a fairly complex array of forbs, shrubs, vines, and trees to suit specific or specialised purposes. There is an obvious role for seed, vegetative, and general aquatic nurseries and suppliers, which are undeveloped in most countries.

Rather than enumerate all the cultured species, I have chosen to deal with a few selected polycultures of plants, to briefly treat the marginal plantings, and to suggest plant assemblies for specific sites. I will describe both a cold area and subtropic plant system to illustrate the aquatic potential, selecting wild rice (*Zizania*) for cool areas, and taro (*Colocasia*) for the tropics. Rice (*Oryza*) itself is grown from temperate to tropical areas, and is not dealt with here, but is very well described by Fukuoka[3,4].

### WILD RICE CULTURE

(*Zizania lacustris*) Minnesota, very cold winters and hot summers.

Wild rice is a tall annual grass (to 2.5 m) with several perennial species in the same genus; it has been gathered as a grain for centuries by Amerindian tribes of Canada and the United States, from Minnesota to Florida.

Species or seed collected for culture trials should be gathered from selected plants at the climatic and water provenance suited to the culture site. Some few crops have been grown in the Southern hemisphere, but for the most part the 3 million kg produced are grown in the Minnesotan region. Of the total production, about 50% is still wild-gathered in traditional fashion by Amerindians, who beat out the grains into a canoe, and the remainder in extensive fields of up to 100 ha created by modern growers, with all the inefficiences that moncultures entail.

Wild rice has been brought into culture within the last 30 years, and selection is now taking place. It is therefore one of the most recent grains to be developed, but one peculiarly suited to cold swamps and shallows with intense summer heat. The original culture was for duck flyway (wildlife) seed, and wild ducks harvest perhaps 70% of the total production, as the seed ripens slowly over 3–4 weeks. Mechanical harvest gathers only that seed which is ripe at harvest. Thus, while commercial yields are low (only 50–100 kg/ha), prices are high (at $10 kg in 1984), so that fields of 100 hectares or so give a cash return of up to $100,000 annually in rice alone.

Wildfowl, in dabbling the fallen seed in fields, help thin out seed which will germinate after a winter stratification; the plants crowd if not so thinned. Ideal spacing is 20 x 35 cm, and for small plots, with selected heads, yield can be 200–500 g/head. Obviously, the problem with yield is not in the plant, but in the need to harvest at one time, mechanically. Home plots, gathered over 3–4 weeks, are in fact very productive, and only 200–800 plants should supply a family if well cared for. A strategy used by Indians to save the grain from predation and shattering is to bundle and tie 10–20 heads together, and to untie them periodically for threshing into canoes.

Seed is saved from selected plants and held over winter in bags under water in the icy lakes, or in water in refrigerators at 40°F. It is sown in spring in fields flooded to about 16–20 cm deep, and harvested from mid-autumn. The fields are dried out for 2–3 weeks before machine harvesting, and must be rested or sown to another crop to clean the ground if a new cultivar is to be introduced, as self-seeding otherwise perpetuates the first-sown variety.

In the large fields and deep margin ditches of Minnesota, a self-generated polyculture of crayfish (*Homarus*), mink, beaver, and thousands of waterfowl has evolved with the wild rice culture. Coyote also range the bunds, and packrats store much of the seed. The crayfish live in ditches and browse 5–10 m into the crop, causing some damage, but as they are themselves a potential crop, or a food for mink, this is tolerated. Duck potato (*Sagittaria*) can become a weed of the system, but this is also a waterfowl food and prefers somewhat deeper water than the rice plant, or can be removed by culture or hand weeding if necessary. There is an obvious potential for coldwater fish-rearing in the canals and ditches of the system (species such as trout and bullheads), not as yet developed. Manuring by *Azolla* is not practiced, and the fields are rested dry in winter.

An intriguing potential is the propensity of the packrats to carry and store large quantities of sound, cleaned grain into artificial shelters (like engine manifolds), insulated and plugged by *Typha* (cumbungi, cattail) seed silk. Narrow fields and a set of such artifical storage sites may well be the best way to harvest, and breeding packrats could be supplied with alternative food for the winter, or allowed to keep 15% of their stores full. They may well be the most efficient, as well as the cleanest, harvesters for the crop, and can scarcely do worse than the 50–100 kg (or less than 10%) gathered by machines costing $300,000 or more! Bill Mackently (pers. comm.) uses grey squirrels to collect hickory nuts and acorns in this way, and provides them with buried pipes to store the nuts. He leaves them about 15% of the harvest.

Duck fattening, crayfish harvest, mussel meats, fish production, and vine crop of hops or silverberries (*Actinidia arguta*) are obvious supplementary products to the crop, and could be viable accessory systems, together with restricted fur production, some special forestry, and recreational fishing or tour potential. I have attempted to portray some of this complexity in **Figure 13.37**, and acknowledge my debt to the pioneer growers Hubert and Leonard Jacobson of Aitken, Minnesota, who kindly supplied me with data (and some wild rice to eat). A small terrace or pond of wild rice should be the aim of every home gardener who can obtain seed and who enjoys a nutritious grain, as most Americans do. For wildlife (especially waterfowl) refuges, there is no better autumn fodder.

## TARO CULTURE

(*Colocasia esculenta*) Hawaii, subtropics to tropics, and cooler frost-free areas.

I admit to a weak spot for taro fields and terraces, especially those of the traditional Hawaiian culture. Taro is an herbaceous perennial to 1 m high with large arrow-like leaves and a swollen stem base or tuber which can reach 10 kg, but is normally marketed at 1 kg or so, after an 8–15 month growing period (there is no "off season" in the subtropics).

There were some 1,100 Hawaiian varieties, and perhaps 100 or so are still preserved. It is a staple food in Hawaii and some other parts of Polynesia and southeast Asia, where rice or breadfruit are also staples. Grown as a monoculture plant for centuries, the recent accidental or deliberate introduction of *Azolla*, *Tilapia*, fish, crayfish, and Chinese edible coiled gastropod snails have diversified the wet terrace cultures, although the Hawaiians traditionally rear local fish and prawn species in the ponds.

Taro is propagated by small side tubers or more commonly by a cutting based on a crown disc of about 1 cm thick, and the lower 18 cm of stalk from the old tuber at harvest. Cuttings have the leaves removed by a slant cut just above the first leaf node.

There are special varieties for boiling, baking, ferment to *poi*, or cooking as green leaf spinach (*luau* taro). All taro must be cooked due to the stinging crystals of oxalic acid in the leaves (which can grossly irritate the bare back of non-Hawaiians like myself, incautiously carrying bags of tubers in this way).

There has always been a fish culture tradition with taro, of local prawns, shellfish, and freshwater fish. *Tilapia* and introduced prawns have merely extended the potential, as have crayfish (Homarus *spp)*. What is missing is a good variety of edible freshwater mussels to fix phosphates in the terrace mud. In older times, nutrient supply was of forest leaves (chiefly *Aleurites* or *Hibiscus*). The stems of kukui trees (Aleurites ) were stood to rot in the upper terraces where they produced a local edible ear fungus. About 80% of the bulk of a log was in this way converted to fungus, and the remainder broken up as water mulch. Very extensive canal and wet terrace systems were developed for taro culture, and the fermented *poi* used as a staple, as were boiled or baked taro.

Accessory margin crops are ti (Cordyline)—the Polynesian "wax paper" and wrapper for baked foods—papaya, banana, coconut, and sugar cane. No vine crop was grown, but as taro appreciates partial shade, there is a potential for marginal or wide- spaced overhead kiwifruit, passionfruit, pole bean, or cucurbit crop. Bunds planted to *Dolichos hosei* or *Phyla nodosa* (was *Lippia nodosa*) would be useful nitrogenous mulch sources, and would remain short and trimmed at the water level by *Tilapia* or grass carp (which are also on Hawaii).

As pigs and latterly ducks are also traditional livestock, construction of their pens over feeder canals or the upper terraces would add substantially to nutrient supply, although the ducks need confinement to a few ponds as they too appreciate the edible Chinese snails (which are a high-priced local delicacy).

Taro is also grown on dryland areas under irrigation, and responds very well to thick mulch and green crop. In these situations intercrop of *Brassica*, melons, ginger, or lettuce is viable. Beds are normally 1.3 m wide at 30 beds/ha, with taro spaced at 40 x 60 cm in diamond pattern. There are 55,500 bulbs/ha, averaging 1 kg or a little more for each bulb, or a yield of 55 t/ha. Drip irrigation is also used on land crop, at 120 lines/ ha (4 per bed). Spacing in wet terrace is similar, but the "intercrop" there is more profitably prawns, although kangkong and watercress are spot-planted in many taro terraces for greens, and both are planted as low mound crop in special shallow terrace or canal systems with faster flow than is found in taro systems.

In other climates, or mild coasts of the Atlantic and western Pacific (New Zealand), eel rearing would combine very well with taro culture. Taro is set out in wet mud or shallow water, but at maturity can be kept flooded at mid-thigh, or with 0.5 m of free water above the softer muds of the terrace, where prawns and grass carp (which co-exist very well) can be stocked.

It is obvious from the above information, much of which I owe to the hospitality of friends like Chuck and Tina Busby, Imu and Rachel Naki on Moloka'i, and Richard Waller on Hawaii itself (dry taro culture), that taro is a very productive and flexible plant for a basic starchy food, and that a rich polyculture can be developed in the taro which is itself well protected from browsers by its oxalic acid spicules.

Every tropical garden deserves a patch or so of taro; it is often grown as a mulched patch or groundcover below fruit trees in higher rainfall areas, or as a subsidiary crop in banana, guava, avocado, and macadamia nut orchards. There is no more pleasant environment than a rich taro, comfrey, papaya, guava, and banana polyculture, with chilis, ginger, peppers, ducks, pigs, and fish, a visit to the sea for *limu* (seaweed) and crab, and a good earth oven *(imu)* to cook in.

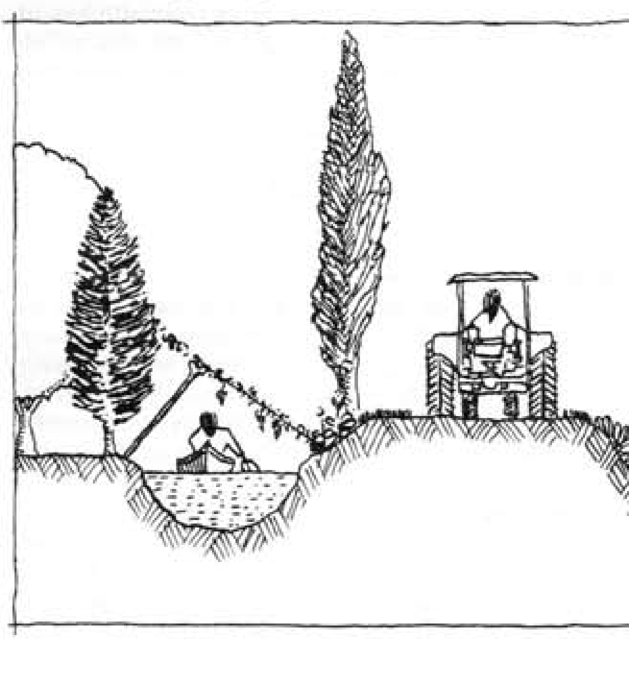
The foregoing detailed accounts of the traditional and possible aquaculture systems may give designers and farmers some different ideas for productive local land-water integrations.

## 13.11
## AQUACULTURE: DESIGNERS' CHECKLIST

Due to the special susceptibility of water life, minimal to zero biocide use is essential near or in waterways.

With fish:

- Stock rates below, at, and above suspected optimum (plus or minus 2,000/ha).
- Fertilise pond and bring pH to 7+.
- Select diseasefree stock.
- Exclude or guard against predators.
- Maximise edge and natural foods.
- Introduce predator fish at about 1:5 ratio.
- Select fish for no pond aeration, or to suit the aeration method proposed.
- Select fish for good local value, but assess food costs for each species.
- Provide shelter from predators and excess light and heat.
- Select fast-growing brood stock for the particular



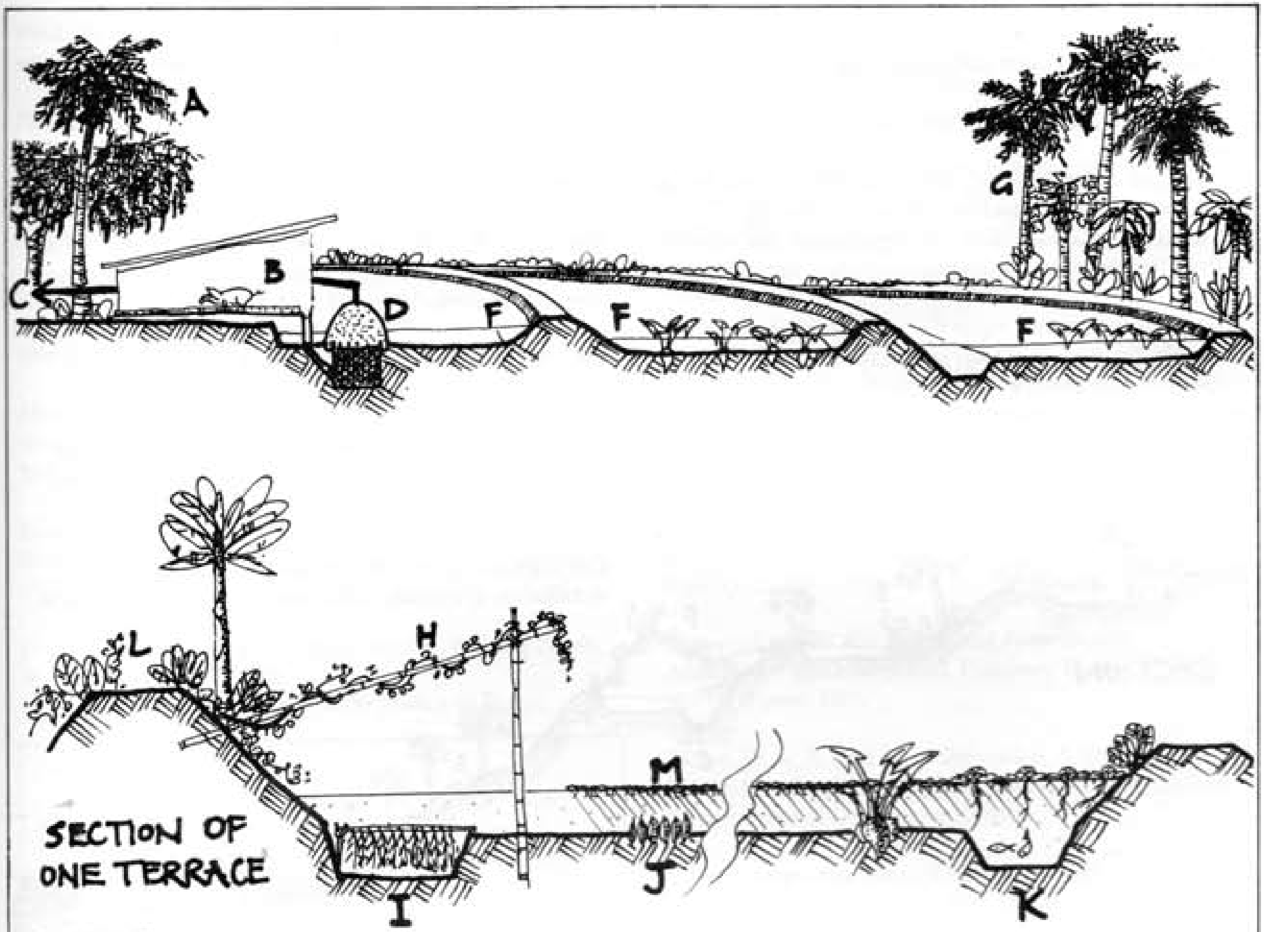
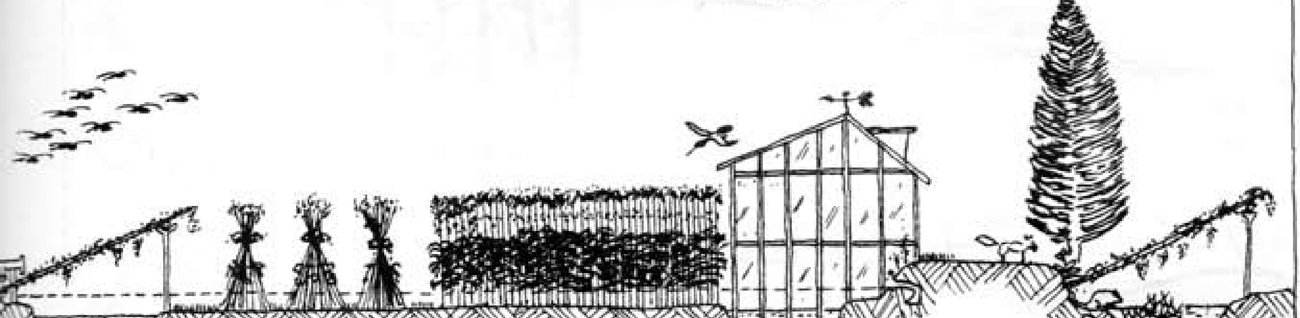



**FIGURE 13.38**
TARO TERRACES.
Nutrient as an in–pond gas digester (**D**) is released to all ponds (**F–F**) in series; pigs (**B**) bring nutrient from land forages (**A**), which are also used to clean up discharge water (**G**). Useful bund crop (**G**), trellis over ponds (**H**), screened deeps for prawns (**I**) or fish (**K**), azolla as mulch (**M**), mussels as phosphate (**J**) all add to yields of traditional taro terraces, or rice culture.

**FIGURE 13.37**
WILD RICE CULTURE.
Associated mink, beaver, crayfish, mussels, pack rats, trellis, greenhouse adds to yields; tying of heads prevents seed loss from shattering. [Jörg Schultz].



site, from fry to adults.

- Devise a fish/plant polyculture for the ponds.

Analyse landscape for natural or cultivated food resources.

Vary pond depth, pond size, and pH to suit a set of food species and productive fish for the district.

Carefully analyse pond configurations for specific polycultures, easy management, site, and weather effects.

Pay attention to aquatic and marginal crops, downstream crop, and total landscape balance.

Devise accessory food systems for fish or invertebrates, as vegetation, root crop, invertebrates.

In any design, include some appropriate (small or large) wetlands, even if it is from waste water.

## 13.12

## REFERENCES


Augusthy, K. T., *Fish Farming in Nepal*, Institute of Agriculture and Science, Tribhuvan University, Nepal, 1979.

Bardach, J. E., J. H. Ryther and W. O. McLarney, *Aquaculture: the farming and husbandry of freshwater and marine organisms*, Wiley, N.Y. (A basic text.)

Bryant, P., K. Jauncey, and T. Atack, *Backyard Fish Farming*, Prism Press, Dorset, U.K., 1980.

Chakroff, Marilyn, 1982, *Freshwater Fish Pond Culture and Management*, Peace Corps/VITA Publications No. 36E, 1982.

Darlington, P. J. Jr., *Zoogeography: the geographical distribution of animals*, John Wiley & Sons, Inc. London,

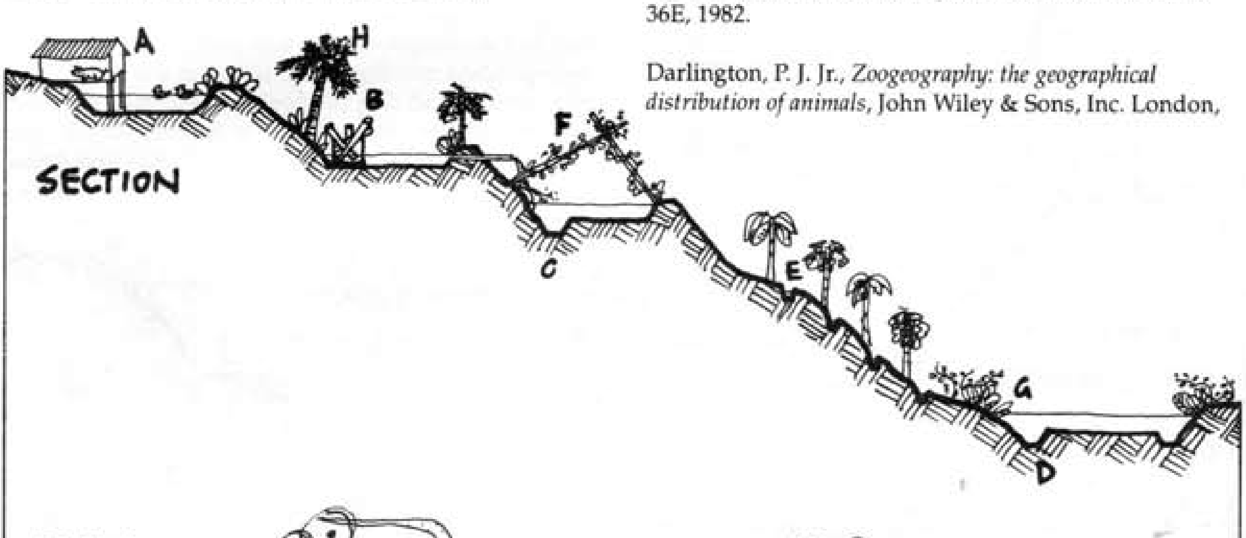




**FIGURE 13.39**
MODIFICATIONS TO TARO FIELDS.
Water is diverted from stream, fertilised, used in crop, and returned to stream free of pollutants.
**A**. Animal house; **B**. logs rotting to produce edible fungi (*Aleurites*); **C**. deep channel for shrimp, fish; **D**. fish–taro padi with peripheral channel; **E**. series of irrigation channels in papaya crop, bananas; **F**. cucurbits, beans on trellis; **G**. margin crops e.g. comfrey, taro, Tradescantia for fish food; and **H**. coconut on margins.

1963. (Some good discussions of species groups; for a wider reference.)

FAO Fisheries Technical Paper No. 130, *A Catalogue of Cultivated Aquatic Organisms*,1974.

Hawaii State Center for Science Policy and Technology Assessment, *Aquaculture Development for Hawaii (1978)*.

Hills, C. and H. Nakamura, *Food from Sunlight* , University of the Trees Press, California. (Algal culture and aquaculture.)

Huet, Marcel, *Textbook of Fish Culture*, Fishing News Books Ltd. Surrey, U.K., 1975. (Excellent text on breeding and rearing of fish and coldwater species.)

Huke, R. E. and R. W. Sherwin, *A Fish and Vegetable Grower for All Seasons*, Norwich Publications, Vermont, 1977.

Iversen, E. S., *Farming the Edge of the Sea*, Fishing News Books, Surrey, U.K., 1968.

Machado, A. E. de Mafra, *Criacao Pratica de Peixes*, Livraria S/A, Sao Paulo, Brazil, 1980.

Maclean, J. L., 1975, *The Potential of Aquaculture in Australia*, Aust. Govt. Publishing, Canberra, ACT, 1975.

Palmer, E. L. and H. S. Fowler, *Fieldbook of Natural History*, McGraw-Hill, N.Y., 1975. (A useful compendium of species and families.)

Pullin, S. V. and Ziad H. Shehadeh, *Integrated Aquaculture and Aquaculture Farming Systems*, International Centre for Living Aquatic Resources Management (ICLARM), 1982, PO Box 1501, Metro Manila, The Philippines.

Swingle, H. S., *Biological Means of Increasing Productivity in Ponds*,1966. F.A.O. Symposium on warm-water pond fish culture 40-181, Rome, 18-25 May 1966. (A key reference on yield strategies in fertilised and supplemented food ponds.)

Tapiaor, D. D. *et. alia*, *Freshwater Fisheries and Aquaculture in China*, F.A.O. Fisheries Technical Paper No. 68, Rome, 1976.

Toews, D. A. A. and M. J. Brownlee, *A Handbook for Fish Habitat Protection on Forest Lands in British Columbia*, Government of Canada (undated).

United States Academy of Sciences, *Making Aquatic Weeds Useful*, Washington, D.C., 1976.

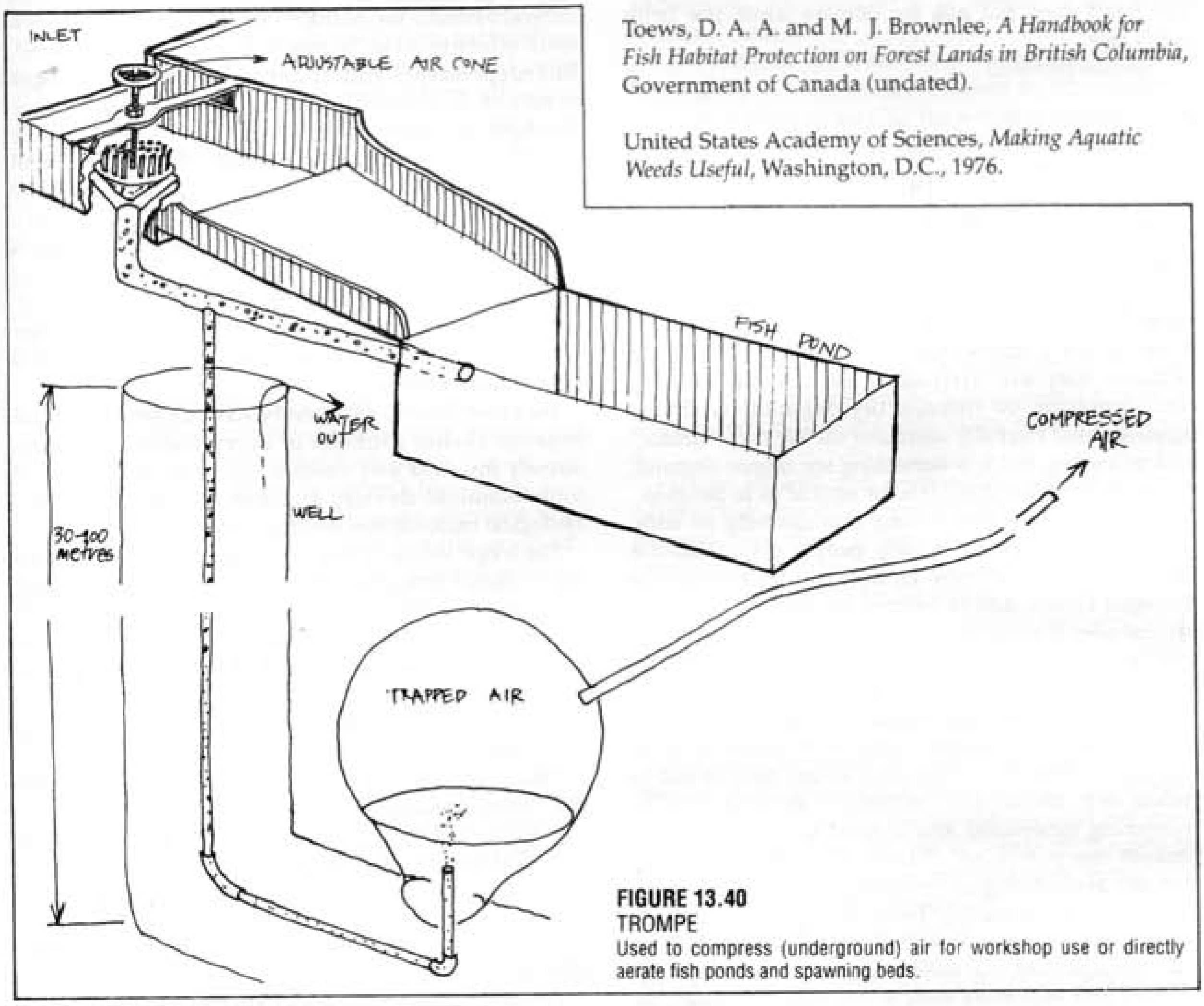
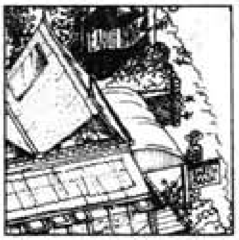



**FIGURE 13.40**
TROMPE
Used to compress (underground) air for workshop use or directly aerate fish ponds and spawning beds.



# Chapter 14

# STRATEGIES FOR AN ALTERNATIVE NATION

He who desires but acts not, breeds pestilence.
(William Blake, *Proverbs of Hell*)

The head does not ask for flowers while the belly lacks rice.
(Indian proverb)

## 14.1 INTRODUCTION

The pragmatic and practical approach to the main body of this work largely omits reference to those visions or beliefs classifiable as spiritual or mystical; not because these are not a normal part of human experience, but because they are arrived at as a result of long contemplation or intense involvement with the mysteries that eternally surround us. We may "dream" understanding, but it is something we cannot demand, define, or teach to others; it is for each of us to develop.

There are things that nobody else can help us with, but in a book written to help people make real-life decisions, to build new landscapes, to regenerate damaged forests, and to lighten our load on earth, the present need is for *clear and practical* approaches.

In the preceding chapters, well-tried and commonsense techniques and strategies of earth restoration have been described and figured. All of this comes to naught if we, as a people, continue to invest in arms and destruction, to permit land abuse, and to fail to tackle the social and political impediments to reclaiming desertified and abused lands, or even to prevent the poisoning of land. Thus, the following sections give strategies for change in the social and economic areas of society. These strategies may, in fact, be of more assistance to real change than the skills of land management, for society has far more competent farmers and engineers than it has ethical bankers or lawyers whose work relates to curing or preventing (not just treating) social and environmental problems.

First we must learn to grow, build, and manage natural systems for human and earth needs, and then teach others to do so. In this way, we can build a global, interdependent, and cooperative body of people involved in ethical land and resource use, whose teaching is founded on research but is also locally available everywhere, and locally demonstrable in many thousands of small enterprises covering the whole range of human endeavours, from primary production to quaternary system management; from domestic nutrition and economy to a global network of small financial systems. Such work is urgent, important, and necessary, and we cannot leave it to the whims of government (always short-term) or industry as we know it today.

We know how to solve every food, clean energy, and sensible shelter problem in every climate; we have already invented and tested every necessary technique and technical device, and have access to all the biological material that we could ever use.

The tragic reality is that very few sustainable systems are designed or applied by those who hold power, and the reason for this is obvious and simple: to let people arrange their own food, energy, and shelter is to lose economic and political control over them. We should cease to look to power structures, hierarchical systems, or governments to help us, and devise ways to help ourselves.

Thus, the very first strategies we need are those that put our own house in order, and at the same time do not give credibility to distant power-centred or unethical systems. In our present fiscal or money-run world, the primary responsibility that we need to take charge of is our wealth, which is the product of our sweat and our region, not representable by valueless currency.

There is no need to stress that we are imperfect people, living in an imperfect world; "Do not adjust your vision, reality is at fault" (graffiti), so that many strategies given here are starting points rather than endpoints. However, there is so much damage to ecosystems—hence so much rehabilitative work to do—that we will be employed in good works for a few generations to come. In several generations (if we are allowed this time) we may have achieved a truly free world of international affinities, but we always start where we are.

In this chapter, therefore, I will try to set out the currently successful social strategies that enable a small group or a region to define problems and to solve them locally.

## 14.2
## ETHICAL BASIS OF AN ALTERNATIVE NATION

A people without an agreed-upon common basis to their actions is neither a community nor a nation. A people with a common ethic is a nation wherever they live. Thus, the place of habitation is secondary to a shared belief in the establishment of an harmonious world community. Just as we can select a global range of plants for a garden, we can select from all extant ethics and beliefs those elements that we see to be sustainable, useful, and beneficial to life and to our community. It would appear that:

- Sustainable societies emphasise the *duties and responsibilities of people to nature* equal to those of people to people; that any code relates equally to other lifeforms and elements of landscape. To conduct oneself only in terms of response to other people gives a potential to evade responsibility for damage inflicted on the total resource base, and thus ultimately to others.

Beneficial behaviour involves managing natural systems for their own, and our, long-term benefit, not for our immediate and exploitative personal gain. The American Indians (Irequois nation) frame this as a "seventh generation" concept: that our decisions *now* are carried out in terms of their benefit or disadvantage to our descendants in seven generations' time (about 100 years ahead). This helps explain why we always found tribally managed lands to be rich in natural life resources, and why we have managed to ruin much of the resources we inherited.

- As people, we need to adopt an ethic of *right livelihood*, for if we bend our labour and skills to work that is destructive, we are the destroyers. We lay waste to our lives in proportion to the way in which the systems we support lay waste to the environment. Although societies for *social* responsibility are rapidly forming, we need to expand the concept to *social and environmental* responsibility, and to create our own financial and employment strategies in those areas. We should not be passive workers for established destructive systems, but rather we can be investors in life. We cannot profess or teach one ethic, and live another, without damage to ourselves and to common resources.

- We must always study and learn as part of a *total integrated system framework*, conscious of how our knowledge and actions permeate all systems. It is in the fragmenting of knowledge into unrelated disciplines that we can plead ignorance of effects; but we are always responsible for the distant effects of our actions, and in fact should work for foreseen benefits.

- We need to develop *conserver socirties*, with this conservation achieved by close attention to recycling, the avoidance of waste, and to very durable technologies so that their use is prolonged. Similarly, it is unwise to abandon satisfactory older forms of technology even if we install improved forms and processes; just because we develop a new windmill for electricity, we should not allow a dependable older grain mill to sink into disrepair. Because we can use a forage harvester, it doesn't mean we should lose the skill to use a scythe on steep slopes.

Part of being conservative is to concentrate on *developing a mosaic of small, well-managed, and effective systems*. Such modest systems are unlikely to cause widespread upheavals or to be subject to external or unethical control.

- Meaning in life is lost by striving after status and future glory; it is gained and realised by *action* towards a common ideal, in serving the whole according to our physical, mental, educational, and revelationary (understanding) capacities. It is never enough to mean well ("fair words plant no cabbages"),rather, it is necessary to ensure that *it gets done*.

- Security can be found in the renunciation of ownership over people, money, and real assets; insecurity and unhappiness arises as a result of trying to gain, keep or protect that which others need for periods of legitimate access. A lending library enables people to help themselves to information; a locked-up book collection is useful only to the person who owns it.

- If an ethical and responsible community can establish a durable, dependable, and waste-free resource base, then leisure time (time to express our *individual* capacities) becomes a plentiful resource. We will have gained time for life. While leisure is inevitably available for enrichment of cultural life, and to an extent for recreation, emphasis on spectator recreation is just another way to waste the time gained; we then see the professionalisation of arts, sciences, sport, and even education as spectators replace actors.

We should therefore resolve to gain time to evolve ever more effective ways to assist systems or people. It is only when others feel secure that we need not guard our environments, so that the very best preparation for security is to teach others the strategies, ethics, and practices of resource management, and to extend aid and education wherever possible.

I do not, in my lifetime, or that of my children's children, foresee a world where there are no eroded soils, stripped forests, famine, or poverty, but I do see a way in which we can spend our lives towards earth repair. If and when the whole world is secure, we have won a right to explore space, and the oceans. Until we have demonstrated that we can establish a productive and secure earth society, we do not belong anywhere else, nor (I suspect) would we be welcome elsewhere.

## 14.3
## A NEW UNITED NATIONS

The "United Nations" today is neither united nor represents nations; it is like the oft-quoted "moral majority", which is also neither of those things! Many true nations, such as the Iroquois confederation or any tribal alliance with a common ethic, are not represented by such a body, nor are whole nations such as the Basques, Tartars, Kurds, Palestinians, Hawaiians, Hopi, Tibetans, Pitjatjantjara, Misquito, Aranda, Basarwa, Herrero etc etc etc.

Most nations in the United Nations *repress a majority of peoples on earth*. Talking with Thomas Banyaca, a Hopi messenger of his people, it became clear to me that we need a new concept of "nation", and a new representative body to speak for them. We start by defining a nation as *a people subscribing to a common ethic*, and aspiring to a similar culture. Such nations may not have a common land base, or language, but do have a common ethic, minimally;

- To care for the earth; to repair and conserve;
- To seek peace, and to guard human rights everywhere; and
- To invest all capital, intelligence, goodwill, and labour to these ends.

At present, many thousands of organisations, affinities, tribes, bioregions, and spiritual and non-government organisations aspire to such beneficial ends; in every continent, a majority of people—*the ethical majority*—want peace; a clean and forested earth; a cessation to torture, malnutrition, and oppression; and a right to work towards these ends.

It would take very little additional organisation for these groups to meet together, count their numbers, and recognise each other's rights. There are, for instance, far less paid-up or active members of political parties or oppressive societies now than there are organic gardeners whose life works seek peace and plenty. As groups discuss, and accept, the minimal ethic above, they they can quickly proceed to recognise each other.

Such initiatives have in fact commenced in the Amerindian groups subject to national (i.e. political) oppression in both North and South America. Throughout the world, groups are talking of issuing their own passports, or adopting world citizen status—given a common aim. Perhaps the first move to a new body of *nations united in earth care* are the bioregional and tribal congresses that are occurring today.

Unlike the present United Nations, we do not need a world centre, or paid administrators, but can instead meet as *affinity groups* (e.g. in alternative economic summits, bioregional congresses, tribal conferences, garden and farm design groups) to deal with our specific areas of interest, and to make these affinities global in scope. By avoiding centralised administrations, we avoid power blocs, and by avoiding tax funding, we avoid inefficiency. Fees for a regional secretariat would arise from an annual fee forwarded by participant groups.

Once continental groups and some global groups have allied, these congresses can increasingly bring in less informed or more remote groups to share resources in an humane alliance; after all, global seed exchanges, technology groups, gardening forums, and regional groups already meet and are increasing in cooperation. A concept of a global nation is, in fact, very well developed in such groups, and the idea of war or oppression across race, language, or territory is anthema to those allied in good works. The advantage of such alliances is that even isolated people can find global affinities; this is not necessarily true of regional organisations.

## 14.4
## ALTERNATIVES TO POLITICAL SYSTEMS

Systems of government are currently based on self-interest, economic pragmatism, belief, impractical theory, and power-centred minorities (religious, military, capitalist, communist, familial, or criminal). Almost all such groups set up competitive and "adversary-oriented" systems.

We need to set about, in an orderly, sensible, and cooperative way, a system of replacing power-centred politics and political hierarchies with a far more flexible, practical, and information-centred system responsive to research and feedback, and with long-term goals of stability. And we need to do this in an ethical and non-threatening way, so that the transition to a cooperative (versus conflicting) global society is creative (not destructive).

The world needs a new, non-polarised, and non-contentious politic; one not made possible by those in situations that promote a left-right, black-white, capitalist-communist, believer-infidel thinking. Such systems are, like it or not, promoting antagonism and destroying cooperation and interdependence. Confrontational thinking, operating through political or power systems, has destroyed cultural, intellectual, and material resources that could have been used, in a life-centred ethic, for earth repair.

It is possible to agree with most people, of any race or creed, on the basics of life-centred ethics and commonsense procedures, across all cultural groups; it matters not that one group eats beef, and another regards cows as holy, providing they agree to cooperate in areas which are of concern to them both, and to respect the origins of their differences as a chance of history and evolution, not assessing such differences as due to personal perversity.

It is always possible to use differences creatively, and design to use them, not to eliminate one or other group as infidels. Belief is of itself not so much a difference as a refusal to admit the existence of differences; this easily transposes into the antagonistic attitude of "who is not with me is against me", itself a coercive and illogical attitude and one likely, in the extreme, to classify all others as enemies, when they are merely living according to their own history and needs.

Most human communities function in relation to a long-term sustainability only because they *do* differ from others; what is possible to an Inuit (Eskimo) is not possible to a forest pygmy. Thus, it is not differences in themselves that are important; it is how all groups relate to the basic rules of the local ecology that permit them to function on a long-term basis. Belief, like religion, is a basically private and non-global characteristic, and should not be subject to comparisons. On close examination, we "believe" in those systems that enable us to behave without guilt, with respect to our resources and our own culture.

It has long been apparent that our current political, economic, and landuse systems cannot solve such long-term and worsening problems as soil degradation, ground water pollution, forest decline, the spread of poverty, unemployment, and malnutrition (or its extreme, famine). Despite good scientific prognoses and assessments, effective ground strategies are lacking. The temporary nature of political systems is an impediment to effective action. We could describe all western political systems as those of competing belief elites; whether they are self-described as communist, socialist, capitalist, or democratic, they all function in ways which are essentially short-term.

By their nature, political systems seek to impose a policy control over as wide an area of influence as possible, are power-centred (not life-centred), and are often composed of very few families or (in the case of royalist and feudal societies), one family. Thus, the continuing and long-sustained programmes necessary to reverse forest loss and soil decline are usually sacrificed for the short-term policies of an elite maintaining power. It was said of a recent prime minister of Australia that his national policies all worked to maximise profits from his farm!

"The argument for simplicity is never a political argument...when people practice it in their lives... they don't even need any politics." (*Manas*, 17 Oct 1984). This same statement also refers to the adoption of an ethical basis to action, to the placement of money and resources, and to the determination to act in accordance with one's beliefs. All of these can occur independently of political change, and can be long-term (life-long) personal actions of great effect. That is, people can act independently of political theory (which rarely, if ever, covers the questions of ethics, simplicity, local autonomy, or life-oriented action). Such changes in people come about by education and information, and when enough people change, then political systems (if they are to survive) may follow, or become as irrelevant as they now appear to be in terms of real solutions.

For this reason, the place to start change is first with the individual (oneself), and second in one's region or neighbourhood.

## THE RIGHT NOT TO BE IN DEBT.

Some of the most charming and climatically appropriate houses on earth are built without bank loans, architects, metals, concrete, or contractors. However, in every case they are built in areas where trade unions, building surveyors, health officials, and local or state governments do not impede the home builder or the community providing shelter for themselves. While Chile (as an economic system guided by "experts") accumulated a $12 billion foreign debt in 1985, poor people, acting without loans, together built at least $11 billion housing in slum areas by local cooperation without incurring any foreign debt. Why is this the case?

Stone, mud, bamboo, round timbers, rope, thatch, and even baked brick and tiles, are the age-old durable building materials of mankind. All can be locally produced if energy from community forests and people is provided. Even cement and mortar can be made if needed using kilns fired by wood, as can pottery, bricks, and roof tiles. None of this needs money if people work together.

The real cause of a lack of shelter (as with food) in any country is not that of finance, but of restrictive practices by a regulatory bureaucracy. Moreover, state or private ownership (versus *community* ownership) of forests, small mines, and lands is devoted to state or corporate profits to support a largely urban, leisured class of bureaucrats, which denies these basic biological and earth resources to the very people who work to produce or mine them.

We have had "national service" to fight wars, but I cannot recall any but sustainable tribal societies that require every man and every woman to help shelter and feed themselves. Curiously, we are drafted to kill strangers, and denied the right to preserve life; no armies are created to build houses, grow potatoes, or plant forests for the future; unemployment for others is preferred by those who choose power as a method of exploitation.

In very recent societies, our basic "right" is to vote, form unions, protest, or go to law (i.e. to support professional classes). Truly basic rights to grow or protect forests, to build a shelter, grow food, or provide water from our roof areas are commonly denied by local or state regulations. Effective local group action restores the true basic rights, which are those of personal responsibility for our sustenance on earth, and to earth itself. While "natural law" demands a fair return for every gift received, the laws of power demand gifts without thought of return—this is called "economic growth" and means unlimited resource exploitation and the concomitant exploitation of people.

The wealth of any area lies not in banks or cities, but in those basic resources, skills, and natural systems developed by its peoples.

POLITICAL AFFILIATIONS.

There are two ways to ensure the political changes which will bring ecological changes. The first is to mobilise ground support in every electorate where a candidate of any party takes a stand on good ecology, or against nuclear and polluting industry; and the second is to form a local Ecological or Green Party, or a bioregional group.

This would be an easier task if all intentional groups affiliated, and subscribed to a common policy; it is difficult for a small group to evolve a total policy in isolation, and a common policy statement sums up the skills of all groups. Common policy always leaves room for local issues, but gives strong *principles* for guidance in those issues. As well as a guiding ethic, the broad aims of such a party are (as stated in *Planet Drum*, P.O. Box 31251, San Francisco, CA 94131, USA): ecological, socially egalitarian, grassroots democratic, and non-growth. In Germany and other European countries, the Green Party has increasing support and representation, with 23 federal and 48 state seats by 1983. The Green Party's address is Die Grunen, Bundestag, Bonn, West Germany. In the USA, International Green Party, 113 29th St., Newport Beach, California 92663.

EVOLVING A NEW POLICY BASE.

A common global policy can start with a *general ethic* as stated in the beginning of this book; it can then proceed to specific policies, for specific cultures, regions, and landscapes. To structure such policies, we must search out working solutions (e.g. we know that Singapore has solved most housing funding problems, that some towns are energy and food self-reliant, and that many problems have already been solved in other areas or at other times). Thus, the structure under which we should gather common policy is:

- Define what is seen to be the problem or concern; give weight to priorities on a scale from 1–10.
- State *intent* of policy for your region; what it is intended to do (the principles of this policy).
- Collect strategies that have been proven to work; this really means a set of case histories.
- Frame a set of policies based on all successful strategies.

Overall, set policy priorities in rough order, weighted for urgency, public cost or loss of wealth, general or global spread of the problem, long-term effect, and threats to basic resources or life systems. Do not, in the first place, try to frame policy on purely local or trivial matters, unless as a case history applicable to a broad principle.

## 14.5
## BIOREGIONAL ORGANISATION

A bioregional association is an association of the residents of a natural and identifiable region. This region is sometimes defined by a watershed, sometimes by remnant or existing tribal or language boundaries, at times by town boundaries, suburban streets, or districts, and at times by some combination of the above factors. Many people identify with their local region or neighbourhood and know its boundaries.

There is an obvious conflict between the need to live in a region in a responsible way (bioregional centrality) and the need to integrate with other people in other places (global outreach). We need not only to "think globally and act locally", but to "act and think globally and locally".

The region is our home address, the place where we develop our culture, and take part in bioregional networks. Through global associations and "families of common interest" we cross not only the regional but also state and national borders to set up multicultural alliances.

Just as bioregions need a federal congress periodically, so do they occasionally need global congresses; societies or families also need global meetings to break down the idea of defended regional boundaries to humanity. Ethics and principles of self-governance, interdependence, and voluntary simplicity or restriction of human numbers on earth still apply at regional and outreach levels. Intermarriage, visits, mutual trade and aid, skills exchange, and educational exchange between regions of very different cultures enriches both. This is the antithesis of "integration" (bureaucratic genocide) that is promulgated by majority groups who disallow language use and cultural life to minorities. In particular, reciprocal education values *both* sets of knowledge and world concepts, and respects others' lifestyles.

Tribal maps often defined bioregions very well; totems and "skins" (clan groups) of tribes might take, as their totemic mothers, a particular tree or animal, which itself was limited in distribution by the sum of topographic and climatic factors. Other groups occupied ecologies of grasslands, stony deserts, swamps, or mountain ridges. Today, minority language groups (Saamen, Basque, Pitjatjantjara) claim territories that are ancient, and specific to their life mode. Obviously, cities break up into different, often occupational or income, districts, each with its own dialect and ecology, consumption spectrum, and morality. The acid test of a bioregion is that it is recognised as such by its inhabitants.

Ideally, the region so defined can be limited to that occupied by from 7000 to 40,000 people. Of these, perhaps only a hundred will be initially interested in any regional association, and even less will be active in it. The work of the bioregional group is to assess the natural, technical, service, and financial resources of the region, and to identify areas where leakage of resources (water, soil, money, talent) leave the region. This quickly points the way to local self-reliance strategies.

People can be called on to write accounts of their specialities, as they apply to the region, and regional news sheets publish results as they come in. Once areas of action have been defined, regional groups can be formed into associations dealing with specific areas, e.g.:

- Food: Consumer-producer associations and gardening or soil societies
- Shelter: Owner-builder associations
- Energy: Appropriate technology associations
- Finance: An "earthbank" association

And so on...for crafts, music, markets, livestock, and nature study or any other interest. The job of the bioregional office is complex, and it needs 4-6 people to act as consultants and coordinators, with others on call when needed. All other associations can use the office for any necessary registration, address, phone, and newsletter services, and pay a fee for usage.

Critical services and links can be built by any regional office; it can serve as a *land access centre*, operating the strategies outlined later under that section. It can also act as leasehold and title register, or to service agreements for clubs and societies. More importantly, the regional office can offer and house community self-funding schemes, and collect monies for trusts and societies.

The regional office also serves as a contact centre to other regions, and thus as a trade or coordination centre. One regional office makes it very easy for any resident or visitor to contact all services and associations offering in the region, and also greatly reduces costs of communication for *all* groups. An accountant on call can handily contract to service many groups. The regional group can also invite craftspeople or lecturers to address interest groups locally, sharing income from this educational enterprise.

Some of the topics that can be included in the regional directory are as follows. These can be taken topic by topic, sold at first by the page, and finally put together as a looseleaf notebook (volunteers enter local resource centres and addresses under each category; the system is best suited to computer retrieval). The following Resource Index for Bioregions has been compiled by Maxine Cole and myself for the Northern Rivers Bioregional Association of New South Wales, Australia.

The primary categories are as follows:

A. Food and food support systems
B. Shelter and buildings
C. Livelihoods and support services
D. Information, media, communication, and research
E. Community and security
F. Social life
G. Health services
H. Future trends
I. Transport services
M. Appendices (maps, publications of the bioregion)

All of the above sections can contain case histories of successful strategies in that area.

CRITERIA: Practical resources (people, skills, machinery, services, biological products) essential to the functioning of a small region, and assisting the conservation of resources, regional cash flow, the survival of settlement, employment and community security. (Security here means a cooperative neighbourhood and ample, sustainable resources for people.)

**CATEGORY A** - FOOD AND FOOD SUPPORT SYSTEMS.

Criteria: Native and economic species, organic and biocide free, products of good nutritional value.

A1. Plant resources

1.1 Nurseries and propagation centres, tissue culture, sources of innoculants, mycorrhiza.

1.2 Plant collections and botanical gardens, economic plant assemblies, aquatics.

1.3 Research institutes, horticultural and pastoral agencies.

1.4 Seed sources and seed exchanges.

1.5 Native species reserves and nurseries.

1.6 Demonstration farms and gardens, teaching centres, workshop conveners.

1.7 Government departments and their resources, regulations.

1.8 Voluntary agencies involved in plant protection, planting, and propagation.

1.9 Skilled people, botanists, horticulturists.

1.10 Publications and information leaflets of use in the region, reference books, libraries, posters.

1.11 Contractors and consultancy groups: implementation of plant systems, farm designs.

1.12 Produce: products and producers in region, growers.

1.13 Checklist of vegetables, fruits and nuts which can be grown in the region, and species useful for other than food provision .

A2. Animal resources

2.1 Breeders and stud or propagation centres, artificial insemination, hatcheries.

2.2 Species collections, including worms and like invertebrates.

2.3 Fish breeders and aquatic species.

2.4 Useful native species collections and reserves, potential for cultivation.

2.5 Demonstration farms, e.g. free range, bee culture, workshop conveners, teaching centres.

2.6 Government departments and their resources, regulations.

2.7 Voluntary agencies and animal protection societies.

2.8 Skilled people, farriers, vets, natural historians.

2.9 Contractors (shearers, etc.) and consultancy groups, farm designers.

2.10 Publications, posters, libraries for the region

2.11 Produce: species and suppliers in region.

A3. Integrated pest management (IPM)

3.1 Insectaries and invertebrate predator breeders and suppliers of biological controls.

3.2 Suppliers of safe control chemicals, traps.

3.3 Information sources on IPM.

3.4 Pest management of stored grains and foods.

3.5 References and libraries.

3.6 Checklist of common pests and predators, and safe pest control procedures.

A4. Processing and food preservation

4.1 Suppliers of processing equipment.

4.2 Food Processing Centres (FPCs).

4.3 Information sources on food processing and preservation.

4.4 Sources of yeasts, bacterial and algal ferment materials.

4.5 Processed–product producers in region.

A5. Markets and outlets

5.1 Local markets.

5.2 Delivery services.

5.3 Export markets and wholesalers.

5.4 Urban–rural co–op systems, direct marketing.

5.5 Retail outlets.

5.6 Market advisory skills and groups, contract and legal skills.

5.7 Roadside and self–pick sales.

5.8 Market packaging and package suppliers, ethical packaging systems and designs .

5.9 Annual barter fair.

A6. Support services and products for food production

6.1 Residue testing services for biocides, also nutrient, mineral and vitamin content (food quality control).

6.2 Soil, water and leaf analysis services for micronutrients and soil additives, water analyses, pH levels.

6.3 Hydrological and water supply services (dams, domestic water), design and implementation.

6.4 Fence and trellis suppliers and services, cattle grids and gates.

6.5 Suppliers of natural fertilisers, mulch materials, trace elements, soil amendments.

6.6 Farm machinery, garden and domestic tool suppliers (see also processing), appropriate and tested equipment, fabricators and designers, repair services, hire and contract services.

6.7 Land planning services.

6.8 Glasshouse, shadehouse, food dryers, suppliers, and appropriate materials.

6.9 Lime quarries and sources, stone dusts, local trace mineral sources, regional geological resources.

**CATEGORY B** – SHELTER, BUILDINGS.

Criteria: Energy–efficient house design and non–toxic materials only

B1. Construction materials

1.1 Timber growers and suppliers, community timber plantations.

1.2 Stone and gravel, earth materials.

1.3 Plumbing and piping, drainage, roofing.

1.4 Bricks and concrete products (tanks, blocks, etc).

1.5 Tiles and surfaces, paints (non–toxic)

1.6 Furniture and fittings.

1.7 Tools and fasteners, tool sharpening services and repairs, glues and tapes.

1.8 Library and research resources.

1.9 Current state of housing in the region (numbers seeking housing, rentals available).

1.10 Sources of toxins and unsafe materials in buildings, appliances, furnishings, paints and glues; high voltage equipment.

B2. Energy systems

2.1 Home appliances for energy conservation and efficiency, energy saving and insulation.

2.2 Hot water systems, solar systems.

2.3 Space heating and house design for the region.

2.4 Power generation systems for region: current and proposed.

2.5 Appropriate technology groups, research centres and demonstrations.

2.6 Designers of low energy home systems and buildings.

2.7 Sources of information, publications, trade literature, library resources.

2.8 Reliable contractors and builders.

B3. Wastes, recycling

3.1 Sewage and greywater disposal (domestic).

3.2 Compost systems and organics.

3.3 Solid wastes disposal and collection (boxes, bottles, plastics).

3.4 Occupations based on waste recycling.

**CATEGORY C** – LIVELIHOODS & SUPPORT SYSTEMS.

Criteria: Concept of right livelihood or socially useful work. Durable and well–made items.

C1. Community finance and recycling

1.1 Barter and exchange.

1.2 Small business loans.

1.3 Community banking and investment systems.

1.4 Land access systems, commonworks, leases, trusts.

1.5 Legal and information services.

C2. Livelihood support services

2.1 Small business service centres.

2.2 Skills resource bank: business, legal and financial advisory services, volunteer and retired people.

2.3 Self–employment (work from fulfilling regional needs: job vacancy lists).

2.4 Training courses in region.

C3. Essential trades, and manufacturing services and skills

3.1 Clothing and cloth (spinning, weaving).
3.2 Footwear and accessories, leatherwork.
3.3 Basketry and weaving, mats and screens.
3.4 Functional pottery.
3.5 Steelwork, fitting and turning, smithing and casting, welding.
3.6 Functional woodwork.
3.7 Engines and engine repairs.
3.8 Functional glasswork.
3.9 Paper recycling and manufacture, book trades, printing and binding.
3.10 Catering and cooking (food preparation).
3.11 Draughting and illustrating services.
3.12 Soaps, cleaning materials.

CATEGORY D – INFORMATION SYSTEMS , MEDIA SERVICES , COMMUNICATIONS AND RESEARCH.

Criteria: Essential community information, aids, and research

D1. Communications networks

1.1 Regional radio and C.B., ham radio .
1.2 Regional news and newspapers, newsletters.
1.3 Audio-visual services, photography, television, film
1.4 Business and research communications e.g. fax, telex, modem, card files, computer, journals, libraries, graphics, telephone answering services.
1.5 Computer services and training.
1.6 Libraries and collections of data in region.
1.7 Maps.
1.8 Bioregional groups and contacts—local and overseas.
1.9 Standard documents and data sheets available via the bioregional centre.

CATEGORY E – COMMUNITY AND SECURITY.

E1. House and livestock security.

1.1 House siting.
1.2 Neighbourhood watch.
1.3 Cattle and livestock watch.

E2. Fire volunteers and reports (4 wheel drive clubs).

E3. Flood (cleanup, rubber duckies).

E4. Bush, cliff, beach rescue services.

E5. Communication systems.

6.1 Report centre.
6.2 Emergency communications.

CATEGORY F – SOCIAL LIFE.

Criteria: Assistance for isolated people to meet people of like mind

F1. Introductory services.

F2. Think tanks.

F3. Expeditions.

F4. Work groups.

CATEGORY G – HEALTH SERVICES.

Criteria: Basic preventative and common ailment treatment, necessary hospitalisation, accident treatment, local resources

G1. Medical and pharmaceutical services.

G2. Surgical and hospitalisation services.

G3. Gynaecological and midwifery services, home birth support.

G4. Profile of morbidity in region, life expectancy, infant mortality, causes of death, ailments in order of importance, under:

4.1 Accidents & injuries; infectious diseases; addictions & drugs.
4.2 Genetic and birth defects; nutritional problems.

**Note**: until the above listing is made, no region can assess health priorities.

CATEGORY H – FUTURE TRENDS & POTENTIAL THREATS TO THE REGION (AS A SERIES OF RESEARCH ESSAYS).

H1. Sea level rises, greenhouse effect.

H2. Ozone depletion.

H3. Water pollution and biocides; radioactives and chemical or waste pollution.

H4. Financial collapse; recession.

H5. Implications for policy making.

CATEGORY I – TRANSPORT (SEE ALSO CATEGORY H).

I1. Barge and sea systems.

I2. Draught animal systems.

I3. Joint or group delivery/cartage.

I4. Innovations; local fuels and new sorts of vehicles.

I5. Transport routes, bikeways.

I6. Air and ultralight craft, blimps.

CATEGORY M – APPENDICES.

Maps – Bioregional map
Geological
Plant system
Soils
Sources and references to maps, suppliers
Regions, parishes,
Land titles
Access and roads
Reserves and easements
Rivers and water supplies

**Note** that if essential servies are listed, deficiencies noted, and leaks of capital detected, then there is immediately obvious a category of "jobs vacant". If, in addition, there is a modest investment or funding organisation set up (itself a job), then capital to train and equip people to fill these gaps is also available. When *basic* needs are supplied locally, research and skills will reveal work in producing excess for trade—this excess can be as information and education to other regions.

Bioregionalism is an excellent concept, given the irrational land use systems and land divisions developed by the present power structures. However, it is rarely an achievable reality, unless enough people gather in one area and manage to attract a sufficient number of like people to achieve a viable internal economy and trade infrastructure, together with the community common funds that make such enterprises possible.

And that is the secret of success: assembling sufficient commonsense people in one area. If we are one isolated biodynamic gardener in a district of contract vegetable growers or graziers trained in chemical agriculture, we find both the practice and infrastructure support of the isolated system difficult; there may be no one to talk to, let alone share resources with. On the other hand, as land titles in a region are bought out and occupied by any group who share an ethical philosophy, so the shops, markets, processing centres, equipment, and support services for the new economy become worthwhile and available.

As much as "the will to do" indicates health in the individual, so an increasing biological resource indicates health in the community. Every bioregion should monitor tree cover, wildlife, seaweed beds, bird colonies, species counts, and productive cultivated land at regular intervals. If these have increased in yield and maintained in species, the area maintains health. If no increase, or a *decrease*, is evident, something is wrong and should be immediately assessed for correction.

It is only the increase in the variety, quantity, and health of natural systems that indicates the health of any area. Where species disappear, trees or fish die, farmland and forest yields are reduced, and species lists simplify, there is trouble, and a degenerative effect is operating. A "life census" needs to be compiled every 2–5 years, and some data needs continual records, as absences are harder to detect than presences. Modifications to habitat can result in a constantly increasing biological resource, both qualitatively and quantitatively.

Every region needs to act as a curator and refuge for some critical life elements of allied regions, so that *absolute* loss of species is unlikely short of global catastrophe. In some land trusts, it is this biological–environmental accounting which sets the basis for the "economic rent", and (in the event of a degenerative trend) even the basis for continuing in occupation and use of the land.

## 14.6
## EXTENDED FAMILIES

*Chiajen* (the family): The family is society in embryo; it is the native soil on which the performance of moral duty is made easy through natural affection, so that within the family circle a basis of moral practice is updated; this is later widened to include human relationships and society in general.

(From *The I Ching*)

The concepts of village and bioregion refer to a base or home area, but today many people travel about. Many societies extend as close affinity groups across many nations, thus forming a non-national network. Such groups develop a familial, rather than a competitive or conflicting, inter-relationship. With a common interest and ethical base, cooperative interdependence supplants competition. A "family" of this type, with 1,000 or less members, can ally with like groups to create a tribe, and 20–40 such tribes form a nation. Families, unlike many societies, have child care and the welfare of their members at heart.

Such families already exist in Europe, with small groups living in a scatter of households and locations across many existing national boundaries; some have existed for 18 or more years, and members report individual satisfaction with a larger support group. In practice, any person has 3–5 close friends (who change slowly over time), a support group of 30 or more acquaintances, and resource access to the whole system. A familial system of shared ethics can:

- Keep in touch via a registrar and news service;
- Co-invest in family property development and joint enterprises;
- Rationalise resources for most efficient sharing of space and equipment;
- Develop a series of social contacts via visits;
- Care for the children as one group, and set up a fund for their needs;
- Widen the cultural and support base for households.

Membership in a family of shared ethical values does not conflict with any other membership or duties, and is mainly a matter of organisation of a family registrar and some common funds. Such families need to define each adult as an individual, with a right to the essentials of their own space (bed and work space), garden, and occupation. As nuclear family households are a minor part of modern societies (13–18% of all households), households based on friendship, or work affinity, or designed for students, single, or elderly people, are needed.

Like land ownership, the ownership of people is an illusory aim. Some couples can tolerate years of close work, but many might prefer a slightly more independent existence, close to but not necessarily living with each other.

In particular, children need a wider alliance and support group than just one or two parents. People can find "aunts and uncles" to take part of the responsibility for children in any such extended family, and if the children have a common fund (like their own credit union) for basic needs, then their care at a basic level is assured. They also have more than one household to relate to, or to visit or dwell in when educational needs change.

Families can, for instance, maintain a student dormitory near secondary or tertiary institutes, whereas at present many rural families have no such facility to send children ages 12 or over when they need or request higher education.

People can feel, and sometimes are, trapped in the nuclear family or the "compound" family of blood relatives who may share no ethical or interest base. At times, traditional extended families grossly exploit (in particular) younger women, as household serfs, or are exploited by indolent members. Blood relationship is no guarantee of freedom of choice, or fair dealing. Besides, as people grow and age, they develop differing needs for space and relationships, and other (intellectual or interest) factors call for different personal relationships.

Many of us have been locked in to unsatisfactory work or personal relationships, or too much alone in the context of nuclear family "ideals", which in real societies are for the few. It is good to be able to visit, stay with, and cooperate with a few households and to form new relationships as needed; it is also necessary to have the freedom to choose new work alliances.

In the extended family, problems such as lack of shelter, land access, access to capital and services, deserted or neglected children (or adults), transmission of infective diseases, and population control can largely be dealt with by internal behaviour on some ideal of (dynamic) stability. By selective recruitment, skills and resources can be acquired, or developed by education and group capital investment. Funds can be established as follows:

- COMMON ENTERPRISE FUND: the family fund, held in 2–3 places and convertible to a variety of currencies, and managed by a few individuals as a full-time job. All savings and contributions are accounted to individuals, and available as loans as for any credit union or revolving fund, across all currencies and regions.
- ANNUAL MEMBERSHIP FUND: invested and the interest used. This services the registry, newsletter, and pays part or full-time wages to a collator.
- CHILDRENS' PERMANENT FUND: all adults (age 17 or over) contribute $50 to this fund, with additional gifts encouraged. The fund is managed with the Common Enterprise Fund for essential child-oriented ventures or for education. This is a non-returnable fund. Each mother or mother-to-be would encourage 5–6 support people to contribute donations, and agree to help in other ways. Until age 12, parents can apply for loans, and thereafter (until age 17) the children can themselves apply, after which they are recognised as adults.
- SPECIAL VENTURE FUNDS: to be raised by proposal, open to groups or individuals, and handled by the Common Enterprise Fund administrators for such group ventures as a shared house, boat, overseas programme, or business.

It is probable that some (or all) members could run one or more enterprises to fund a charity or "trust-in-aid" programme for areas of need. Given such basic financial tools, secondary needs are to rationalise resources as a type of real estate service and resource listing internally, so that all members can assist others as producers, consumers, trustees, or by land, appliance, and shelter rationalisation.

As some ideal, groups of 30 or so people could gather in core regions (with some outlier households) and so make travel locally an easier affair. Meta- networking (tribe to tribe) enables such higher-level organisations as travel and accommodation nets to be set up on a global basis, cash to be transferred to areas of need, and larger joint enterprises developed.

As for the touchy subject of population control, taking group responsibility for a very few children sometimes cures the urge to breed, and those who want more than two children are far outnumbered by those who don't, so that where children are not seen as a "future insurance"—as in very poor rural families— the population can soon achieve a steady state. The schematic of **Figure 14.1** gives the basic parameters for both steady-state and out-of-control or declining populations. A registry can therefore inform people of the balances in sex ratio and age structure, and recruitment in the late stages of enrolment can be adjusted to give a fair balance of sex-age distribution. It does not matter, of course, if perfect balances are not achieved, but resources remain plentiful only if people remain relatively few.

Given an extended family, a bioregional network locally, and some form of common work opportunity, any individual is assured of access to resources, capital, cultural exchanges, and good work. We need not only fixed villages and bioregions, but open corridors to other regions, other people, and across nations.

As I see it, conflict arises on "national" boundaries that are fixed or disputed. A web of multi-racial, multi-cultural, and multi-occupational families and global nations obliterates these "defended territories" and suits peaceful lifestyles. The framework for such nations already exists; it remains to give those frameworks the mechanisms that create true interdependence via a new type of extended family.

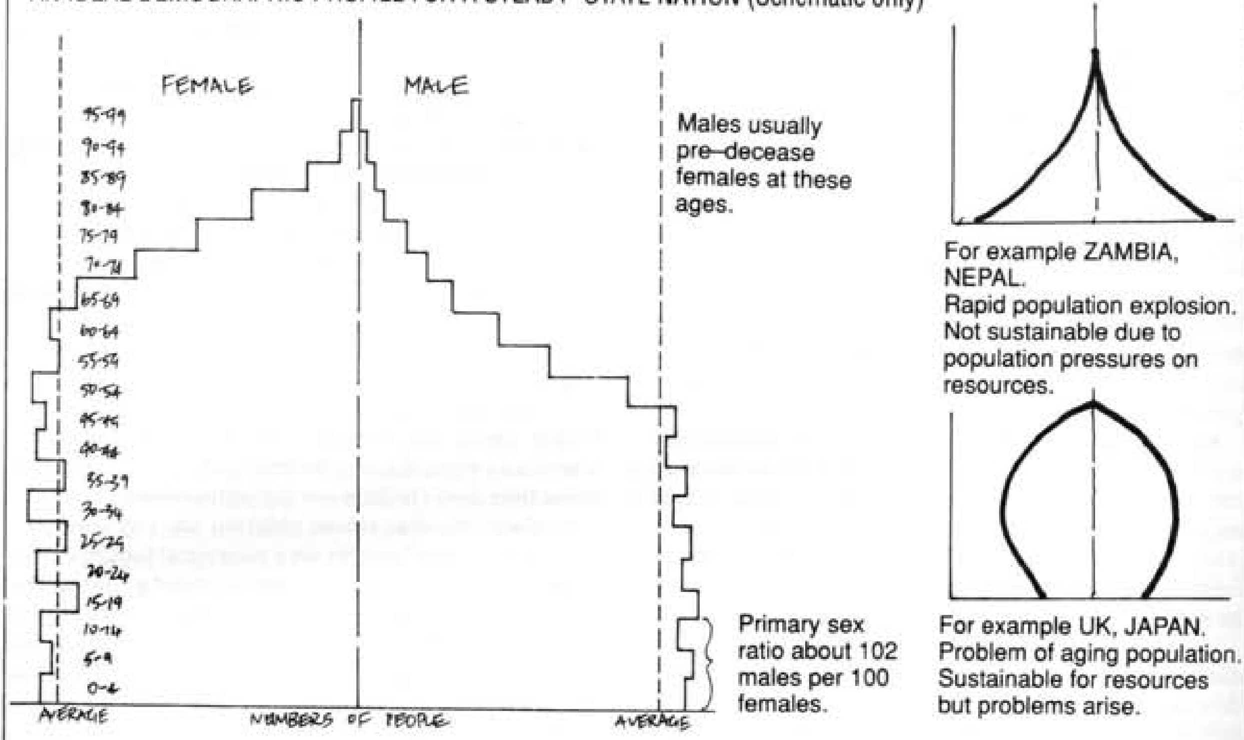
We all value cultural and environmental diversity—or the world would become one vast Toyota-Coca Cola-McDonald-Hilton monoculture. Thus the concepts of unique bioregions, intact language and culture, and cross-cultural enrichment is central to a permaculture of human resources, and an ecumenical global nation.

## 14.7

## TRUSTS AND LEGAL STRATEGIES

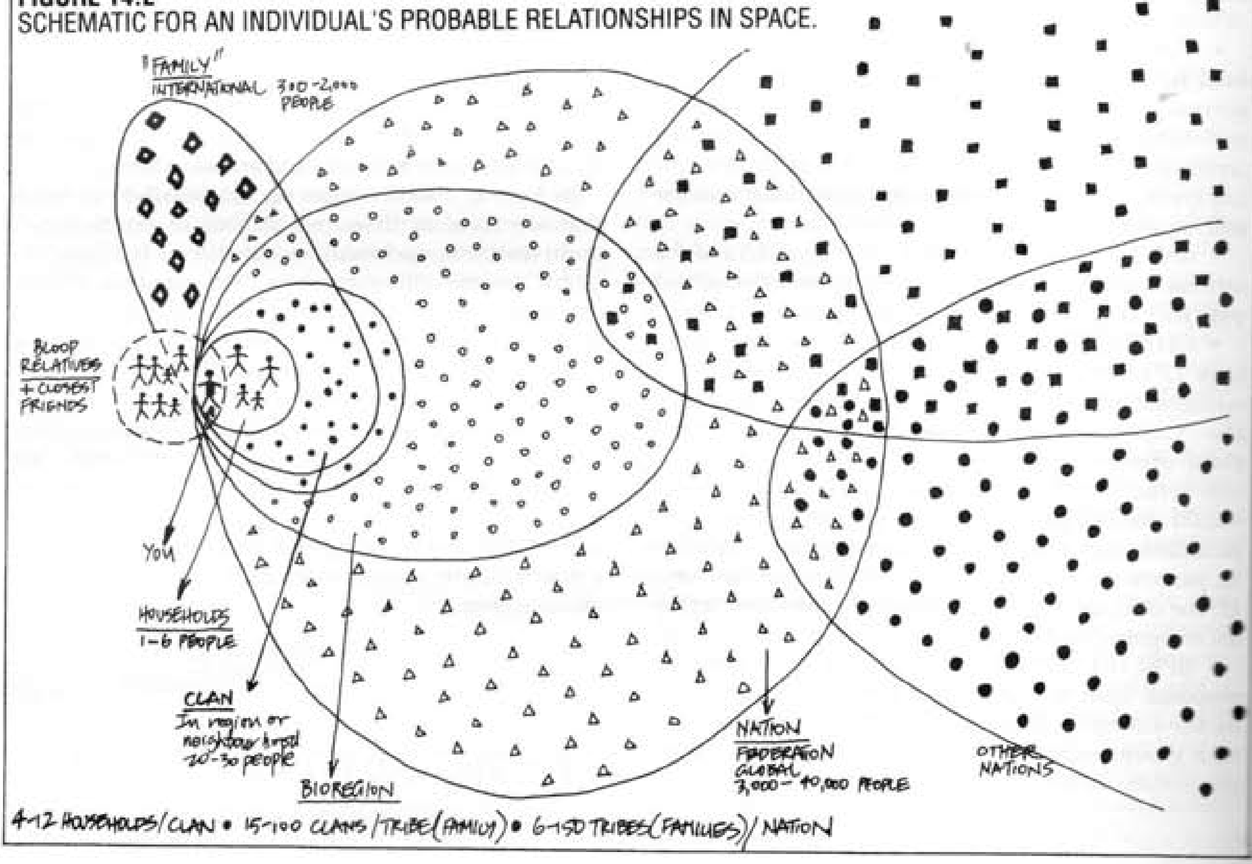
Trusts in the public interest are the legal basis on which churches, universities and many schools, research

**FIGURE 14.1**
AN IDEAL DEMOGRAPHIC PROFILE FOR A STEADY–STATE NATION (Schematic only)




NOTE: For a nation of 30,000 people (20 families or tribes) 1 unit would be about 1,000 people.

**FIGURE 14.2**
SCHEMATIC FOR AN INDIVIDUAL'S PROBABLE RELATIONSHIPS IN SPACE.



establishments, some hospitals, many public services, aid programmes, and charities rest. Few people realise how many, and how varied, are the trusts that serve them in one or other way. About 18–20% of businesses may also be non-profit trusts owned or operated by the charitable trusts that benefit from (are beneficiaries of) them.

It is quite possible, even sensible, to completely replace the bureaucracy of public services with a series of locally administered trusts, and Holland (in particular) largely supplants expensive paid public services (burdened as they are with heavy salary and capital costs, and liable to inaction, self-interest, and executive inefficiency) to publicly formed trusts (called *stichtings*). In the case of any small country, such trusts can run all public operations, and the "government" becomes simply a way of conveying tax capital back to the regions via local trusts. However, trusts can also self-fund via non-profit businesses to become foundations, fully equipped with their own income sources.

Trusts are usually formed, operated, and staffed by people (often initially volunteers) motivated to perform one or other public duty, or who seek to assist a defined or special group in need. Such trusts often have names including the words: church, foundation, institute, communion, school, congregation, charity, bureau, trust, or even company. When the trusts are formed to *trade*, they can take or own any business name that suits their work; such businesses are administered by a trustee.

Trusts are formed just to conduct businesses and trade, giving away their profits annually to named beneficiaries. If the beneficiaries are individuals, such gifts are taxed as private income; if the beneficiaries are charitable trusts or churches, the gift is not only not taxable but can be tax deductible to any giver. Trading, or "unit discretionary", trusts are also known as non-profit corporations (not to be confused with for-profit organisations).

Many large companies set up, and to some extent fund, non-profit organisations or even charitable trusts as a means to reduce taxable income, to carry out educational services, or to obtain public goodwill; some businesses tithe to worthy trusts that they believe in (a tithe is usually a tenth of income, but in practice ranges from 5–15%).

Legally, a trust body consists of a TRUSTEE and a document or TRUST DEED, registered with the public company registrar. There are many good reasons to make the trustee a private company, as directors of such companies need to be few in number (3 or 4 are enough), can appoint others if one dies or resigns, and can be anonymous. A company does not die, unlike its directors, and the small group of trustees can act quickly and decisively without reference to the cumbersome and often uninvolved "board of directors" that some trusts have appointed. It is wise to restrict directorships of a trustee company to those who are very active in trust affairs, and preferably live close to each other in one region. Such a set-up is diagrammed in **Figure 14.3**.

Should any person wish to set up a trust, the very first thing to do is to closely define the purposes of the trust, the group to whom it will apply ("all the citizens of Australia" or "those suffering from spina bifida"), and to instruct a lawyer to draw up the trust deed and to register this and the trustee company.

It is usually possible to buy a copy the trust deeds of other ethical organisations, and to use these as a model for a local trust, so reducing legal costs. Some law societies service ethical trusts at no charge for their time.

Any trust can have (unregistered, no cost) an ASSOCIATION of volunteers, aides, or clients who can publish a newsletter and generally assist the trust in its affairs.

It is also very wise for any charitable trust to establish a non-profit trading (business) trust to help finance its activities, and this trading trust can refund costs to volunteers, pay wages, and gift profits to the charity or to any other charity. Thus, if the charitable trust is TRUST A, and the trading trust is TRUST B, the system as a whole works as per **Figure 14.4.**

The trust deeds state not only the purposes of the trusts but in addition the "will" of the trust is usually included, leaving its assets to an allied trust if this trust completes operations, closes down, or fails from lack of interest or of funds. Also, the trust deed gives an estimate of the *duration* of the trust; if this is intended to be "forever", then legally the statement is likely to be on the lines of "until 21 years after the death of the last descendant of Ming emperors" or some such legally indefinable period.

Trusts are durable, efficient, easy to administer, and of great public service; everybody should be associated with one! There are several small independent but cooperative Permaculture Institutes and allied groups in existence which have associated non-profit trusts operating businesses to fund them; in this way, many trusts are independent of gifts or grants, and become self-reliant for funds. It is estimated that France has 100,000 public interest groups, each with its own areas of interest and subscribers, and that about 10,000 form up annually; one can only suppose that others also fade out, their work redundant or completed.

As so few (dedicated) people can operate a trust effectively, it is far better to set up many such local trusts than to risk the power-centred inefficiences of a monstrous hierarchical system, such as some religious sects and foundations have become. These are essentially fossilised and no longer of relevance to ordinary people. Every dissenter or group of dissenters should therefore set up trusts to promulgate their own views, or form an independent trust in a cooperative network of like trusts.

Unless the formation of trusts is a common practice in a particular country, very few lawyers can set up (or even know about) trusts. They often give bad advice to groups, setting up litigious or cumbersome systems,

FIGURE 14.3
A TRUST STRUCTURE

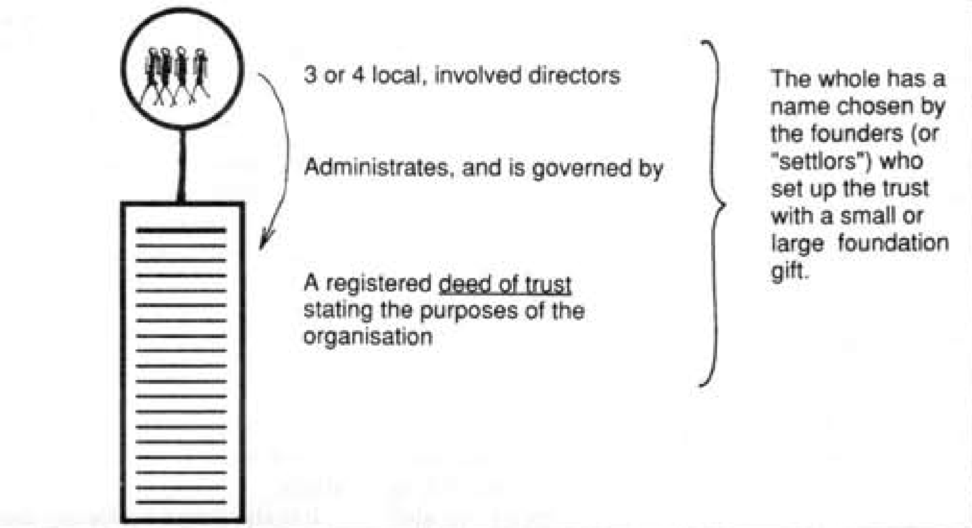
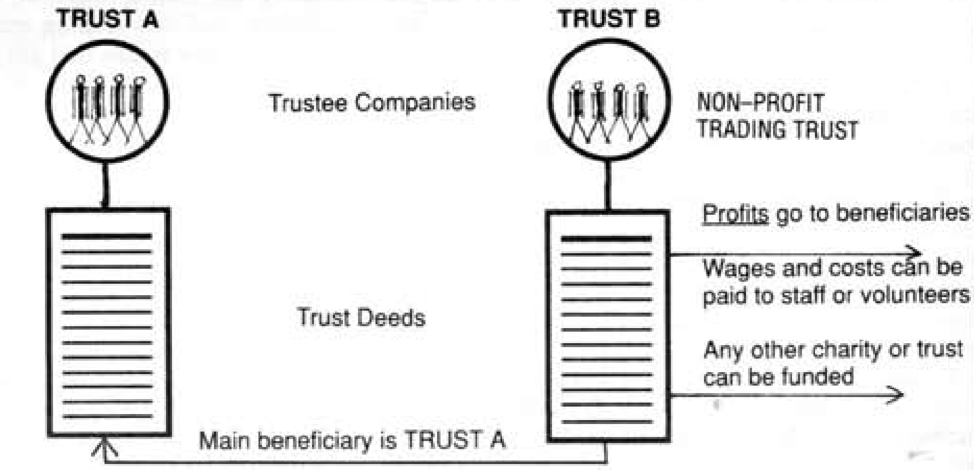



FIGURE 14.4
CHARITABLE TRUSTS




**TRUST A**
"For the public good"
In this trust lies all real property which *is not at risk*, e.g. land, buildings, copyrights, leases, and important equipment that is clear of debt. This trust *takes no risks* (It does not trade).

**TRUST B**
"To trade and to gift profits"
This trust accepts volunteer or contract labour, and can pay employees. It can involve itself in areas of normal business risk, and can rent or lease real property from TRUST A.

giving endless trouble and necessitating agreement among many people (an end which is, in practice, impossible to honestly attain), and which involves distasteful accomodations and compromises, explicit or hidden. Therefore, a careful search for the right lawyer is essential (corporate lawyers are often knowledgeable about trusts).

Other simple legal structures necessary to companies, cooperatives, credit unions, public investment trusts and so on are all well–outlined in company law, have excellent support services, and are routine arrangements. A good accountant to lay out the bookkeeping and give advice is necessary, as is an efficient office manager to communicate with the trust's target population.

## 14.8
## DEVELOPMENTAL AND PROPERTY TRUSTS

(Appropriate to village development, land rehabilitation)

No investment in glamour stocks (coal, oil, uranium, city properties, paper pulp, agrochemicals, mining) is likely to yield anything to us but more pollution and to hasten global collapse. The evidence on acid rain alone (well documented) will convince any sane person that further "progress and development" will cause social and environmental upheaval.

We need to turn our money resources to truly rehabilitative ends. We accept the need, therefore, for accelerated reafforestation, the preservation of existing forests, sane village development, and the rehabilitation of eroded and misused lands.

In forming a development trust, our aims are not just financial, but also ensure community survival by community involvement. With good management and skillful work, there is no reason why this should not also pay for itself, or show a financial advantage to investors. It is an invaluable experience to model such a property trust, and to teach others how to follow any successes that we achieve.

A property trust purchases real estate for improvement, lease, or rental on behalf of many small investors who cannot afford to individually own or develop such properties. By improving properties so purchased, their value increases, and (under present rulings) taxation is not incurred on that increase in value if the property is held for 10 or more years, nor is the trust itself taxed on its income from investors. A "small business centre" can be a property trust. Many such trusts concentrate on city office properties or rural monocultures; we can concentrate on other aspects of property investment, as outlined herein for village development, or land rehabilitation systems.

The management group obtains backing from investors (via a public prospectus) to float a Property Trust on the investment market. The prime purpose is to give every person a chance to do more than object to or protest inappropriate land sales to overseas investors, land misuse, and poor planning, and to invest in saving critical or endangered national resources (such as wildlife and forests), while actively rehabilitating eroded lands.

In the first trust of this type, the aim can be to stop accepting investors at $2–5 million, which will develop a property or properties as listed in the prospectus. A low unit price ($100) enables even poorer people to invest; a single unit can be held by a partnership, society, or other corporate group so that even less money need be contributed per person in order to assist (e.g.) unemployed people. There need be no limit to the number of units held by any person.

Unlike other property trusts, investors should be given every opportunity to involve themselves in their investments via on-site work, consultancy, leaseholds, tree nursery supply, preference in sales of titles in villages, access to products or services, and (controlled) recreational access to lands and buildings. The trust can inform investors of any opportunity for their involvement at any level from volunteer or recreational use to paid consultancy, building, or in leaseholds available.

Funds can be used for the following:

- To set up the trust deed and management company;
- To pay for the work of the trustee;
- To pay management a retainer for their work; and
- To pay for normal running costs of the trust, including office expenses, printing, bookkeeping, accounting, valuation, and the travel of management to properties.

The precise amount so used should not exceed 4–8% of funds (based on figures from other property trust expenses), and the remainder is devoted to the purchase and development of properties as outlined in the prospectus. Costs reduce as trust income grows.

Any surplus or unused funds accumulating in the trust can be invested in ethical systems, including housing cooperatives, inventory for development projects, and shares in ethical businesses.

The specific project areas in which ethical trusts operate are:

- Purchase of threatened wildlife and forest habitat (usually with a specific plant or animal group in mind). Managed for the aims stated in a specific prospectus.
- Purchase and development of eroded, salted, deforested, or misused land for rehabilitation.
- Development of an energy–efficient, sustainable village on trust lands, for sale as developed, or pre–sale to raise capital for development.
- Special interest/group developments such as trout fisheries, aquaculture, or seed orchards for lease or sale.
- Bioregional development as purchase of community resources in a specific region(s) for use by residents, community groups, trust unit holders, or by residents buying trust properties in that area.
- Purchase of selected properties for assisting developing countries (overseas outposts).
- Bioregional clean energy systems or clean transport methods.

The way such trusts stage development and show a return is as in **Figure 14.5**.

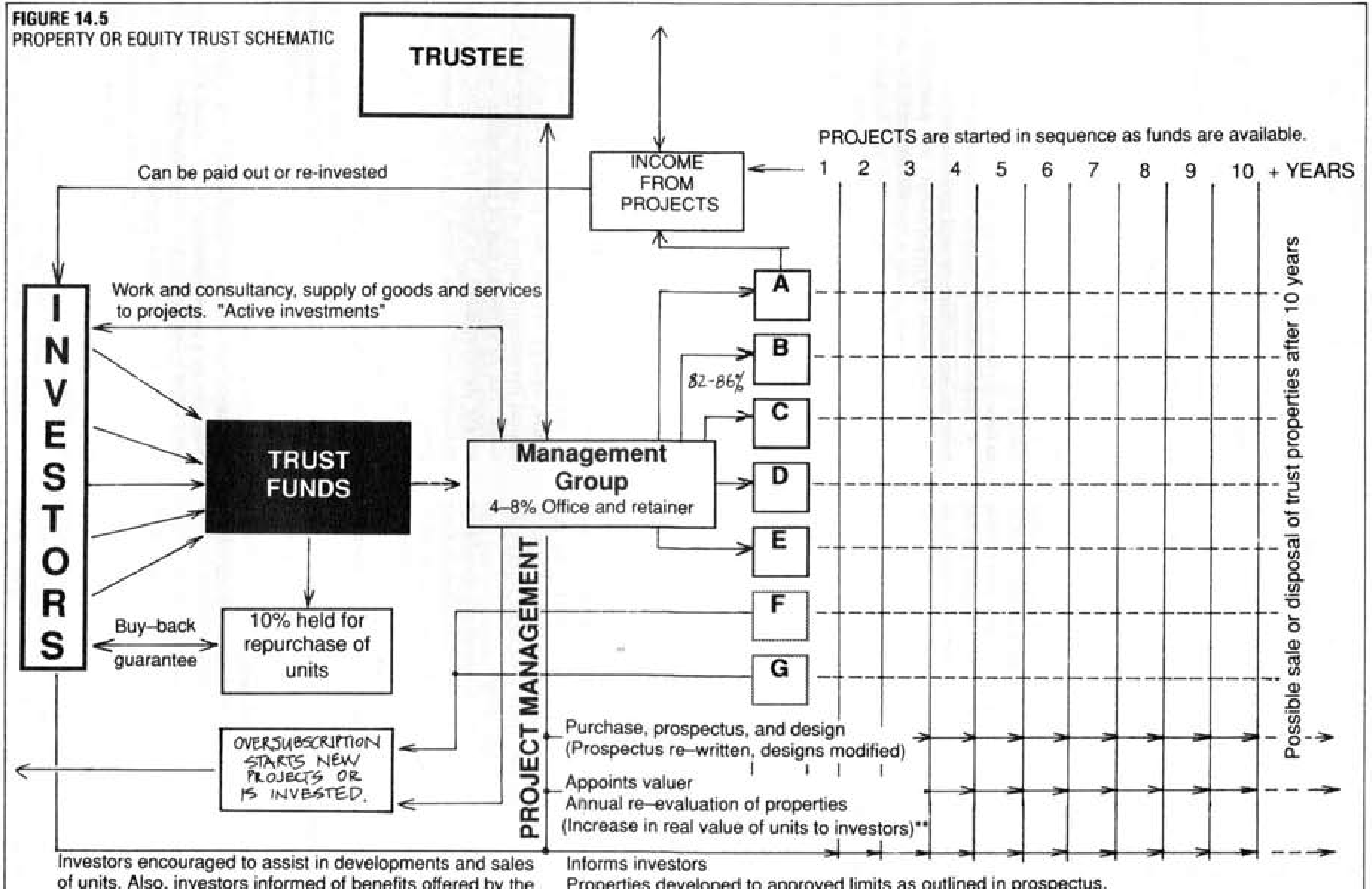
## 14.9 VILLAGE DEVELOPMENT

As individual designers gain field or applied skills in house, energy system, and property design, and as ethical investment comes of age, the idea of "client work" can be joined to that of earth repair, and to real estate development. In order to do this, finance managers need to join forces with good managerial or design groups. The whole development group thus evolved can then purchase lands, capitalise them, and get them in order as a complex of lake, forest, and village settlement. We need well–designed villages today more than any other enterprise: villages to re–locate those soon–to–be–refugees from sea–level rise, villages to house people from urban slums, and villages where people of like mind can find someone else to talk to and to work with.

Villages can pool their surplus or current financial resources in a developmental credit union, and create land titles to sell in order to develop public service facilities. Nobody need pretend all problems are solved—conspicuous consumption can still ruin the idea of energy self–reliance—but *with good management*, the plan that follows comes very close to a sane village development.

An intentional village should have a group ethic acceptable to all who come there. Ethics, if shared,

**FIGURE 14.5**
PROPERTY OR EQUITY TRUST SCHEMATIC



discussed, and acknowledged, give unity to groups, villages, and nations, indicate a way to go, and control our use of earth resources. They can be reflected in our legal, financial, domestic, and public lives.

The aims of a sensible village group might be to:

- REDUCE THE NEED TO EARN, by developing food, energy, and shelter self-reliance;
- EARN WITHIN THE VILLAGE IF POSSIBLE, reducing transport and travel needs; thus to recruit people who could fill most essential village occupations, or who are self-employed;
- PRODUCE A SURPLUS from services to others, thus maintaining a strong economy and outreach potential;
- PROVIDE MANY OF THE NON-MATERIAL NEEDS of people, perhaps of children in particular, by devising meaningful work, relevant education, and a rich natural environment; and
- COOPERATE in various enterprises and small associations.

A village can provide PRIVACY in homes and gardens; ACCESS TO TOOLS as leased, rented, or easily accessed equipment from computers to tractors; ENTERTAINMENT from local folk groups to video cassettes; CONSERVATION as a village wildlife, water, and forest reserve, and RECREATION in the near environment. It can also provide the BASIC LIFE ESSENTIALS of shelter, food, and energy.

No isolated or scattered group of people can self-provide for the above, but it is probable that about 30 to 200 houses can support these services and basic facilities, especially if there is planning for cooperative funding. What is easy for a group may be impossibly stressful for a nuclear family. It is possible for a group to provide many services, and for many people to earn a living in so doing.

It is quite practical to create such new villages without much initial capital in the actual development phase. This can be achieved in these ways:

- By receiving a gift of land to a land trust, intended for village development.
- To find suitable land for sale, and to take out an *option to buy* from the owner, dependent on pre-sale of the idea to buyers.
- To work on tribal or trust lands already communally owned.

To work with an *investor* or finance group to purchase land for village development, and to stage the development.

- To convene a *group* which wants such a village and use their capital to stage a village development.

The first few of these options presume a developer, are faster, and probably easier than the last option. All, however, need careful forward planning. The development *may* give considerable profit (but that is not guaranteed). In fact, fair or normal profits can be used to benefit both people and land, can give young or poorer people titles, and can rehabilitate landscapes otherwise neglected.

As a guide, 30% of titles available should cover (in value) all land and development costs, so that surplus titles are available for community access, profits, gifts, labour equity, and new project development. Land should be priced to local real estate values, and only very poor management would then show a loss on development.

For example, for 100 titles in the village:

<u>Development Stage:</u>

- 60% are sold by the development group to a village group at best prices (30% of that covers all costs, and actually sets the land price);
- 30% are given to the village group for later use;
- 10% are allotted by the developers as labour equity to such people as surveyors, earthmovers, landscapers.

<u>Village Trust Stage</u> (the titles given to the village group by the developer):

- 20% are sold by the village trust to fund village projects, and can be sold at lower (50% or less) value to low-income families;
- 10% are reserved for sale to crucial new recruits, e.g. medical, computer, energy-producing people.

OR

- 10% issued on easy terms to low-income families;
- 20% sold to finance village services.

## SITE CRITERIA FOR VILLAGE DEVELOPMENT

There are a variety of locations that can be used for village development:

- TYPE 1. In a city block or suburbs.
- TYPE 2. Adjoining an existing village.
- TYPE 3. Within a part-vacant village.
- TYPE 4. Isolated from any existing integrated settlement.
- TYPE 5. On the site of a pre-existing but now vacant or destroyed village.
- TYPE 6. As a new suburban development.
- TYPE 7. Specialised settlements on coasts or near wilderness.

All need a different real estate and planning approach, so that Type 2 and Types 4 to 6 are probably outright purchase or option systems; Types 1 and 3 are part of a gradual takeover or buy-in system over some years; and Types 2 and 6 may have both factors operating at once, i.e. some land is purchased for development, while older village resources are also purchased for use. Type 4 is the pioneering or kibbutz approach and needs the most intensive planning, especially for water resources, access to market, and specified enterprises.

Type 2 is probably the easiest to plan and administer, and allows a whole graduation of involvement and committment. It also attaches to pre-existing essential services, although these are unlikely to be as useful or appropriate as those indicated here. Purchase of existing homes and lots results in little delay in the pioneering stage.

While the site choice may be very much influenced by opportunity, a criteria that is essential is that any village should be able to catch, store, reticulate, and clean up its own water supply. It is also advantageous that wood, wind, solar, or high-pressure water is available for energy production, and that clear ideas of how clean energy can be obtained, or developed and maintained, is part of the design.

Likewise, road, rail, boat, and not-too-distant air access are also advantageous for trade and travel. Computer and telecommunications will enable most villages to be in a data network, but real-object trade needs transport.

Finally, one cannot stress too much the factor of mixed ecologies. Any village which has access to or can develop forest, aquatic, marine, agricultural, and market areas has many more options open to it than a village marooned in a simple ecology.

Procedural Stages to Follow

1. Formation of a group *or* location of a site.

2. Arrange site option or purchase terms. Options are cheaper, often as little as, e.g. $50 per year for several years *if* the price offered is about 20–30% of the developed site value. The seller may retain a house title on the land if so required, and the price is then discounted.

3. Obtain an "agreement in principle" from the local shire or planning authority, establishing:

- Road type needed, e.g. gravel or sealed;
- Number of allottments allowed in the cluster or per acre;
- What services the developer must provide;
- The stages of development, if the shire requires building to be completed in stages.

4. Do careful sums, establishing prices based on roading, water supply, and sewerage.

5. Prepare a detailed and careful site plan and proposal for the village.

6. Convene, by advertisement, prospective customers and obtain firm commitments. Issue the proposal and site plan.

7. Obtain sealed permission for subdivision from the local authority.

8. Sell to prospective buyers, using a trust fund for road, water, and site preparation.

9. When costs are cleared, decide on future projects from profits and skills gained.

There are various ways to finance the process:

- Developer has all funds for survey and plans.
- Developer raises funds for proposal from investors.
- Potential buyers form a trust account to purchase and develop the land.

Some mix of the first two is possible, with trust funds established by the developers. These funds can be released when the development is fully approved by the shire council, and roading and services can be installed at those stages that may be demanded by the shire or region.

There are appropriate legal structures for a village. The developer needs to set up a trust (Trust A)—a land bank—to hold commons (village land) for the common good and for later development. Here, the developer acts as a foundation director (settlor), and should retire as soon as the site has 10–12 residents, who then assume directorship of the trust lands and cash assets for the village (about 3–4 directors are enough).

Residents should, as early as possible, set up a separate unit discretionary trust (Trust B) for trading operations. Such trusts are currently immune from company tax; they also reduce family tax and enable a wide variety of enterprises to be initiated by one organisation.

The essentials of Trust A are that it holds assets for the public good, does not take risks, and leases or rents to Trust B, which *does* trade and take risks, and has Trust A as one of its beneficiaries. Trust B can duplicate or triplicate itself to accommodate new enterprises and to insulate from risk those successful operations which may later develop. It can also handle financial systems such as leasing and lending units.

Although cluster and strata titles give privacy, negotiability, and autonomy to individuals and families, and titles and houses can be resold, traded, or given to Trust A, it is necessary to set up a land trust if only to administer the common lands, recreation reserves, and sites for future structures such as schools, restaurants, machine shops, or primary production.

In fact, as soon as possible after the developers pay land and developmental costs, they should seek to have village trustees elected. As the current costs of such trusts are minor in the total, and as they are so useful in planning and in income-earning, they should be part of all new village design. It is superfluous and unwieldly to have any more than 3 or 4 trustees for each trust, although small sub-committees can also be allotted part of any specific project work, and other people can contribute their special skills.

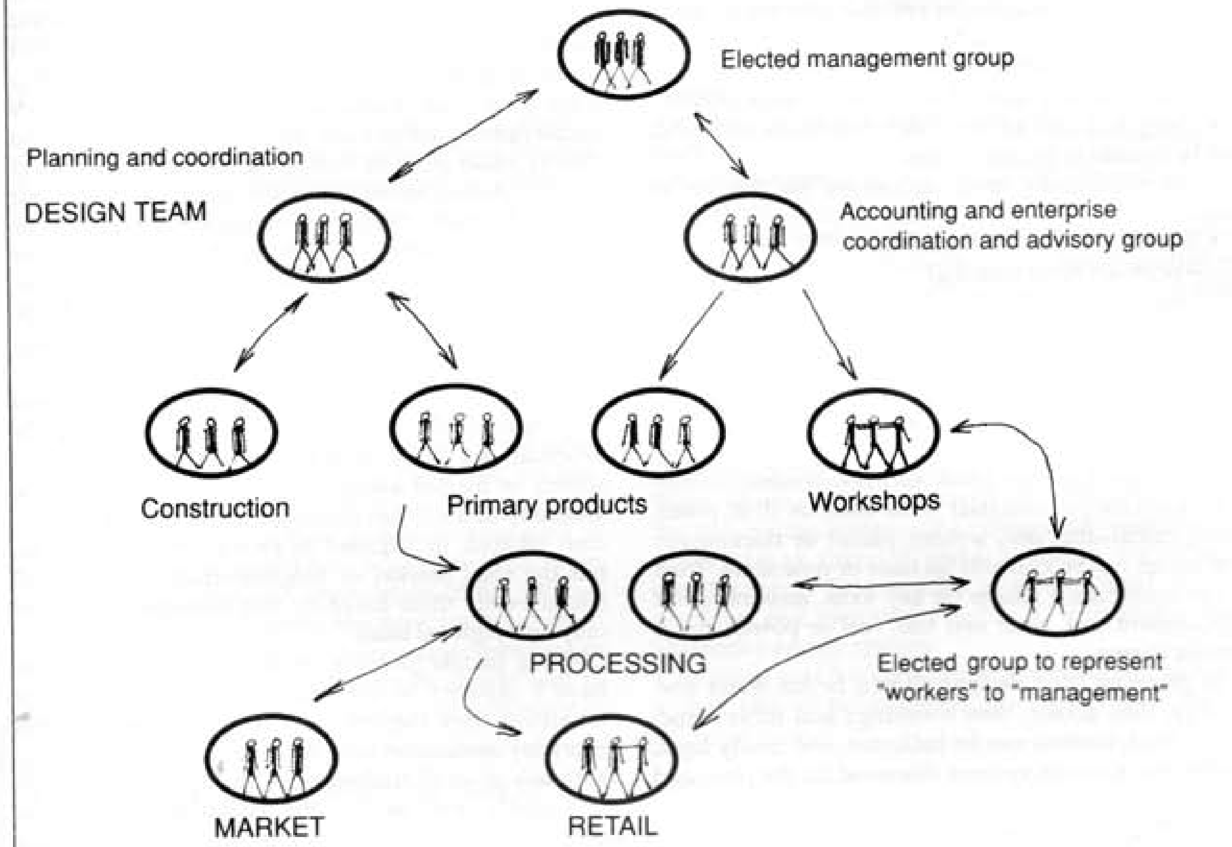
The developmental group works best as a small core of 2–4 people, each with special skills such as real estate, design, planning, or law. Surveyors, road-builders, builders, and landscapers are usually locally available for such projects. (Although these may also be developers, some contractors will work for equity in the project either as village occupants, or for resale at a later date.)

The development group should hand over a site design and user's manual to the directors of Trust A, who can display and circulate the initial design, record changes and modifications, and keep clear the essential land areas for productive use. Of course, all initial designs are made to be changed. The challenge is to change the design for the better! A design gives a starting point, not an end point.

Size of Villages

Human settlements vary in their ability to provide resources, to develop a high degree of self-reliance, and in their alienating or (conversely) neighbourly behaviour according to population size and function. At about 100 income-producing people, a significant financial institution can be village-based; at about 500 all people *can* know each other if social affairs are

**FIGURE 14.6**
ORGANISATIONAL STRUCTURE OF A COMMUNITY; Each group has independent decisions.




Feedbacks are obvious; any group can offer external services or goods. Each group is separately accounted and manages their own money. All groups pay basic rent, rates, time–use fees for vehicles and equipment. A community of 30–300 adults. Includes light industrial commercial areas, arable and forest or orchard land.

organised from time to time.

At 2,000 people, theft and competitiveness is more common, and sects set up in opposition—the "ecumenical alliances" are lost. Perhaps we should start small, at about 30 or so adults, build to 200–300 people, and proceed slowly and by choice to 500, then "calve" into new neighbourhoods or new villages.

However, alliances of 200–500 household-size hamlets can make a very viable manufacturing or trading alliance and maintain a safe genetic base. Many tribes of 200 or so confederate to alliances of 4,000–7,000 in this way, share special products by trade, or arrange out-marriages. Thus, pioneer villages can seek alliances with others for the common good.

The Mondragon Cooperatives of Spain at first grew large (3,000–5,000), but later reduced to coopseratives of 300–500 to preserve the identity of every individual. Nevertheless, a group of such small coopseratives can make any vehicle or machine if each produces a part, and this is in fact organised by the smaller cooperatives in the Mondragon system.

In my view, the neighbourhood factor—knowledge of each other's names—is a primary factor, and has proved to be a major factor in survival in disaster, as assessed (e.g.) in the 1967 Hobart fires, where casualties in "anonymous" areas and commuter suburbs were many times higher than in neighbourhoods where people knew and cared for others.

## Land Allotment and Village Infrastructure

Infrastructures for energy, commerce, and land allotment are an integral part of a self-reliant village. Few villages own all of these, however, and new villages need to reserve off land and areas for future priority development of both structures and primary product areas. A general plan of these resources must be published for all participants.

The following areas can be reserved for future use:

- School, seminar, and workshop rooms, computers, library, artwork, some crafts areas.
- Food processing centre, cafe, coffee shop, home baked goods, some commercial or surplus sale products.
- Noisy/oily work, woodwork, metal-work, machine shop, repairs, bulk fuels and oils, grease, air pump, vehicle service.
- Retail shops (including plant nursery retail), reception for visitors.
- Dairy and dairy processing centre.
- Domestic livestock housing, chickens, goats, pigs,

sheep, rabbits.

• Methane generator and ferment tanks, sewage, sullage, biomass conversion systems and water clean-up. All sites for energy and water provision are public reserves.

• Glasshouses, commercial crop, and special crop.

• Camp area for casual visitors (toilets and showers); can be a youth or student hostel.

Some community tools are needed for the site at large:

• Tractor – slasher (fire control)
  – posthole borer (fencing)
  – trailer
  – chisel plough/soil conditioner
  – chipper (biomass and mulch provider, fire control)

• Tow truck (mulch and goods)

• Van (goods)

• Back-pack slasher (blackberry and brush)

In workshops, essential tools such as drill press, lathe, radial-arm saw, welder, planer or thicknesser, and router can be available on lease or time share. Trust B can undertake a charge on any tools, accounting for replacement cost, wear and tear, fuel or power, and a service charge.

In planning, first designs should be for water and energy, then access, then dwellings and other structures. Next, landuse can be indicated, and finally legal, social, and financial systems discussed for the place and time.

Dwellings need to be of varying types:

• Family homes (individual or trust ownership; 2-5 bedrooms);

• Singles quarters (flats with strata title; some guest accommodation, 1-2 bedrooms);

• Elderly and hospital quarters (strata and community trust title; single and double bedrooms); and

• Terrace housing where appropriate.

A mix of such housing provides much more for needs and age differences than does the traditional family home. Every village could maintain one empty strata title for emergencies such as family break up, or to stage people in to permanent housing.

Recently some American towns have enacted ordinances to force buildings to comply with a 60% selfsufficient space heating requirement. Every house built today can be close to 100% efficient *by design alone*, at no extra cost in construction. Solar hot water systems are now routine installations, and photo-voltaics almost so. That is, energy needs are solved mainly in the home by a combination of good design and hardware. However, energy can be generated in other ways, and site allowances should be made for this.

The very modern "urban planning" where city or town sectors are designated as industrial, commercial, residential, or recreational are in fact the very antithesis of good planning for transport energy conservation, and bear little or no relationship to the zonation of function and available time around a settlement or house, as outlined in Chapter Three.

Wherever possible, life, work, and recreation should be integrated in a dwelling; not only are households better informed, children less alienated, and adults less isolated from social contact, but the need for complex transport systems is eliminated. We have a great deal to learn from older cities, which evolved in an energy conservative environment; cities such as Florence and Vienna, older parts of Berlin, and almost every village that functioned before 1930. In all such settlements, the cultural, crafts, trades, commercial and domestic functions were *integrated*. Old city blocks in Berlin have housing over street level shops on the sunny side, trades and work in the easily accessible interiors of *hofs* that penetrated and opened up the centre of the block, and a market or supply depot close to this assembly.

Such integrations are conducive to the development of complementary skills in the neighbourhood. In Istanbul and India trades may well be grouped in streets or market areas, so that both new materials, assembly, and sale are facilitated (and branches of each craft allotted, or adjusted to production by demand), but the total market or neighbourhood contains all trades except those based on rare resources or needed only on a regional basis.

Young people growing up in such an environment have a capacity to use many materials, or to make whatever they require, as a result of the informal everyday association with the 'open shops' that are the hallmark of small tradespeople, and where neighbours and family come and go the workplace itself. Davis (California) is one modern town where energy-conserving legislation is in place, and people are encouraged to conduct all non-polluting businesses from their homes; and where bikeways are available throughout the settled area. Elsewhere, "zoned" industries create vast traffic problems, and the separation of people from services.

How is the land not attached to dwellings to be allotted? The following categories are of use in villages everywhere:

• Land for public buildings and services.

• Land for recreation, trails, and walks.

• Water storages and reserves, energy sites.

• Productive land for food: livestock, orchard, nursery, greenhouses.

• Forested areas (fuels and timbers).

• Reserves for wildlife and flora; conservation areas.

• Easements, wayleaves, roads, and public utility allotments.

• Commercial areas for retail, manufacturers, offices, professional services, common markets.

Family dwellings and their 0.2-2 ha lots can accommodate some of these, but in miniature. Many homes are in fact commercial premises for home services and industries; many store their own roof water, provide much of their food from the garden, and may contain recreational assets. However, a larger site plan does allow more convivial access to land, some commercial crop potential, significant forests and ponds, and access and utility easements.

Public access and service centres owned by the village, such as food processing, freezer, and laundrette facilities not only provide a part-time income for a resident but sharply reduce the energy needs for each house to provide and maintain such facilities, and provide a wider district resource.

An even greater saving is realised by a modest tractor–tool–truck hire service, in which Trust B leases these infrequently used assets to residents as needed. In fact, a sensible village would closely investigate the advantages of a total vehicle leasing system, fleet purchase and insurance, local maintenance, and bulk fuel supply.

Village Energy

Coupled with domestic energy conservation, modest power units can supply small villages or regions with their energy, and can certainly be started by the same protest groups who rightly oppose giant coal, nuclear, oil–powered, centralised and polluting energy systems.

Like any other enterprise, a diverse approach is recommended, with energy from wind, tide, river, solar, and methane used where appropriate. **Table 14.7** on energy conversion efficiency has been compiled from several sources. It includes primary conversions (gas to electricity) and secondary conversions (waste heat to high-grade gas). However, mechanical efficiency is perhaps the least important concept for people, and is relevant only if:

- The process is non–polluting, or relevant to the place.
- The technology is socially acceptable, and locally benign.
- The cost is affordable, and amortises under 10 years.
- The technology can be locally produced and maintained.

Finally, no matter how efficient a technology may be, if it lays waste to or destroys the basic quality or quantity of soil, water, or clean air, then it must be rejected, as this is the "economics of extinction". For this reason, I have not included fission processes with radioactive by–products, coal as now used, or mineral petroleum beyond initial or transition use.

Financing Public Services

When all titles sell, the monies generated by the sale of the 30% of titles vested in the village trust would ensure a very large interest yield annually for village development. This would, in effect, build fences, terraces, and eventually schools, workshops, and alternative energy systems.

At about year 5 of development, when residents have a clear idea of future needs, the capital itself can be

**FIGURE 14.7**
THE CONVERSION EFFICIENCY OF SOME DEVICES AND SYSTEMS

| DEVICES OR SYSTEMS | CONVERTS (COMMONEST) | CONVERSION EFFICIENCY (%) Lowest | Average | Highest |
|---|---|---|---|---|
| Amorphous silica solar cells | Sunlight to electricity directly (cheap to produce in quantity) | 2 | 3 | 5 |
| Cow dung burnt as fuel | Dung to water heat (reduces available fertiliser compared with biogas) | | 7 | |
| Crystalline photovoltaic solar cells | Sunlight to electricity | | 13.5 | |
| Open fires | Wood to room heat (very wasteful of wood) | | 15 | |
| Solar ponds for electricity | Sunlight to electricity generator (110 sq. m/kW) | | 15 | |
| Humphrey liquid piston engine (pumps) | Gas fuel to water lifted (engine and pump). Very durable and trouble–free engines | 10 | 17 | 20 |
| Gallium arsenide photovoltaic cells (If these were cheap, all home energy could be electrical from 100 sq. m roof) | Sunlight to electricity | | 17.5 | |
| Undershot straight–paddle wheels (see poncelot models) | Water flow to shaft horsepower | 18 | 18 | 20 |
| Modern photovoltaic solar cells | Sunlight to electricity | | 25 | 29 |
| Stirling hot air engines | Solar to mechanical energy | | 20 | |
| Solar flat plate collectors | Sunlight to hot water (Conditions vary widely) | 10 | 30 | 50 |
| Kenyan bell–bottom metal cookstove (also applies to fairly efficient "pot belly" stoves) | wood to cooking heat | | 30 | |
| Gas turbines | Gas to electricity (waste heat produced) | 30 | | |

| | | | | |
|---|---|---|---|---|
| Wood burnt to generate power | Wood to electricity | | 33 | |
| Piston air compressor on water wheels | Shaft horsepower to compressed air | 30 | 35 | |
| Typical diesel engine | Fuel to horsepower | | 36 | |
| Turbo–charged diesel engine | In production (ceramic turbines) | | 41 | |
| Adiabatic (cool) diesel | Prototypic in 1984 | | 48 | |
| Gas fuel cells (not widely in use; models are in operation) | Gas to electricity | 40 | 50 | 60 |
| Solar attic (Compared this with an open fire) | Sunlight to heated air | | 59 | |
| Well–made slow combustion stove (May pollute air) | Wood to hot water, cooking, and space heat | | ±60 | |
| Cow dung converted to methane (Useful fertilizer residue) | Gas to cooking heat | | 60 | |
| Elevated dams or ponds as "batteries" | As energy storage (Water pumped up with off–peak electricity) | | 60 | |
| Undershot Poncelot (curved vane) water wheels | Stream flow to shaft horsepower | | 60 | |
| Breast water wheels (curved vanes) | Water power to shaft horsepower | | 60 | |
| Organic Rankine cycle engines | Thermal efficiency only | | 65 | 70 |
| Concentrating solar collectors | Sunlight to water heat | | 65 | |
| Propellor turbines (hydraulic) | Streamflow to shaft horsepower | 65 | 68 | 70 |
| Farley Triplate wave machine | wave motion to compressed air or water lifted | | 70 | |
| Plenum heat exchangers (Combine well with a solar attic) | Air to air, save waste heat | | 75 | |
| Rotary hydraulic turbines | Water at head to shaft horsepower | 75 | 78 | 90 |
| Pelton wheel coupled to air compressor | Supplies compressed air | | 79 at motors | |
| Solar ponds used for heat | Solar radiation to water heat | | 80 | 86 |
| Heat cells | Heat stored to heat given out | | 81 | |
| Well–designed overshot water wheels | Streamflow to shaft horsepower | 75 | 80 | 82 |
| Diesel co–generation (providing the heat is used constructively) | Diesel fuel to heat (60%) and electricity (30%) | | 89 | |
| Biogas conversion | Heat rating of material to gas BTU | | 90 | |
| Thermal mass heater (compared with most stoves) | Wood to heat | 80 | 90 | 92 |
| Good pelton wheels or Turgo impulse wheels | Falling water to shaft horsepower | | 93 | |
| Inverters (electrical) | 12V to 110 or 240V | 75 | 90 | 95 |
| Electrolysis of water | Water to hydrogen fuel at 200°F, at 250 atmospheres | | 92 | 93 |
| Unglazed fast–flow collector (Stream flow over black surfaces) | Solar radiation to water heat | | ±100 | |

| **AMPLIFIED EFFICIENCY** | | **Factor of gain** | **Efficiency** |
|---|---|---|---|
| Heat pumps | Extracting low grade heat to useful space heat or cooling (as compared with using the same fuel more directly with heating) | (x 3.5 to 7) | 350% |
| Compressed air heaters applied to air lines | Expanding cool compressed air just before using in engines (compared with same fuel used in engines) | (x 5.5 to 6) | 5-600% |

used to install wealth-producing assets for employment in the village (glasshouses, computers, machinery). By allotting 30% of sites to the body corporate (Trust A), the developers ensure that:

- All necessary public services are funded;
- Residents, over a period of 20 years, have effectively paid nothing for land; and
- As soon as sales exceed 60% of total titles, either capital or interest for public services is available.

The Trust can use this asset in many ways, but would be most effective in ensuring either conservation of energy or business development on site, and in using the common wealth for increasing local productive assets. If a credit union has been established, much of the trust capital can be transferred to a loans account, so that residents can draw on it at low interest for local occupational development. Conscientious use of a credit union by village residents would greatly increase capital flow to village enterprises. There may be some capital available as housing loans, but a building cooperative would be much more effective in this instance.

The result of having such capital and interest flowing in to the Trust is that village morale is greatly increased, with every resident seeing long-term plans fairly rapidly achieved. Well- managed, the capital should actually increase, giving a large annual capital for village use.

The Trust will always need income for maintenance of roads, fences, water supply, fire control, and other site factors. This can be raised from small charges for leases and loans to residents, by charging an hourly rate for lease, use, or hire of machines and facilities, and by a 10% levy on net profits of locally-funded cooperatives. This levy is the same as that paid by the Mondragon cooperative system to fund their banks, schools, and research facilities in Spain, and applies only to net profits of trust-funded cooperatives.

A Community Services Council at any new community or village with common lands may be elected to administer policy on publicly owned or common assets, to collect lease monies on utility plots, to administer funds for schools and medical services, and to see that rates are used in maintaining roads, water supplies, and other public services.

"Community Services" in any community can encompass the following:

- Fire control services
- Land leasing of common properties for business use.
- Public reserves and sports grounds
- Ambulance and health services; cemetery administration
- Education and educational facilities
- Community centre: use and hire
- Power and water supply
- Forest management
- Tourism/promotion (if desired)

Some of these are income-producing, some subject to state aid or tax immunity, and some are income-consuming. The Services Council needs to attempt to balance these costs, allot land and assets for income to service groups, and ensure that common property and rights are fairly assigned and well managed.

Council should be comprised of a selection of those *active* in the above areas, not of an uninvolved group. Each area of action can have a basically independent management sub-group, reporting to Council regularly. These sub-groups can appoint one of their number to represent that group on Council.

Council needs to meet monthly, or even more infrequently, with the sub-groups normally handling everyday business within their budget and allotted areas of operation. A Council can call for and act on submissions or reports relating to specific policies and strategies. Sub-groups can raise their own funds (as well as have access to public funds) may have an active business management role in income-producing areas, and supply workers to carry out such businesses.

Income is needed by a community for the continued upgrading of public services. There are several ways in which this may be done:

- LEVY: A yearly levy on each family or property can be collected by the Community Council. This would probably be in addition to the normal Shire Council rates, and may create a hardship on some households.
- TITHE: Individuals, groups, and businesses (including the cooperatives) can tithe 10% of net profit to the public services. All the Mondragon cooperatives do this, and so fund schools, libraries, churches, and recreational grounds. This means "rates" would be on a sliding scale, not a flat rate for everybody regardless of earning power.
- LOCAL CURRENCY: The Community Services Council can print its own currency, backed up by a valuable community resource (firewood, clean bottled water) to fund projects, new buildings, etc. Local currency operations are detailed later in this chapter. A timber forest planted early on and harvested at various stages of maturity can produce most income needed for subsequent years, as it does in some modern towns which have developed social forestry.
- CHARGES: Charges by the school, community centre, and health services can be offset against costs on a "user-pays" basis for tuition, use of facilities, medical needs, etc. This is a method which should be used in conjunction with another model, as it covers only those public facilities which not everybody uses or wants; universally used services are usually pro-rated ("rated").

<u>Potential Enterprises and Occupations</u>

It is of great advantage to analyse just how village occupants can self-employ in service to the village itself and to nearby districts. Let us presume a 50-house (100 adults) village situation. Costs are high in three areas: food, energy, and transport.

We can now speculate how residents can earn their living in the village. Much depends on a village development credit union which is founded by the village under Trust B to serve the village needs.

• *Food*: About 20 adults can support 1 adult providing a food supply; thus, 5 to 7 families can earn a living from food provision, e.g. open air market gardens, glasshouse crop, co-op store (with local trade), domestic livestock and fishery enterprise, and a part-time livelihood from cafe, food processing, and baked goods. All surplus can be sold off to visitors or locals from outside the village proper via a village market.

• *Energy* Energy needs include space heating, cooking, electric, hot water, gas, and appliances. To establish energy-efficient systems, plans need to include prior excellent house design, design for the retrofit of inefficient houses, insulation, and good appliances. Most need capital to start, but almost all amortise in 3–7 years. Two to five families can earn a living from house design and retrofit, with some contract and extension work outside the village, hardware and appliance sales to the village and to the district, and installing, repairing, and tending a village energy system. Over time, some manufacturers in the village would enable a balanced trade in appliances.

• *Vehicles*: These are perhaps the most costly item and need a careful and planned approach, better on a village network level than on a one-village system. Two to four livings are indicated in service, repairs, maintenance of village vehicles, bulk fuel and oil supply; in growing, distilling, or fermenting fuels for engines; and in fleet lease and insurance, special vehicle lease, tractor lease, etc. Village alliances can establish special engine or chassis manufacture.

• *Financial*: Handling the income, loans, accounting of enterprises, and running a credit union is an essential job for a village. A computer is certainly needed, as are accounting and managerial skills. Two people could perhaps handle the financing. A community credit union, holding insurance money as well as incomes, can fund enterprises such as energy systems, glasshouses, dairies, and food processing centres.

• *Medical and pharmaceutical*: One or two people can offer medical and pharmaceutical services to the village or area, including prescription, massage, counselling, and local treatment. Some medications can be made and sold more widely, and specific remedies grown or manufactured. Community health should always be based on prevention of most illnesses.

• *Building*: For some time, a plumber-builder-mechanic can serve village establishment and later maintenance needs locally, and can produce useful furnishings and sale items for extra income, if a woodworking area is made available.

The above occupations cover the essentials of shelter, food, economy, energy, transport, and health. This would initially fund about 20 of the 50 households, and more as manufactures develop.

Other than the essential occupations, there are a range of potential village enterprises. Some can be based on land resources (glasshouse crop, special crop, cut flowers, herbs, pharmaceutical, processed dairy products, fish and aquaculture). Others can develop from local skills: teachers are needed for children, for adult education, and for applied workshops on site. Careful forward planning can yield one or two livings in workshops (craft, medical, or design). A small business service centre may be needed in the mid-term, employing 3–4 people.

Consultancy for other sites in architecture, landscape, and design is possible, as is implementation and provision of plant materials from a nursery on site, which can further develop special crop for site, fire control, bees, orchards, or forages for animals (comfrey, tagasaste, etc.) Some people may like to cooperate in an animal-breeding programme for special poultry, pigeon, sheep, or goat breeds as a small stud.

Computer services to a network, programming, and data bases on special subjects are now in demand, and can be placed in homes. Publishing is greatly assisted by computer word processing and allied computer typesetting services.

Trade, as distribution rights, wholesale potential, import-export trade and village trade networks are yet another probable enterprise, as are craft products from metal or wood workshops, pottery, and art. There is a modest income from guests, visitors, and site tours if the village concurs on that aspect, and from sales to visitors and travellers in the district; educational services and accommodation are much in demand.

All of these, and many others, need little transport. Many can operate on site, and the cooperative store would serve as an outlet, or other leasehold retailers can offer goods and services for the village. Physical therapists and paramedics, especially in massage and stress-related problems, often find plenty of customers in a rural district.

These enterprises depend on two basic factors: capital (enough money to start up and develop), and management (careful accounting, forward planning, market research and development, product development, sensible costing and staffing, correct lease and rental agreements, appropriate legal structures); thus a small business service centre is economical and necessary for 20 or more businesses.

Many small enterprises yielding products or services can pre-sell their wares for initial capital, and many others need no capital to start up, but these may need time to develop. Some small businesses (massage, paramedical) need only skills to start, while others (market garden, orchard, furniture making) need skills, capital, and time.

A careful assessment of skills and available capital will indicate priorities in any village. Income-earning for local development is a priority, while other capital-intensive schemes (e.g. commercial pottery) need to wait. A very reliable early income can be made from information, by way of workshops and classes, although workshop income fades over time as students gain skills themselves. However, workshops yield capital for further developments locally, and a village can, in fact, develop as a special education centre if enough skilled people are attracted to that idea.

It should be the long-term aim of any village to own and operate its own employment enterprises. In past times, it was unusual for a villager to hold just one job; the banker was also a part-time barber and trader and perhaps gardener. Thus it is wise to share even simple occupations, so that individuals have occupational shares in 2–3 enterprises.

In this way, total failure is unlikely, as is unemployment. Holidays can be taken, and wet days spent on indoor work. Thus, in every occupation, job-sharing should be the rule, not the exception. Although the total village structure is complex, the work of any individual is simple, as is the case with a plant in a polyculture.

### RECYCLING IN THE COMMUNITY OR NEIGHBOURHOOD

The borough of Devonport, in the city of Auckland, New Zealand, has a total solid waste-recycling system, and from this conservative endeavour manages to return a cash benefit to households (versus the cash payment or rates paid to Councils in non-recycling areas). Data is available from the borough, but there are two or three key features that make the system work:

1. The borough issues an annual calendar, colour coded, and picks up *only* one or other category of waste on any one day, e.g. clean glass, metal, tyres, paper, organic waste, oils, etc. No other, and no mixed loads are collected. Thus, recycling begins with separation of wastes by the consumer.

2. At the waste disposal site, loads must also be in one category. Here, wood is sorted into useful wood (a community woodwork centre is available), firewood (issued to elderly people), and chipping or mulch wood. All organics are composted by a small tractor windrow system, and all oils are collected for re-sale as lubrication oils after filtration. Compost is sold, as is mulch, and any surplus is used to carpet a "ziggurat" (ascending spiral ramp) made of broken pipe, brick, clay, concrete, and clean fill; as the ziggurat ascends, community organic gardens follow the fill.

The waste site is supervised, loads directed, and mixed waste sorted; saleable or recyclable items are grouped in clearly marked areas.

3. People who will not sort their waste (about 4%) must buy a strong plastic bag from the borough (hire cost $7) which itself is recleaned for use. The charge on the bag pays for the bags, into which people separate the waste, and for the calendar; the borough also gets income from the sale of paper, glass, metals, wood, plastics, and compost.

Obviously, the opportunity for local co-ops to enter into recycling industries is there; many small local industries can buy wood, glass, paper, or oils from the borough. Such examples dictate that no Council has any excuse for *not* recycling; not only does waste cost the ratepayers money, but there is also a vast waste disposal problem. It is up to ratepayers to elect officials who *will* recycle sewage and solid wastes, and to vote out waste-promoting councils, who "cost the earth"!

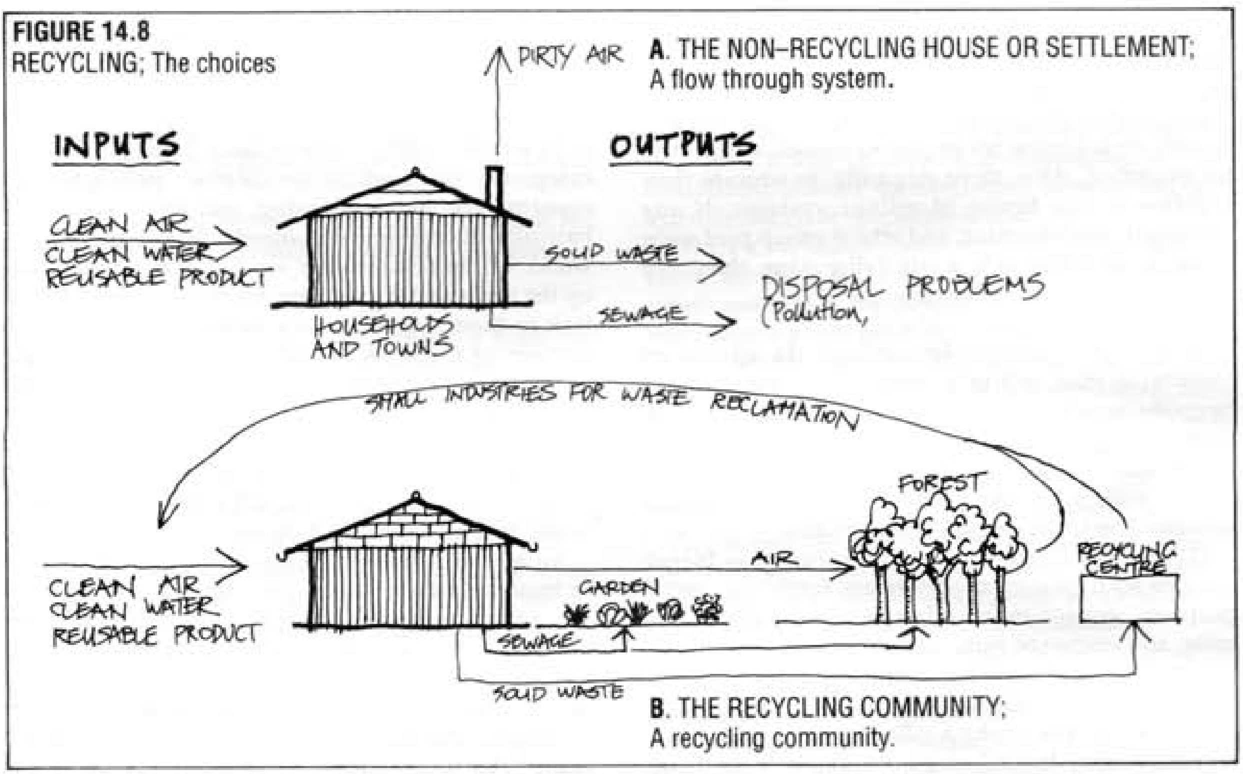



**FIGURE 14.8**
RECYCLING; The choices

EVOLUTION IN COMMUNITY

No group can achieve financial self-reliance overnight, but within 5–7 years of a determined start, a cooperative group using their creative talents can succeed in making a living for themselves and building up a strong business sector in their community. Any person can feel a sense of social cohesion and group spirit in such a situation. The danger point of "going under" is past, and now it is time to think of diversifying and disinvestment before the group gets too affluent, or too big. At some point, therefore, a decision must be taken to take some positive action (and avoid the fate of affluence):

**1.** To hand over to other some income-earning but superfluous (to the existing group) enterprise, and so reduce income.

**2.** To extend aid and services to areas in desperate need, such as those experiencing real poverty, natural catastrophe, or medical insufficiency.

Many groups put off such actions, but it is better to start them (at modest levels) very early in the whole process. There are many ethical groups and individuals who regularly tithe 10% of their gross income to such endeavours. Most of us do not have large appetites; we wish only to have a shelter, enough food, some small luxuries, money to travel, and friends. These are modest needs to achieve; beyond them lies adventure in helping others get on a firm footing. The only real security in life is a secure society of interdependent people, thus the only valid "defence" is aid to others.

Any village group can help others become more self-reliant and give sound management advice to new groups. Fiscal management, like energy management, also needs *social, environmental,* and *ethical* accounting. Money is of no use if its ends are destructive to society, life forms, or values.

Cooperative groups, communities, associations, and shared work groups fail in part to foresee and to plan for evolution. Also, more tragically, to educate their children in the basics of village systems. If any intelligent, hard-working, and ethical group pool some resources and take only a fair living wage, then they *must* amass spare capital in time.

As and when independent villages do achieve an identity, an ethic, and unity, beneficial connections can be made ranging from radio and land links to bulk purchase, trade, and share facilities, so that coastal, urban, arid, tropical, and primarily rural villages can access and share the resources of others on an agreed-upon lease, hire, or exchange basis.

Village coalitions can fund and operate larger systems such as mutual investment funds for special purposes, engage in manufacturing on a reasonable scale, and exchange skills and strategies. At present, few villages have the initial sound legal, financial, and social structures to achieve this.

There is no reason why a village could not own and operate a boat, trucks, or pack animals to facilitate trade, why a mountain or urban village could not purchase and manage a foothill farm for food production, and why an inland village could not finance part of a coast development, as many villages already do in India (along the Ganges) where towns and regions own pilgrim houses for voyagers. All these strategies enrich village or regional life, and give access to a wider world; this is particularly important for children and young people.

## 14.10

## EFFECTIVE WORKING GROUPS AND RIGHT LIVELIHOOD

In any human group endeavour, there are practical and effective, or impractical and ineffective, ways to manage a complex system. Impractical, frustrating, and time-consuming systems are those governed by large boards, assemblies, or groups (seven or more people). These "meetings"; have a chairperson, agendas, proposals, votes, or use concensus, and can go on for hours. Concensus, in particular, is an endless and pointless affair, with coercion of the often silent or incoherent abstainer by a vociferous minority. Thus, decisions reached by boards, parliaments, and concensus groups either oppress some individuals (votes) or are vetoed by dissenters. In either case, we have tyranny of a majority or tyranny of a minority, and a great deal of frustration and wasted time.

The way to abolish such systems is to have one meeting where the sole agenda is to vote to abolish decision meetings—this is usually carried unanimously!—and another where a concensus is reached to abolish concensus—this too shouldn't take long. What do we put in place of such impediments to action?

In every group, there is work to do. This work needs to be set out clearly, as jobs or tasks. Tasks fall into two categories: those which are creative, productive, or constructive, hence pleasing, and those which are basically maintenance (domestic, office, and garden work). Of the first category, we seek volunteers to take up the tasks, and if they come forward, we ALLOT that task to them, agreeing on a timetable and stages of completion. Of the second category, we ROSTER people to do the work, laying out a worksheet and a (usually weekly or monthly) roster.

Wherever no volunteers appear for any task, then the group as a whole contributes a tithe to pay for the task to be carried out by a contractor (as in many trade tasks); thus all work gets done one way or another.

An essential strategy for rapid and flexible action is to limit the number of people responsible for any one area of action or task. Some ideal number is between one and three individuals, who *manage independently*, but who may work to a general plan and schedule to fit in with others. Completion dates are set and notified to all people, and some form of report, diary, or plan is made public or minuted.

Thus, we can form *small* groups of one to three people who are responsible for management of a specific area of activity. It is a fail-safe strategy to attach occasional understudies to this small group, or to stand ready to duplicate the function if it is not being administered. (There is no more time-wasting process than that of believing people will act, and then finding that they will not.)

This "troika" approach (1-3 people per function) ensures that meetings in any one area are few; news can come out as reports, available to anybody. It also means that no one person or group has "rights of decision" over other functions or groups. Unfortunately, despite our most devout wishes, there are very few people who can start up and maintain a function; we are lucky if we can find 6 or 7 of these in any group of 30-40 people. Thus, for all functions needing entrepreneurial skill, we need key people.

However, there are many functions (from crafts and arts to gardening and building) that do not need entrepreneurial skills, but which follow if these resources are available. Thus, many people can be involved in primary production, processing, and building if only a few can manage the essential coordination and funding.

In such a web of function, any one person can be in two or three teams, thus achieving a "portfolio of occupations". Also, each group depends on each other being in function, and this is important for group unity; we presume a shared ethic and values, which are clearly spelt out, but do not assume love, trust, or any particular form of personal diet and behaviour except in line with ethics (we are never perfect, just moving towards improvement).

1. Only in the initial planning do people need to assign or choose functions; once chosen, no group meetings for business are necessary.

2. Each group or sub-group is small enough to reach fast agreements and know of each others' movements and work.

3. No consensus beyond that of an initial ethical and value consensus is necessary; everyday decisions are made by small groups.

Certain behaviours occur at various group sizes; here are some approximate size and function groups:

• 1-3 people: Executive decision, least meeting time, greater pressure to act, fast changes possible, fast replacement of key people.

• 4-6 people: Good volunteer or cooperative group work, or work group for special single projects; good size for work exchange systems.

• 7-20 people: Function well only in social conditions; can be a recreational group or team, but at 7 or so, a *chairperson* is needed and decisions are slow and frustrating, often creating dissent.

• 30-40 people: Acknowledged as the minimal group of people in which most human functions can be covered, and who (if well chosen) can cope with almost any type of problem.

• 40-200 people: Rarely found as a group or settlement, but a good size for a regional organisation.

• 200-300 people: The basic number for genetic variability; such a group can, by careful breeding, maintain their numbers as a tribe and allow for some losses to disease. Probably the minimal human village size (called a hamlet).

• 300-600 people: About the limit at which people know every other person by name; thus, about the limit of "identity". This is the largest satisfactory size for educational or learning systems if personal attention is valued. Acknowledged to be the upper limit for successful cooperatives for real participation.

• 1,000-5,000 people: Usual upper limit of federations of tribes; a good size for a bioregional group or sub-region. Also, a village size limit. Cliques, theft and cheating common and possible; hierarchies are needed.

• 7,000-40,000 people: Towns, large bioregions. Chinese communes start about here. This number is not satisfactory unless broken into small cooperatives and villages. Crowds and very large audiences can reach this size, and can be difficult to control if aroused. It is about the upper limit for any real control by strict hierarchical systems.

• 15,000-10,000,000 people: Cities; mainly disorganised on every level. Effective anarchy and crime, and social isolation in many areas.

As even very small numbers of people (4-6) can be very effective, it is better to set up independent but friendly alliances of small groups than to coalesce into groups of 600 or more. Any alliance of 4-10 villages (12,000-50,000 people) can, by agreement, run a sophisticated trade and travel organisation.

Most groups start with 1-3 people, and recruit slowly. Slow or organic growth is easily coped with, while sudden influxes can be disruptive. As groups pass 30 or so in size, it may be possible to contemplate selective recruitment to make up deficiencies in skills, sex ratio, age differences, or specialties needed.

Where a very large number of people is needed for a job, a calendar is set and conveners let everybody know when and where the personpower is needed. Thus, every larger group needs to delegate responsibility for work to smaller autonomous groups, who are trusted to do the job, and only replaced if they persistently fail to do so. In this way, every person who wants to work controls their work, and non-involved people have no say. This eliminates control by inactive people in tasks they are not familiar with, and nullifies power seekers.

As for dissenters, there never is any impediment to their setting up their own ideal system, and living in it; or setting up a parallel work group to show how it should be done. Above all, there is *no one way* to do anything. "One solution" systems evolve from the concentration of power in one or other form of dictatorship (business, government, or military).

In this way, all group meetings can therefore be social and convivial, and for information exchange. As these meetings are pleasant, we can look forward to them, and so a pleasant and informative occasion replaces a frustrating and stressful "group decision" meeting.

On a wider scale, cells of one to three people can run a very large network; in this way, given occasional (every 2 years) meetings in affinities or work integration groups, attended by small autonomous groups, positive WORK–NETTING (*not* pointless networking) is possible. No person can force another group to cooperate, but must offer reasonable, rewarding, and fair cooperation.

Above all, no group or community need last forever; a group set up to achieve certain ends can disband with a clear conscience if those ends are substantially achieved. Individuals can then take on new and more current tasks, or adopt a different level of effective action based on past experience.

No–one would deny that people are *the* most difficult factor in any design or assembly. It is not that people lack the will to cooperate; it is more often that they have not adapted those sensible legal and administrative, or social mechanisms which allow them to cooperate. At various periods of history, usually coincident with economic downturn, groups of people have left mainstream society to set up intentional communities. This phenomenom occurred in the 1890's, 1930's, and 1960's and at various times between. The most recent (1960–1990) is also the longest period of out–migration, and is still continuing after 20 years; it is a migration of skilled family people towards a smaller society.

Studies of such groups reveal that those who were effective adopted a set of values which ensured their continued internal and external interdependence; of those, perhaps the most important factor was that the group adopted "voluntary simplicity" as an ethic. It is no mere coincidence that there is both an historic and present relationship between community (people assisting each other) and a *poverty* of power due to financial recession.

Thus, the legal and ethical basis for successful community cooperation must stress sharing, trusteeship, and modest consumption; the latter is the more important, as individual power over land, real assets, finance, or group membership leads inevitably to power over others, and we are back where we started. The habit of frugality is perhaps the most important of those assisting other life forms.

Like landscape planning, there are community systems which can cause more time spent in conflict than can be made up later; such errors we can still call *primary errors* as they will lead to constant problems and expense later. Some of them are:

• Group consensus on all decisions (tyranny of the dissenter).

• Group leadership by one or a few (tyranny of the leader).

• Rules about lifestyle (tyranny of proscription).

• Attempts to live in large group households (lack of privacy).

• Overscheduling of meetings.

• Neglect of income–producing activities.

• Poor financial accounting, hence poor maintenance of facilities and equipment.

The individual in the community must recognise the need to subscribe to a group fund for maintaining roads, fences, and infrastructure, or to donate work in lieu of money on a regular basis. There are no "free" machines or free lunches. The essentials to concentrate on are sound land planning, shelter, a capital base, and the development of livelihoods.

Many "communal" systems fail if very few people are legally liable for capital risk. Good ideas and equipment cost money to implement, thus *all those who vote for equipment must be made equally liable to pay for it.* This always keeps the community healthy, as unused tools are expensive, but only for those who buy them! This is a lesson in modesty and responsibility. Moreover, tools on hire should completely repay their cost by charge on a piecework or hourly rate, over a period realistically estimated as half their working life (vehicles, tractors, office equipment and so on).

Every major tool needs to be costed for running costs, repairs, and replacement *plus* any interest on capital. The very powerful principle here is that "everything must pay"; more specifically, in community enterprises "proposers pay capital" and "users pay costs". In natural systems this is the "law of return". We cannot use soils, crops, or forests without costing total upkeep and replacement, or we impoverish the common wealth. Thus, "users pay" should apply at every level of community, except for hardship or welfare services.

There are two unhappy states of human existence; the first and worst is to be defined by your community or nation as unemployed, that is to say, of no use to anyone. In a world where such a great deal of work has to be done just to repair past damage, replace forests, secure soils from loss, house people, or build local self–reliance, unemployment is an obscene concept. Where relief benefits are paid, the state rewards people to accept this role of "no work", and in effect fines them if they work.

Secondly, it is an unhappy state to be employed, but not free to use initiative; any person can go daily to a job, no matter how useless or boring, no matter how destructive, and be paid to be defined in a single role, e.g. as a teacher, clerk, process worker, or labourer; the worker has no say in policy, social value, hours, product quality, or environmental worth.

In most cases, *other people* define the lives of the recipients of relief or salaries; as all such money comes from the pool of public wealth, then all such people are, in effect, on "relief payments", just as a company supported by public subsidy is on public relief (usually our primary production systems in the western world).

The only people who are *self–defined* are those who are self–employed, or who work in community work cooperatives. The consumers pay for their products or services directly, and their houses, products, and choice of work is self–determined; they are only unhappy to the extent they oppress themselves! I could never understand why people struggle to maintain a job down a coalmine, especially when their pooled capital and labour could create a forest, with all the pleasure one gets from working in the open air, and the varied work a forest provides. We can all seek for right livelihood to do work that assists in caring for the earth or other people, work that is congruent with our beliefs.

When we discuss the principle of "commonwork", or study the varied roles of an individual in a village, we can see that no person is just a miner, or clerk, or banker, but that on different days one can be a banker, forester, bee-keeper, writer, printer, or carpenter. It is only the combined pressure of trade unions and monoculture industry that keeps people bound with the invisible shackles of custom to those unguarded slave camps termed industrial suburbs, with all their malnutrition, poor housing, and human suffering.

In boring work, or where people are deprived of intellectual life, emotional life may dominate and so their lives become a drama or series of dramatic events. A balanced life has all three outlets, so that contented people may spend part of their time in: physical exertion (walking, gardening, sport); intellectual pursuits (design, research, education); and emotional-sensual areas (celebration, contemplation, love).

A healthy and balanced life consists of being able to access all such pursuits. In modern life, some time spent in primary production or in manufacture, some in service to a wider group, and some in relaxation–celebration is an ideal; few achieve it. In Central Australian tribes, at every event there may be three "function" groups (independent of totems or "skins"): one group "knows" or records time—*orchestrates* (the intellectual); one carries out dances, increase ceremonies or activity (the physical); and one encourages, applauds, and appreciates (the emotional). Thus, every person fits a matrix of totem and function **(Figure 14.2)**.

## 14.11
## MONEY AND FINANCE

In small and unified groups (tribes), what is achieved by financial systems elsewhere is achieved by a set of exchanges, gifts, obligations, and feasts; here social accounting replaces fiscal accounting and to a great extent, everybody "owes" the others. In many smaller villages, barter and exchange occurs as non-formal financial transactions, and a modest financial component is maintained only for travel and trade external to the region; symbolic wealth such as cowries are used in trade.

Only in very mobile societies does money start to replace fair dealing, objective value, and hospitality shared, and the abstract and intrinsically valueless "money" (usually cheap strips of paper or lumps of metal) replaces real goods and services. Even in fiscal societies however, barter and exchange are highly developed (even by multinational firms), and formal barter centres are now also evolving locally to distribute surplus goods for real or imagined needs. Faith in the fiscal system (an essential delusion if money is to maintain any barter value) is fading as nation states and giant corporations fail to meet their debts, and either repudiate debts or go into voluntary liquidation. In every case, the cost falls back on us. Large banks not only lose our money to start with, but make us pay for the loss. Large companies receive public subsidies (often direct cash subsidies, e.g. the sugar industry) that would make millionaires of paupers.

Fiscal (moneybased) societies give a false impression of security, which quickly falls apart every 40 or so years when inflation—which is itself due to greed—makes currency valueless. The final "inflation" is caused by the misuse of money, and is now upon us. It is seen in the collapse of the *environmental* system. No amount of gold or diamonds can avert, reduce, or soften the blows that nature is raining upon us, and in the final accounting, a cabbage can be worth a king's castle (or more) if it saves your life. For the last 40 years or so, money has been made by destruction of real wealth (soils and forests) and the debts are now being called in by nature herself.

Money is in itself not a resource, it represents (or should represent) a resource which lies "somewhere else". Often, however, that resource is a useless object (a diamond) which people rarely find a need for in any lifethreatening crisis, and never in any global crisis such as now threatens us. Money, in a sane society, must therefore be tied or fixed in value relative to a *useful real asset;* this is the very basis of fair trade in large societies.

All money arises from the wealth of the natural world (plants, clean water, clear air, stored energy). The accumulation of unused wealth, or wealth that does not lead to the proliferation of life, is a pollution of the same nature as any unused resource. Manure and money have much in common.

Insecure people can never have enough material resources, or the appearances of security. They tend to spend this money on monuments and protection rather than in assisting nature to produce wealth. Hence, we can find them associated with addictive, ostentatious, and exploitive occupations. Some tend to erect monuments to contain acquisitions (loot) in such places as museums, art galleries, stately homes, castles, libraries, and churches. Curiously, such monuments often display natural things portrayed in paintings and objects, but in so doing use up nature (the cedar table becoming more revered than the cedar tree, the leopard-skin coat more valued than the leopard).

While natural resources fuel such "wealth", artisans and architects develop the monuments, artists decorate them, and bankers, miners, and oil people fund or value them. The erection of monuments itself becomes a reason for existence. The rich are conspicuously represented in societies devoted to monument repair, but not in the area of landscape rehabilitation.

It is but a short step from worshipping inside monuments to worshipping monuments themselves (people often being more proud of their church than they are of the trees and stones which were destroyed to build it). It is an even easier step to confuse oneself with the creator, and all the easier if one adopts a belief system in which god is portrayed as a man! (Some would say this is an insult to god.)

Money, however, is not intrinsically evil; it is the *accumulation* of money and its use to exploit others that is evil. The evil (privilege, power, stupidity, willfulness) lies within people, not within money itself. Nor is the making of money necessarily evil, providing the uses of money are creative and assist the natural world to proliferate. Thus, we can have a clear conscience on money put to earth rehabilitation.

We should develop or create wealth just as we develop landscapes, by concentrating on conservation of energy and natural resources (reducing the need to earn), by developing procreative assets (proliferating forests, prairies, and life systems), by reducing the creation of degenerative assets (roads, monuments, cities), and by constantly divesting ourselves of any surplus wealth to these ends.

Money is to the social fabric as water is to land-scape. It is the agent of transport, the shaper and mover of trade. Like water, it is not the total amount of money entering a community which counts; it is the number of uses or duties to which we can divert money, and the number of cycles of use, that measures the availability of that money. Leakage from the community must therefore be prevented and recycling made the rule.

Money itself is not a resource, and has no intrinsic value or use, but it can create categories of resources or assets, which we can identify as follows (*after* Turnbull, 1975):

• DEGENERATIVE: Those assets that decay, rust, or wear out: the buildings, roads, cars, furnishings, and appliances of society. Too many of these "assets" in any region will impoverish the region in the long term.

• GENERATIVE: The tools of society; those things which manufacture or process raw materials into useful products (huskers, grinders, blenders, lathes, furnaces, and so on). These do wear out, but can be used to *repair each other* in workshops. All groups need some of the tools of processing and repair; a wise farmer hires out or shares such tools.

• PROCREATIVE: The trees, wildlife, fish, invertebrates, mammals, and domestic livestock of a region. People who maximise a procreative asset base can support the use of some tools, and modest degenerative assets. People who maximise the possession of degenerative assets eventually fail in their attempts to organise upkeep and repair—hence so many ruined castles and stately homes.

I would also add to the above categories:

• INFORMATIONAL: Information (education and data), plus applied intelligence makes the best use of all assets, decides balances in the asset base, assesses future trends, and foresees needs and changes. Seeds have a high information content, as do books or data bases.

• CONSERVATIVE: Insulation, dams, money recycling systems, good storage areas, and strategic forests to guard against erosion or desertification are all categories of conserver society assets. All these guard resources for future use, and are essential to a sustainable system.

It follows that expenditure on categories 3 to 5 conserve and create wealth in any society. If a great many wealthproducing assets are available, then *some* degenerative assets can be supported, but any society which spends only on categories 1 and 2 will first pollute, and then eventually extinguish, its resource base.

Apart from the asset categories given above, careful consideration must be given by any bioregion to what is locally conserved and used (the basis of regional wealth, such as soil) and what can be exported as a trade item (surplus water or surplus manufacture). It then follows that financial institutions should themselves pay close attention to their function in that region, preventing leakages of essential resources, and expediting the export of local surplus in order to bring scarce resources into the region. Such surplus should not, however, be based on the loss of any irreplaceable resource such as soil or humus.

Above all, any financial institution should pay attention to two necessitous "foundation stones":

• AN ETHIC, expressed as a published, legally binding, and publicly known charter; and

• RESTRICTION TO APPROPRIATE RESOURCE DEVELOPMENT AND TRADE, in its operations (for not all financial institutions suit every objective of community).

Without ethics or restrictions, any financial institution is a danger and a weakness in a community. With sound ethics and resource usage restrictions, any financial institution can prevent leakage of wealth and the erosion of basic resources, so that it is itself an asset to community, and builds wealth for re-investment.

Financial institutions (those which deal in public funds) are of the following nature:

- Credit unions
- Credit cooperatives
- Trusts and foundations
- Savings and loan banks, or associations
- Insurance agencies
- Finance companies and lending organisations
- Commercial or merchant banks
- Investment brokers and stock exchanges
- Limited liability companies (risk capital)
- Trading or public companies
- Cooperatives

There are other and minor systems in use, but each of the above are now worldwide, have specific *appropriate* uses, and can be fairly easily understood or created by any community. The essentials of an ethical banking system is not only that it has an ethical charter and is used for appropriate assets, but that it belongs to and is governed by the community it serves, and therefore is not open to distant or centralised control.

One of the more extraordinary features of many of the strategies outlined in this chapter is that they have arisen in (and been developed and applied by) poor, depressed, minority, often unskilled, and frequently "powerless" groups. Good people everywhere *can* take financial and developmental control of their regions, give equal service to all people, and rise from an ethical but outcast sum of minorities to be a driving force in world stability. So go to it, as the sum of minorities is always the majority!.

In this section, we are apparently talking about money, but keep it clear in your mind that we are actually talking about a philosophy of true democracy, peace, and "lifetime". Lifetime is that little space we are given to experience this world, which shapes up to what we can imagine to be heaven, but where the achievement of paradise is constantly set back by the "serpents" of greed, power, stupid exploitation, and war.

Time and money are often interchangeable. To control the cash flow of our society is to control our lives. No price is too high to pay for the right to work at "right livelihood", to consume what we can help produce, to feel secure, and not only to avoid harming, but to actively assist, other people and life forms. People who steal our independence steal our lifetimes; our personal independence relies on a cooperative human society.

By changing ourselves, and living in closer harmony with life processes, we reduce the conflicts brought into our lives by the opposing demands of a truly sound economy and that of "unlimited growth" in the capitalistic sense; between a false assertion of human dominance over nature, and the certainty that we depend on all of nature; between the injunction to treat all people as equal, and the status given to those who consume and prosper at the expense of others; between the tyranny of need created by gadgets and luxury, and the satisfaction of working with others to achieve our basic needs; between our natural drive to accumulate possessions, and the realisation that it is only what we share that gives us access to all necessary possessions.

## THE INFORMAL ECONOMY

Barter is a common economy practiced particularly in rural or neighbourhood areas where people are more likely to know one another. At the household level, people exchange garden products and plants, share labour, and exchange goods and services. Occasionally people may form 35 person *work groups* to build houses, create gardens, or clean up housework; these work groups may be episodic, forming the pattern of a roundrobin until all present needs are met.

On a community level, or with more than 6–8 people involved, labour exchange may need to be coordinated or regulated. The Bendigo Home Builder's Club in Victoria, Australia is a group of 35 people building individual homes. They pay $5 a year per family, mainly to cover the printing and distribution costs of the Club's newsletter. Each member can either be a recipient or donor of labour. The units of exchange are hours of labour, and all labour is considered equal. Using a standard labour exchange form (which is legally binding), the recipient is debited and the donor credited for every hour's work he or she performs. There is a Labour Organiser in the group to sort out the balance of payments, and to despatch labourers to a recipient (who must have at least 60 hours in credit).

<u>A Community Barter Club</u> also works on a system of debits and credits, where residents offer goods, services, and skills, from landscaping to massage, from mowing to printing. Even the Club secretary or organiser is paid in credits. A credit is calculated at one hour, and the donor and recipient agree among themselves what they consider the job is worth. People are not limited to a one–to–one exchange; as the Club organiser keeps records of the debits and credits of each individual, transactions occur as long as services are desired. The Community Barter Club can be an asset for people in the community who are unemployed or underemployed, and for those who need services but cannot afford to pay cash for them.

Internal economics are greatly aided by exchange newsletters, computer services, and advertisement. These represent a good medium to swap *goods* in particular, with the Barter Centre charging only on a proportion of successful swaps. Several newsletters, like "Exchange and Mart" in the U.K. cope with this service. Brokerage houses now deal in large surplus barter systems for industry, using a Trade Unit (T.U.) valued at about $1, for pricing and exchange value. These can then be placed in smaller blocks for a variety of exchanges in goods and services, and are a good way to turn a large surplus of one commodity into a range of services and goods needed.

### <u>L.E.T. System</u>

Conventional money derives from many agencies external to a community, and circulates throughout all communities, tending to be accumulated in cities, multinational coffers, and banks supporting large investors. Community money (or credit), however, is not usable or necessarily wanted outside that community, hence circulates indefinitely in the community, providing a constantly available resource.

The LET System (Local Employment Trading System) centres in a community: every joining member must be willing to consider trading in local "green" dollars. The LET dollars carry no interest, and administration costs are charged on a "cost of service" basis. Any taxes applicable are the responsibility of members, and any member can know the turnover or balance of any other member. Every member gets periodic statements of accounts. The currency, although equivalent to legal tender, is not issued and cannot be cashed in. Green dollars are "earned" by goods or services to others, and "lost" by using services or goods. All trade, or credit standing, is a public act, and refers to the community as a whole. However, unlike simple barter, a member in credit can spend over the whole range of services or goods offered.

Production, as time spent by members in service to others, is thus never limited by the lack of money. Businesses can charge federal currency for spare parts, and green dollars for labour. Price is agreed upon by the individuals, and reported in to the LET centre by the consumer. "Foreign" goods are thus more expensive, and local components increase; local businesses thrive. Charities and local farms benefit greatly, as charity donors can see their funds as likely to return to them. Anyone who wants work can offer services; they need not wait for "jobs". As only members can trade with each other, the community account is at all times balanced. In effect, any member (by working or selling) issues their own currency, and could return any community to full employment. An ideal member has many transactions, but accumulates modest debits and credits. See under Resources at the end of this chapter for addresses.

Finally, the informal economy includes purely volunteer labour, exchanges of gifts, and taking responsibility for a certain community project or area. For example, convivial treeplanting on community common areas should be a part of every household's responsibilities. This may well be achieved by the "adoption" of a few acres of community forest by a household. Other community projects can be helped along by volunteer efforts, gifts of materials, and gifts of time as advisors or entertainers.

## THE FORMAL ECONOMY

"Formal" means that goods or services are conducted under a legal umbrella, and are regulated by accounting procedures. Exchange can still take place, but it is *accounted for* in terms of stocks or services. Such formal economics are necessary where people (managers) act for a group of members or investors, and not just for themselves or their households. Legal procedures must also be followed by selfemployed people or family businesses, where cash is received for goods or services rendered or offered publicly.

A community may have at least these formal structures:

- Cooperatives
- Community savings and loans
- Small businesses service office
- Investment funds for special projects
- Leasing company or system

### Cooperatives

A cooperative is a group of people acting together for the benefit of members. It is a legal entity with limited liability, and perpetual succession (no dissolution for individual gain). It has several principles:

- Open membership (open to all who can make use of the services and will accept the responsibilities of membership).
- Democratic organisation (members participate in decisions affecting the cooperative, with affairs to be administered by people elected by the members).
- Strictly limited interest on share capital (fair but limited award for capital and restricted influence of people holding share capital).
- Surplus or savings out of the operation of the cooperative belong to members (with members to decide on the use of the surplus, whether to develop the business, to provide common services for members, and/or to distribute among members according to the degree of involvement in the cooperative).
- Education (cooperatives should provide education for members, officers, employees, and the public on principles and techniques of cooperation).
- Cooperation between cooperatives (encourages the development of more cooperatives).

The worker–cooperative centred around Mondragon, in the Basque region of Spain, are worthy of note. In less than 30 years, 96 workercooperatives, employing 17,000 worker–members, have emerged. Each person is required to invest about $5,000 when joining. This can be borrowed from the bank or obtained by installments deducted from wages over a two–year period. Of this investment, 20% is a contribution to collectively owned funds, and 80% is for the purchase of an individual shareholding or capital account (which is normally not drawn upon by the worker except on retirement, death, or in cases of extreme hardship). In this way, a co–op can partially fund itself, with generous help from the cooperative bank.

The Mondragon cooperatives have several features:

1. 10% of the profits must be returned to the community for public services. 20% of the profits are held as capital reserves, and 70% are distributed to workers, although not all of this is available for withdrawal until a worker leaves the cooperative, at which point all of their financial interest in the business must be withdrawn. The worker is, in effect, "loaning" the cooperative the money, and so receives interest.

2. A cooperatively run bank oversees the functioning of all new cooperatives in the group, finances new cooperatives (up to 90%), and offers expert managment skills.

3. No redundancies in the cooperatives—workers are retrained and new jobs found in other expanding co-operative groups.

4. The ratio of the lowest to the highest paid person is never greater than1:5.

5. An annual meeting of all workers in a particular enterprise elects both directors (managers) to run the business and a social council (union) to negotiate with directors on work conditions, pay, education, etc. The meeting observes the principle of one worker, one vote.

6. Each cooperative averages about 200–300 worker–owners; large numbers become too impersonal, and large cooperatives are divided into smaller independent units.

7. The community has cooperative schools, hospitals,

a university, housing, health and welfare services, a technical research laboratory, super-markets, banks, and computer centres; all of these are cooperatives, and schools earn part of their costs by contract to manufacturing cooperatives.

Unlike the Mondragon cooperatives, which are usually appliance manufacturing factories, a small community cooperative might have three categories of membership, as below:

1. *Worker-owners:* These manage the cooperative, and are split into "management" and "union" groups. They contribute a set amount of capital into the capital fund, of which a percentage can be withdrawn should the worker depart. Only the worker-owners have a vote. Managers are elected, and are responsible to the rest of the group; they can also be sacked!

2. *Corporate members*: These are the primary producer, manufacturing, or public service associations. They are the *users* of the store cooperative in that their products are sold there, and/or they receive bulk supplies through the store for their business. They also pay a joining fee to capital funds. They may cooperate together for group insurance purposes. Voting powers can be allotted on the basis of involvement.

3. *Households:* Basically consumers, each household pays a nominal joining fee, goods are bought at a discount, and an annual dividend is received for the bulk purchases over the year. There is no vote.

Cooperatives also involve *sharing*, achieved by spreading the skills needed for any one job over more than one person (rotating jobs); by having near equality in shareholding; and by being able therefore to assess how others are coping with a job. Cooperatives have a greater demand on the energy and time of their workers—there are often planning or assessment sessions after working hours. However, *productivity* in such cooperatives is very high, and incomes or profits correspondingly high.

Even in cooperatives, the functions of management (supervision, administration, accounting, and assessing) and worker representation (unions) are necessary, but unlike privately owned businesses, the whole workforce are shareholders, and all vote for people to fill these positions. Thus, the work force has total control over the composition of representatives, rather like a bioregion.

In fact, a bioregion is a sort of multi-cooperative, where smaller groups take on specific services, thus specific responsibilities. Nobody "represents" a bioregion or cooperative in the ungovernable sense that elected politicians "represent" their electorate (i.e. every "representation" or policy decision of a coopera-tive comes from the ground up; whereas almost every politician makes purely *personal* decisions over a vast range of policy and expenditure—and that is "manage-ment out of control"). In fact, today's governments are not only in themselves irresponsible, but they often fund secret and far more irresponsible agencies, responsible to nobody!

Community Savings and Loans

A worthwhile goal of any community would be 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 onsite, such as a credit union, revolving loan fund, or local currency.

Credit Union

Anyone who belongs to an identifiable group of 30 or more people can start a credit union. The purpose or charter of this credit union can be to fund local or neighbourhood self-reliance. A community credit union can pay all routine accounts of a household; some credit unions even have a cheque account service. Credit unions or friendly societies can set aside 10% of income to satisfy instant requests for money from depositors; larger sums can be withdrawn at short notice—often within a week. Friendly societies handle health and insurance.

The credit union can carefully assess loan applications. Money borrowed in order to save money is soon repaid, and so is safe to lend. Thus, money advanced for gardens, fuel conservation, energy generation, or for appropriate vehicles and appliances is soon returned. The savings (in time) exceeds the cash borrowed; from then on, the borrower has some spare capital. Usually, money borrowed to save energy is amortised over periods of from 2–7 years.

The Revolving Loan Fund

The basic principle of a revolving loans fund is that people put in $500–5,000 capital at a *nominated interest* (from 010%) into an established financial institution, and this is then loaned out to new businesses within the community. The group in charge of administering the loan checks references, offers advice, and acts on the recommendation of people who will service the loan (usually a skills or research group of volunteers, some of whom may take part in, or service, the business).

This can be called a loans trust, credit union, finance cooperative or enterprise fund pool; it can include barter, a labour exchange, a regular fair or market, and it needs an open register of local skills and resources, well displayed. Such a modest fund can operate out of a house or old shop front, or from a counter in an established food co-op or cooperative business.

On average, informed and concerned people will initially contribute a few hundred dollars, just "to see a good thing go". This is enough; others will have good ideas about small essential services and businesses, and the research group can be very busy researching and publicising "leaks" of money from the area, so that under or unemployed people can start up services and supplies to stop these leaks, e.g. Does the area make its own bread, yoghurt, sausages, shoes, clothes, pots and paper? Does it reuse its waste wood, glass, metal, paper, or organic wastes? Does it provide a wide range of services from haircutting to legal advice? If not, jobs are open and funds to start them are available! Loans, at low local interest (6–11% is fair) are made, and every borrower must be a contributor (active investment). The skills group help to select equipment, test markets (presale of products is ideal), train young entrepreneurs in bookkeeping, and find resources and materials. Very few of such publicly needed, publicly funded and publicly open businesses fail. Everybody is self-interested in their success!

As confidence in the local fund grows, loans can start to cover energy-saving house additions, insulation, or new well-designed housing, small vehicles, small fuel supply technology, and land purchase for approved projects. Even so, funds subscribed may always exceed demand (businesses are slow to develop), so the fund managers should always be ready to *fund the start-up of more advanced money systems* such as investment advisors in ethical trusts, local insurance and banking, and a local "mint" to print a district currency of non-inflatable money, which in the end is also non-interest bearing.

Every place where this has started (and since 1980, there are dozens or hundreds of funds, currencies, barter fairs, and investment trusts established to build a sustainable future) has benefited. Imports are greatly decreased, local employment rises rapidly, good products (and security) are available, and community morale is enhanced.

Thus, community savings and loans associations are appropriate for reducing community and household costs, and freeing more capital into the community, which leads us to the S.H.A.R.E. and C.E.L.T. systems of "wealth-producing" loans. These are revolving loan funds that provide capital to community-based groups, enriching the community and forming a strong support base for the businesses established.

*S.H.A.R.E.* stands for SelfHelp Association for a Regional Economy. It is a local nonprofit corporation formed to help encourage small businesses that are producing necessary goods and services for the community (in this case, the Berkshire area in Massachusetts, U.S.A.). It works in conjunction with a local bank in the area. Members of the community can become S.H.A.R.E. members, which means they open a S.H.A.R.E. joint account with the bank. They receive only 6% interest (but this means small loans can be given out at 10% interest). The person receiving the loan must first collect references from people who know them as responsible and conscientious. They must show that the proposed business will attract customers from the community or even from outside the community. By doing this preliminary work, the borrower gets to know many people, and the community has a keen interest in seeing that the business succeeds.

*C.E.LT.* .stands for Community Enterprise Loans Trust, a New Zealandwide charitable trust to promote and support small businesses and cooperatives. C.E.L.T. helps people form and run cooperatives and other enterprises by providing advice, running training sessions so that people can learn cooperative business skills, and by providing loans.

C.E.L.T. services are funded by subscriptions from the public ($5), by donations, and by government special schemes. Education and other work is funded by the interest from deposits and loans. C.E.L.T. accepts cash deposits, and lends out to enterprises working closely with them until they are on their feet.

Depositors receive from 0-12% interest per year depending on the amount of time the money is in the account, and whether the depositor wants interest paid. The borrowing criteria is that the entrepreneur must be willing to work closely and regularly with CELT during the loan so that a business has the greatest chance to succeed. CELT has now achieved the status of a bank, and can offer services such as a bank offers.

*Southern Cross Capital Exchange Ltd*, operating out of Wentworth Falls, NSW, Australia, is a nonprofit organisation that brings together those who want to borrow from specific (socially conscious) projects, and those who have money to loan to such projects. The role of the S.C.C.E .is to review applications for loans and to recommend individuals and businesses to receive these loans. It is not a bank or finance company, and so loans through the S.C.C.E. are not secured. However, they are *guaranteed* by the Exchange (though only if loans are made through S.C.C.E., not *directly* to the project). The borrowers make personal guarantees, and "guarantee circles" are set up to spread the risk (e.g. parents who want to build a school will all guarantee to pay back the loan). This sort of capital exchange format may be one way in which community schools and other socially conscious projects can become financially viable.

Local Currency

As the community gains skills in financial management, there is no reason why an internal and district economy should not be bolstered by a noninflating currency *printed by the community*. Already this is done by individuals and businesses who have a product or skill to sell (*real* value), and who print up vouchers or coupons to pay for setting up their business. For example, a publishing company sends out pre-publication order slips to people *before* a particular book is published. People buy or prepurchase the book at a slightly reduced price, which enables the publisher to print the book (this is how the book you are reading was printed).

In another example, a restaurant (Zoo Zoos) in Washington State, USA, in transferring from single ownership to a work cooperative, needed to raise funds to buy out the owner. They printed meal vouchers, redeemable up to one year, and sold them to future customers and friends. Most people came in to eat their promised meal, but some vouchers were traded to other people for some other service in the community, and thus the "currency" starts circulating as vouchers relating to a real commodity.

There are many currencies in every society, such as

FIGURE 14.9
EVOLUTION OF A LOCALLY-APPROPRIATE MONEY SYSTEM

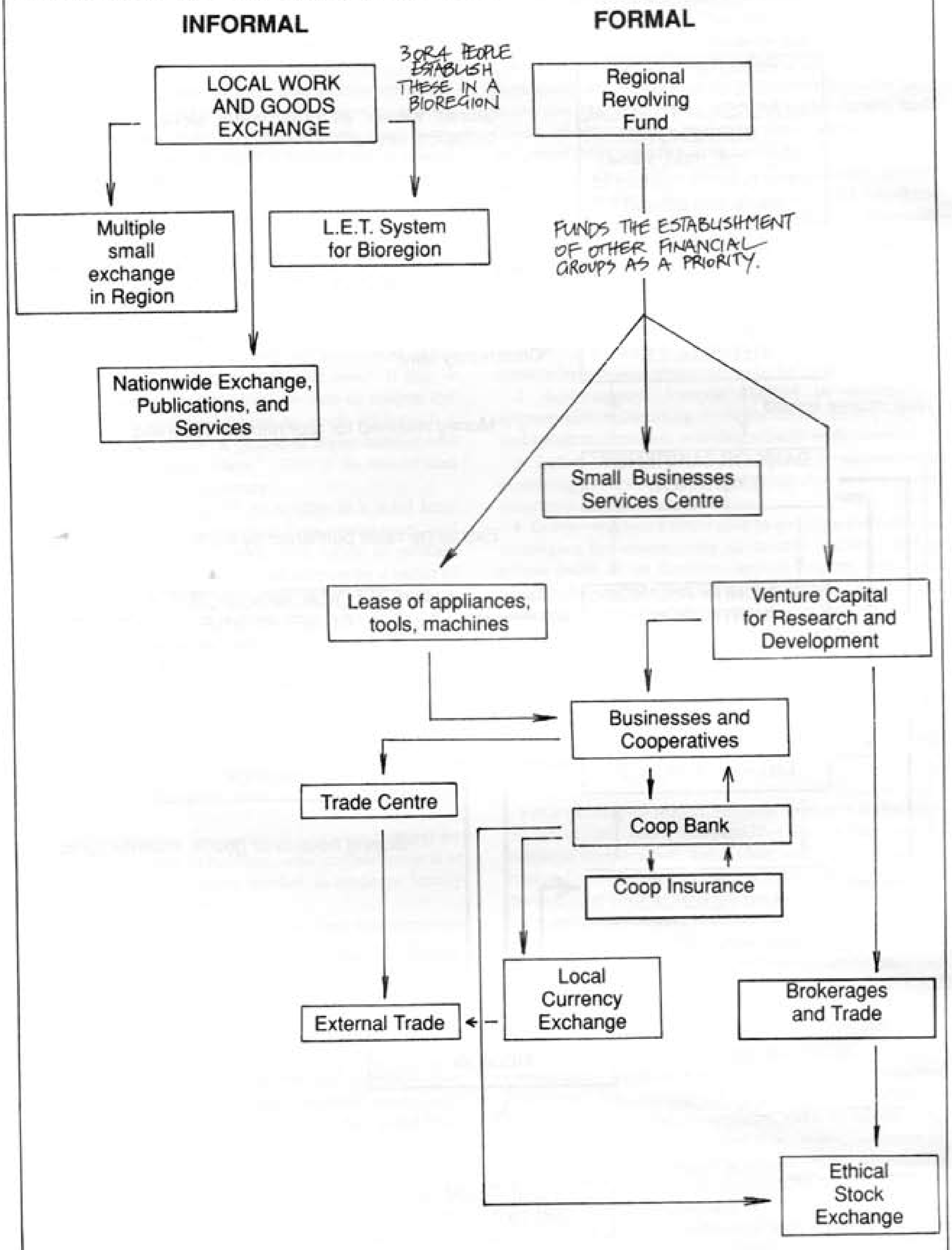
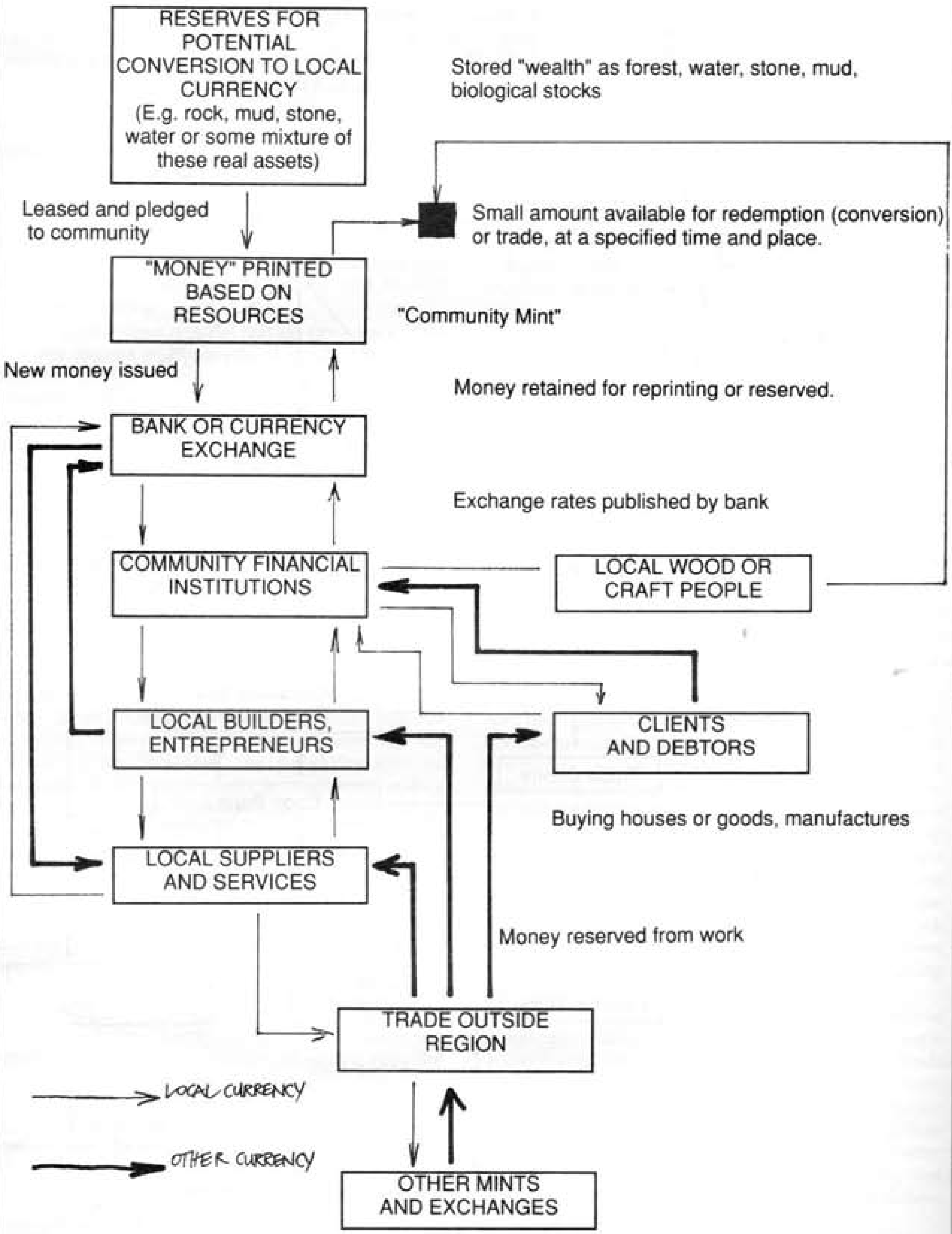


**FIGURE 14.10**
CURRENCY



promises, exchanges, stamps, coupons, vouchers, cigarettes, hugs and kisses. All are freely and legally exchanged for goods or services, which are themselves interchangeable (a song for a lettuce is a good bargain).

However, we need a redeemable, solid, real and objective currency for trade and exchange. For currency to be valid and usable, some preconditions are necessary. First, it must be backed up by a real, objective resource. Secondly, other people must have confidence in it, which is *why* it is backed up by a local resource and can therefore be traded. Lastly, there must be a demand for its use, and a place to exchange it for other currency so that it works as well for other people as it does locally.

Demand means that there must be a real need for some item or service lacking in the local society. Now, any community printing its own currency has these things to do:

- Find and lease a resource that can be pledged to the exchange institution as a redeemable asset. If this is timber, the currency is based on "a cord of timber, cut and stacked in the woodyard at such-and-such a place", or if clean water "a gallon of water bottled and redeemable at a certain place." This is *the reserve* and gives confidence in the currency.
- Print the currency itself, preferably in a solid local material difficult to duplicate or forge elsewhere, and numbered, dated and counted. The value so printed should not exceed the value of the reserve by a factor of more than 3 times. Reserve pledges need to be publicly available and assessed. Notes can exceed reserves if used for procreative assets only (e.g. forests). Forests represent firewood, but reserves are never cut except in dire emergencies.
- Educate local businesses and banks (exchanges) in the use of the currency, which can be changed for the national currency (while this lasts) at the bank, or for other regional currencies. Post exchange rates publicly at the money exchange or bank and issue the currency to banks.
- Start satisfying the demand (e.g. for homes) by lending the currency to builders, who can exchange it at the bank for other currency needed in trade, or locally for products and services.

The bank should not itself decide uses; the community (via a set of financial, advisory or monitoring institutions owned by them) should do that. Currency should be used to satisfy real needs of the community for food, shelter, trade. As we are talking about community money, its uses need to be decided by that community.

Producers of *local* goods, accept *local* currency only; this creates a demand, and other regions must "buy" such currency to obtain local goods. Most local businesses will accept a regional currency.

**Note**: That if reserves are living things such as trees, wealth increases and can be created. Even if a currency was originally based on bricks, it can be used to create such biological reserves as forests over time.

To prevent hoarding, notes can be dated and a new issue us made every 4-5 years; this is also a check on unwarranted accumulation, and possible forgeries.

Wherever there is a need (for housing, roads, small businesses, farms), the dollars needed are supplied by the exchange, but the borrower or user *must repay in local currency*, thus creating a demand for it. Most small businesses accept the currency, and much of the local trade can be carried on in this currency. When most needs of the region are met, the currency can be collapsed. Many small towns funded their public works this way in the 1930's. The E. F. Schumacher Society, Great Barrington, Mass. U.S.A. has data on these systems, and runs one such currency (see Resource listing at the end of this chapter).

Critical personnel to attach to a revolving loans office are in the following categories:

1. *Asssessor-designers:* People skilled in good house, factory, and farm design, energy budgeting, and appropriate technology—the "permaculture" team, used to help assess proposals to be funded.
2. *Accountants:* People skilled in setting up appropriate accounting systems to monitor progress and profit in ventures, working closely with team (a).
3. *Broker-bankers:* People actually handling cash flow, assessing reserves, and operating the banking and insurance functions of the office.
4. *Lawyer-trustees:* People able to package a set of legal strategies for community or family groups, and to advise (with 2) on taxation, export-import, trust and leasing documents, labour exchange agreements, and company, commonwork, or cooperative law.
5. *Real estate or realty*: The office can handle the bookkeeping and serving of local industry and services, supply goods, advise, provide labour and goods exchange, and arrange legal forms. Through the designers, users can obtain help in building and land design, nursery and livestock services, and appropriate tools.

For a developed region, services such as a travel club, credit union, food cooperative (or rather, group purchase cooperative), farm club, and educational and medical services can also be provided. It must be stressed that the "revolving loans office" is not a *place* but a *group* in cooperative function. Each may operate in their own home, but all services are listed in an educational or informational newsletter and can combine where needed.

## Small Business Services Centre

There will no doubt be many businesses run in any community which are not run as cooperatives. However, that should not preclude their sharing in certain commonlyused services, such as accounting, telephone services, secretaries, telex, insurance, distribution, cocataloguing of goods, group advertising, and export assistance. A small business services centre is itself a small business, now very popular and effective in India. It may be a key organisation in a bioregion.

A great benefit to having many business offices located in one place is the increased number of consumers and the ability to concentrate many products in a single *product catalogue*. Direct marketing is a fastgrowing selling technique; it cuts out the retailer and so enables a product to be sold at a lower price than can be offered by a conventional retailer. A product catalogue is often a valuable product in itself, offering product information and advice. Many people want to support small businesses and cooperatives, and often get into the spirit of the venture when they read about individuals and businesses in the catalogue. The real saving to small businesses is shared facilities such as premises, accounting, and office services.

In addition, the possibility of a group label for products exists in a community. Although each business may be a separate entity, the label can be of a similar design, with the words "Another Product from Boon Dock" (or some such) printed at the bottom. Otherwise, each label has its own business name and information. This generates interest in the community products, which should gain a valuable reputation for quality, durability, or taste as standards for the group label are established.

Small business service centres can offer the following facilities to businesses:

- *Secretarial*: Letters, prospectus, submissions, writing and presentation, filing, mail order.
- *Bookkeeping*. Banking, cost accounting, summary and position analyses, presentation to accountants at years' end. Billing and collecting accounts, paying bills.
- *Accounting*: Tax assessment, broad strategies, trust advice, plan of networking monies, common funds, trust administration.
- *Legal*. Legal forms, leases, representation in litigation, land and propertyconveyancy, new legal structure design, seminar services, trust structure.
- *Communication*: Phone, telex, fax services, photocopy, answering services, travel arrangements and despatch.
- *Gift, tithe, and public service deductions*. Setting up funds for aid, tree planting, and accepting gifts to aid trusts; servicing land access and investment systems.
- *Education*. Holding seminars, inviting speakers, and instructing new members in services and procedures; assisting neighbouring regions to set up parallel and allied services.
- *Skills register*. Keeping a file on key people available for special advice and assessment.
- *Research services*. Retrieval and basic research for region and projects.
- *Lease* of seminar rooms, small warehousing, equipment, office space.

In business, there is no substitute for good management, budgeting, accounting, and marketing skills. Most of what makes a successful business is the combination of human-centred values with good management, which we have listed below (paraphrasing from the findings of the book *In Search of Excellence* by T. Peters and R. Waterman, 1984, Harper & Row).

1. *Shared and stated values:* All concerned with the company believe strongly in a set of values, often restated. Such values need to be carefully framed, realistic, and simple to remember. They are also inherent in the following:
2. *Respect and encouragement:* Management should give staff control of their own areas, encourage them to develop new ideas, and to follow guidelines and values rather than a rigid set of rules.
3. *Reputation:* The company maintains a reputation for high-quality products, service, and reliability. This cannot be stressed often enough. Most customers will deal with a firm over and over again if it proves to be reliable, rather than take a chance with a company which may be cheap, but which maintains such sloppy standards as slow service and shoddy products.
4. *Lean management:* Successful businesses use a simple organisational structure, a minimum of staff directing operations, and no "corporate planners" or analysts. Management is often in close contact with both producers (staff) and customers, and involved in production.
5. *Action:* Once a decision is made, effort is made to get it done with all possible speed. Customer reaction is then gauged in a matter of weeks or months, not years.
6. *Familiarity:* In expansion, or in new products, good businesses stick to what they know best (and don't expand into or acquire a business in an unfamiliar field).

In summary then, the successful business:

- states group values and maintains a sense of loyalty to those values,
- personalises services, good quality, prompt service, and reliability,
- innovates in its area of expertise and looks ahead, and
- has a lean structure, and no uninvolved staff.

Attention to current and future trends (social, climatic, economic, political) is essential for any business group, and small business centres can research on such trends; societies change according to new information, products, and materials, and businesses must change or expand with these trends.

In addition to normal business principles, the more intense and more democratic operation of cooperatives demands that co-op staff must participate in planning, seriously contributing to policy, procedures, and innovations. The sharing of "power" is really a sharing of *responsibility*; part of that responsibility is the capital risk of any enterprise.

Leasing Systems

Any cooperative or village could run a leasing service for seldom-used items of capital equipment (photocopiers to trucks) which individuals or businesses do need on occasion.

*User Pays Principle:* From privately to publicly owned

**FIGURE 14.11**

SCEMATIC OF CAPITAL FLOW WITHIN AND WITHOUT A VILLAGE

The aim is to keep as much money as can be usefully and productively used within the system; thus to reduce taxation, consumption of outside resources, energy costs, and outside investment, and to return resources to income and consumer products within the village.
Consumption is reduced by lifestyle changes, vehicle sharing, etc.
Taxation is reduced by legal strategies
Energy, by conservation and technological strategies.
Trade, by developing local resources.
Little of this is possible unless investment, via the village bank, is controlled by the village.

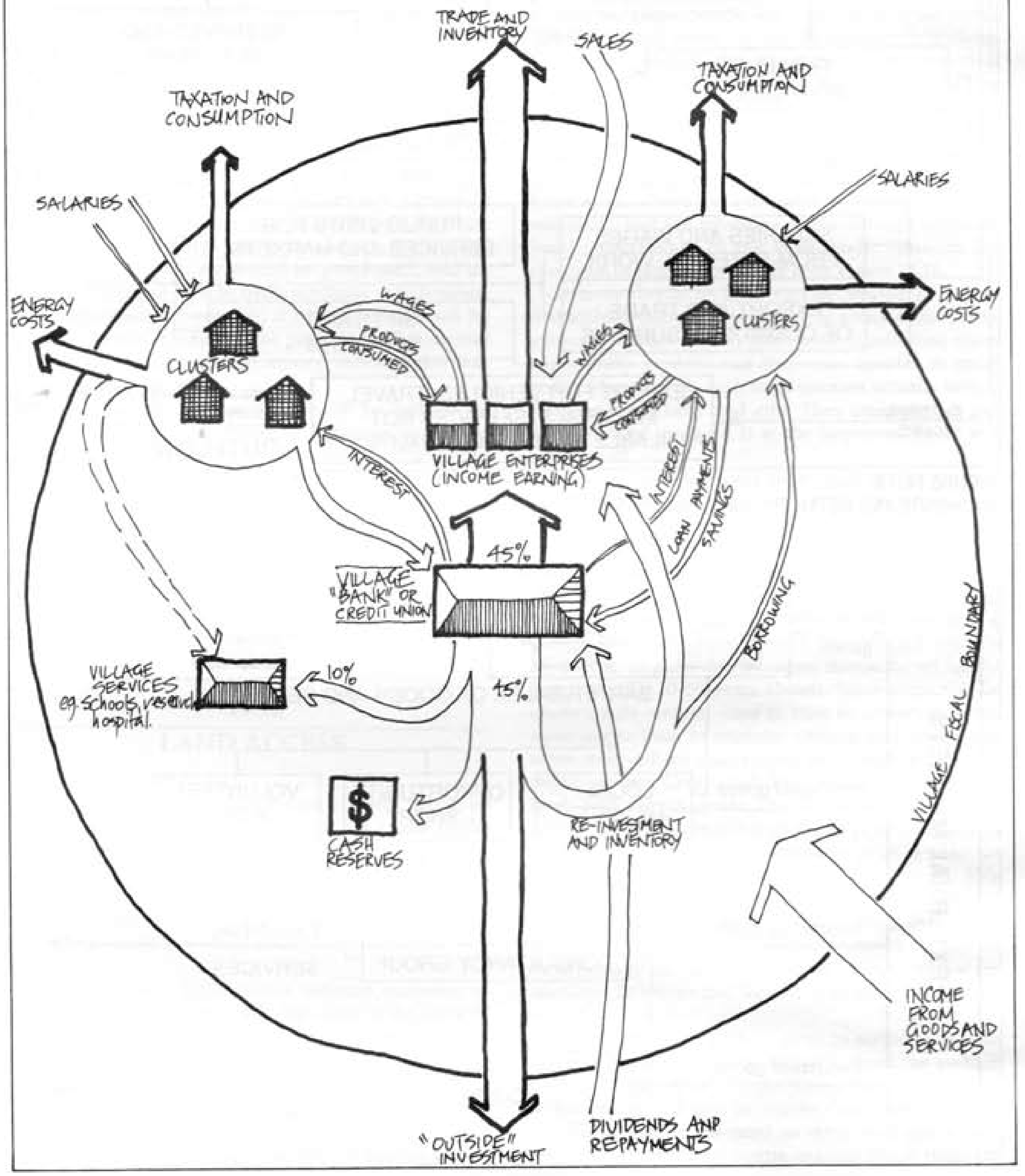


**FIGURE 14.12**
CASH FLOW OF THE VILLAGE

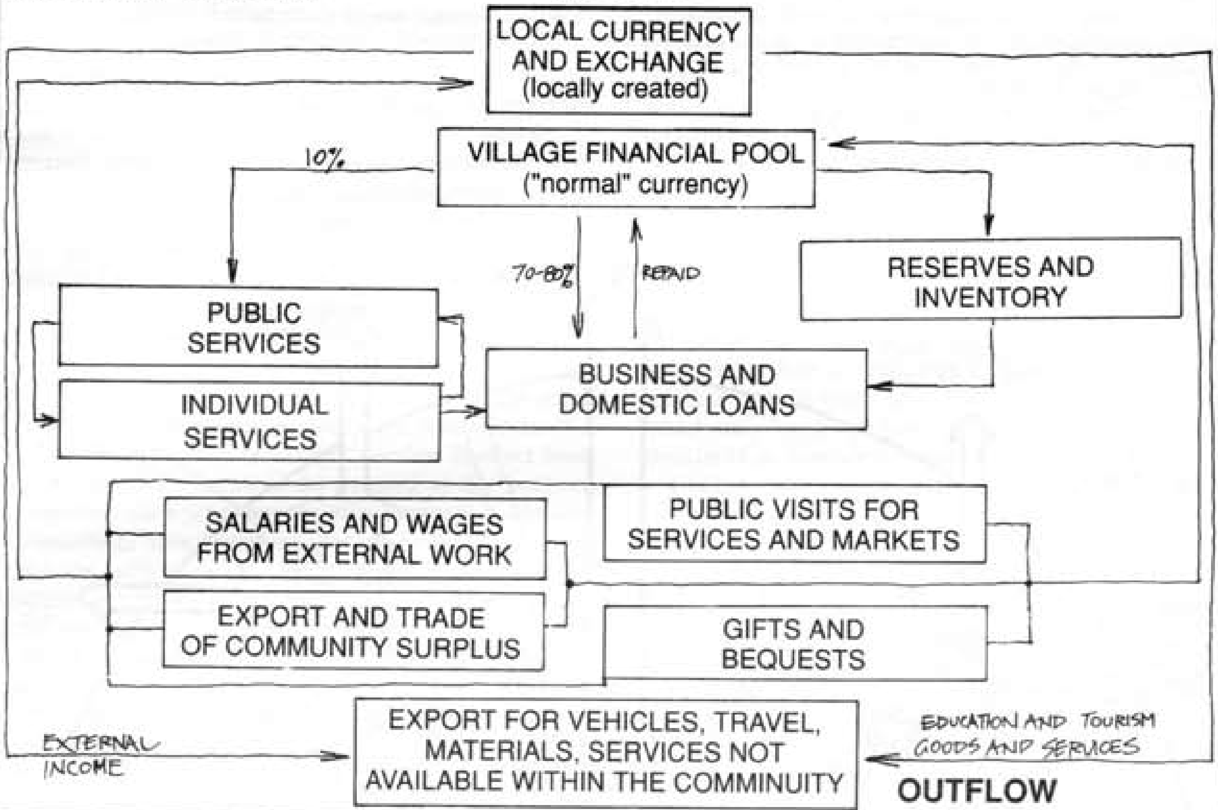
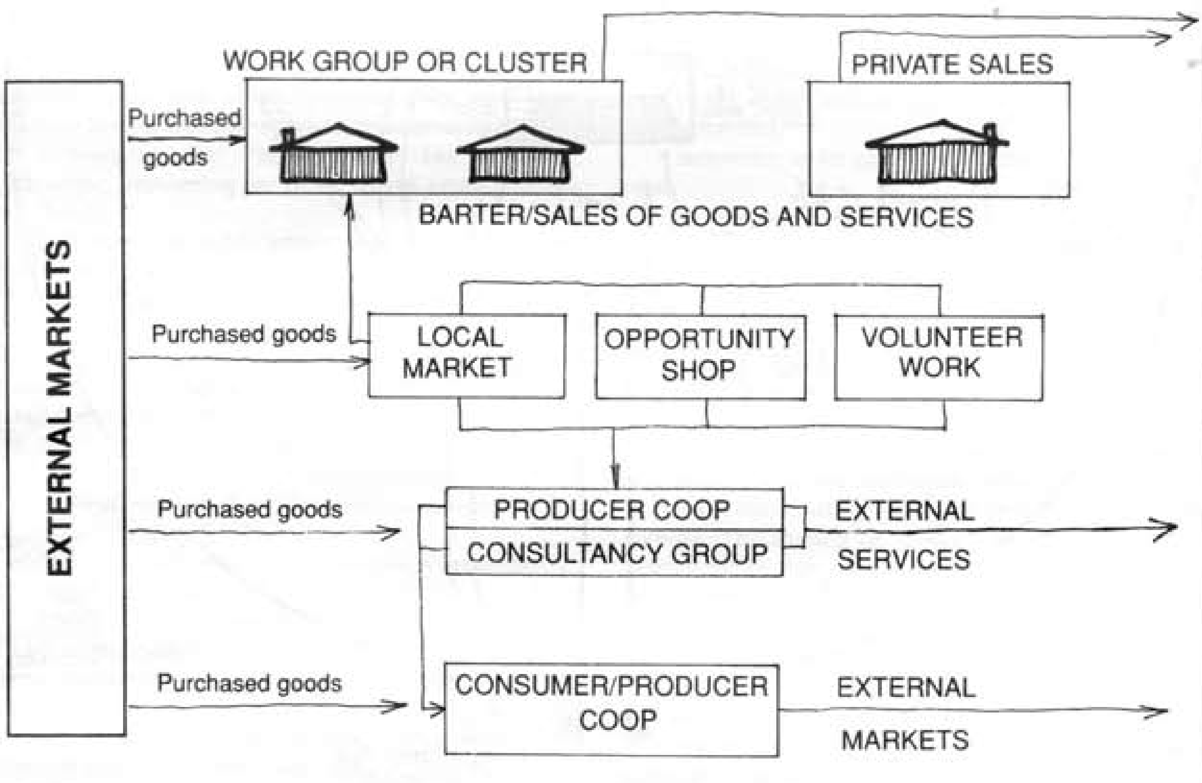



**FIGURE 14.13**
EXCHANGE AND RETAIL OF GOODS AND SERVICES



assets (sewing machines to reference libraries), a charge sufficient to cover running costs, repairs, and replacements *must* be placed on that item. This may be subscription (library) or piece work (photocopier), hourly rate (computer) or miles travelled (vehicle). These charges apply equally to businesses, administration, trusts, and private groups or individuals. Persistent misuse (e.g. of a vehicle) results in a withholding period or permanent withdrawal of permission to use.

*Personal Accountability Principle:* This applies to any group purchases, whether public or private. The *group purchasing* is held totally and individually responsible for payment for any item. This is rigorously applied and holds *even if a member leaves a group* or the community. This principle stops "I'vegotabright idea" and a "let'sgetit" approach—ideas must be paid for. If the idea is a good one, it will pay itself off in time through lease. An example of this sort is if a group of five wanted to purchase a large brush chipper to create compost for themselves and to hire out to others in the community. A chipper would be purchased, and an hourly charge put on it to cover purchase, maintenance, and replacement. Eventually, if the chipper is used by enough people, it may even be possible for the original five to get a return on their money, although this was not necessarily an aim.

Special coinvestment on projects can be initiated by advertisement in the community. Examples are: group water storages or energy systems, group refrigeration facilities, coownership of a fishing vessel or coastal holiday home, etc. These are not working cooperatives or businesses, but rather projects that save money or give the opportunity for a wider range of resources than if each person had to fund them individually. The investing group decides expense, location, and use payments.

## 14.12
## LAND ACCESS

TRUSTEESHIP OF LAND

Our own lifetimes are, in terms of soils, trees, or climate, as ephemeral as snowflakes. For a little while, we have the use of the earth, and our time here is bounded by birth and death. Thus the very concept of land ownership is ludicrous, and we need only to use what is needed for the brief time that we are here; even birth and death are small events in a total life pool continuum.

The law clearly distinguishes between *ownership* or entitlement to a resource, and the *rights of the use of it*. Laws of ownership are relatively modern, and are foreign to tribal or clan law. Laws of trusteeship are ancient, philosophical and realistic. Ownership, in effect, gives the titleholder (person or state) a "right to exploit in the short term". Trusteeship governs any resource for the very long term, with no right to exploit resources beyond essential needs, or replacement time.

The way that land passed from clan management to personal ownership is well documented; since the year 1400 or thereabouts, the methods used were as in **Figure 14.14**

Most of us live on lands once tribal, now "owned". Very few of us have any rights to share the resources of such land, which is either state (army), church, or corporation-controlled.

However, with the benefit of scepticism gained from hindsight, many people are working to reverse this historical trend; tribes are still forwarding their claims to common ground after 200–400 years of occupation, and thousands of people are forming trusteeship organisations to remove land from private ownerships, church, and state control, and to return it to use by those people who live on and near the land. In fact, educated people of good will, and traditional people, have seen where ownership has ruined common resources, and are returning to the concept of taking local stewardship of the land itself. Thus, in the evolution of land concepts, we have **Figure 14.15**.

Gifts or deeds of land can be vested in a tax-deductible trust for use by a specific group or the public generally, under certain reasonable conditions; many community gardens run this way, usually at small rental. Many people with large incomes actually benefit from tax-deductible land gifts. They can purchase and improve land, and gift it at the improved value at a paper profit.

*Essential* land for local food, fuel and structural forestry, recreation, and conservation can be planned, and secured *under a set of public trusts* by public investment, gift, bequest, taxdeductible donation, transfer from other authorities or trusts, or outright purchase. Thus, the district *secures its initial land resource*. Each and every parcel of land needs 3–4 involved, active, and interested *trustees*, and under a legal limit, its plans and purposes should be set for the long-term for 10–50 years ahead). Some areas will be under sports centres, some in trust to conservationists, some under lease to organise gardens and farms, and some reserved for educational and public bodies for public services. Community forestry on steep and rocky lands will provide fuels, food, and buildings for the future. Even here, every *household* can plant and tend an area, and profit from or manage it; it is also an improving asset that can be sold or transferred. This works; "public" forestry does not. Industry should grow every stick that they use by a *charge on product*, and investment in the community forestry owned by local households. Good models of village forestry are operating in Indian and Taiwan; poor models of public forestry are all about us.

Land trusts need be few, close to settlements, and cover all essential uses; the rest of the land can go back to natural forests or prairie. Every scrap of land *in* settlement should first be planned and used. Many, if not most, small towns need no other land assets. Any society that develops lawns beyond those used for

**FIGURE 14.14**
TRUSTEESHIP OF LAND

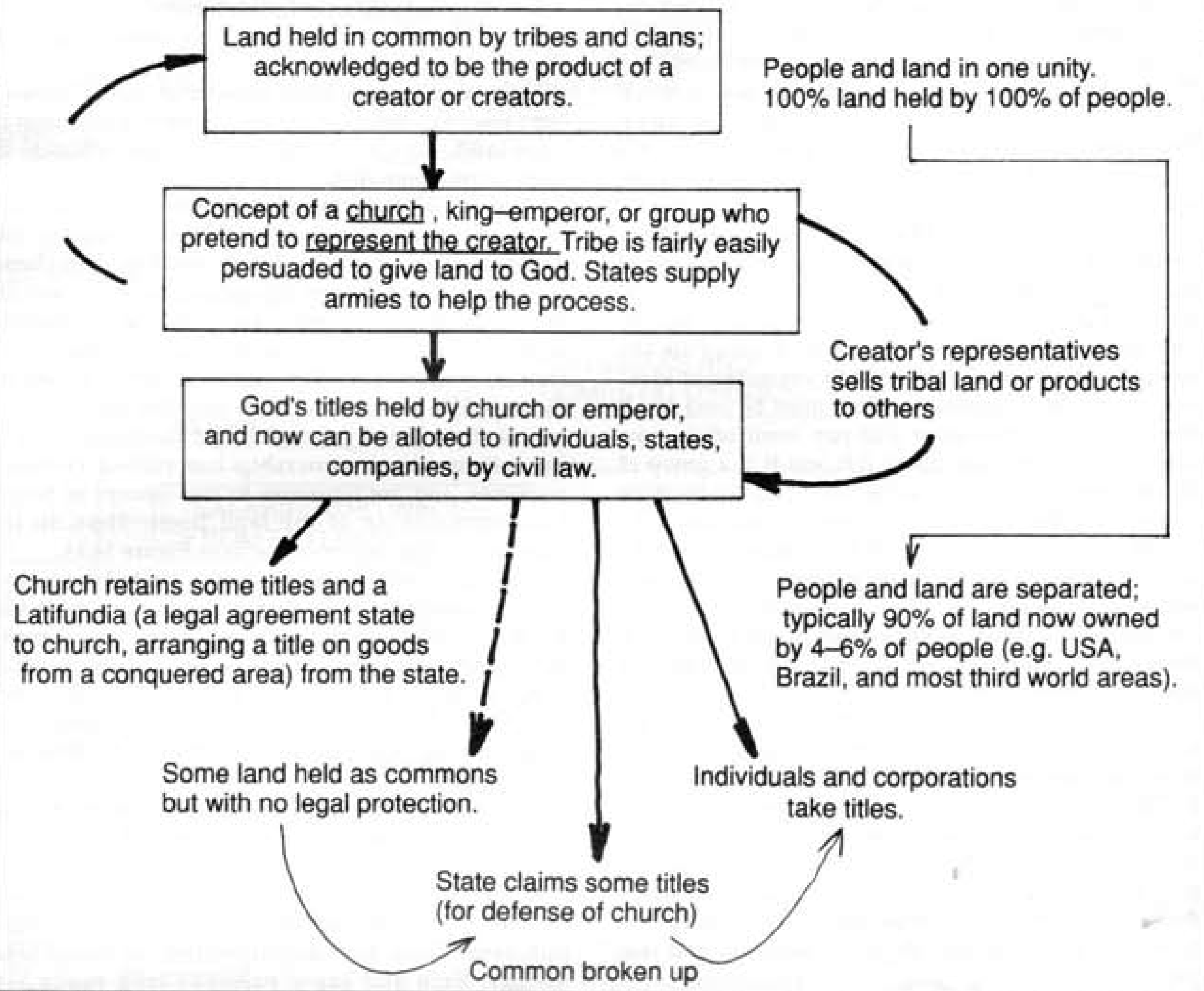



**TABLE 14.15**
INDIVIDUAL IN A GLOBAL SOCIETY

| | VIEW | RESULT |
|---|---|---|
| TRIBAL ERA | People see themselves as a minor part of nature, and as part of creation. | People self–govern in small groups in a world rich in species and resources. |
| INDUSTRIAL ERA | People see themselves as representatives of the creator (people are superior to nature). Remnants of tribes persist. | Land, minerals, forests used by and for people; populations of people deprived, pollution, famine, desert developed by the action of people. Breeding encouraged and supported by church and state. |
| MODERN ERA | Remnants of tribal systems remain. Evidence of misuse of land calls for new Concept of trusteeship (people as guardians of nature and active helpers in land regeneration. | Land trusts and reserves formed. Groups formed to purchase and rehabilitate lands, protect forests and wilderness. Many people voluntarily reduce family size, as global threats decimate populations via disease, famine, desertification. |

recreation can support itself for wood, fuel, and building materials by the conversion of lawns to use.

If people who *really* want land set up a determined research group on "ways and means", or open an advisory centre on such methods, they would achieve their needs much faster and with far less expense than if they rely on undertaking a political "revolution" (a transfer of power), or saved their pennies, and with much greater longterm benefit to society.

Just keep in mind that there is more than enough land already cleared for all people, and that it has long ago been paid for in labour or cash; there is really no need to buy it again, just the get the *right of use*. Every country has some, or many, methods to obtain usage rights.

There is usually only one title, or a few titles, but there are probably thousands of possible rights upon any land. Think of the "ownership" as a blank canvas or empty wardrobe. We can paint on or hang up an array of rights, and (unless we are very thorough) never fill the land space available.

Land in trust can be developed in a number of ways, and can include garden clubs, commonworks, and as leased land for specific purposes. Many have water conservation, developing forest, wildlife corridors, wetlands, and special species reserves as primary aims.

Practical warnings are *not* to accept land gifts that have many restrictive conditions attached; in fact, it is wise to perhaps limit acceptance to unconditional gifts. These can then be sold to purchase more suitable land, or to capitalise land elsewhere.

Secondly, unless a large cash reserve is available, each trust can only manage one area of land, and only slowly expand. Every parcel of trust land is a unique and longterm development, and if too much land is accepted, simple maintenance and land tax costs can bankrupt the trust.

Above all, a land trust should have a very clear idea of what it wants to achieve, and to set a practical time limit to do the job. All trusts need an income, and may thus need a business or trading arm. The trust can gift land to other regional trusts or associations of whom it approves, so that local gifts can be routed through a tax-deductible trust.

Why should people give land away? Some of the reasons are:

• To continue land in its use: as an organic farm, wildlife refuge, economic botanical garden, or as an example of good land use.

• Because people believe in trusteeship: Many of us do *not* believe in private land ownership, but in trust ownerships for public use under sound environmental control.

• Land is surplus to their needs, and a cost: A few people own too much land (are what is termed "landpoor"), thus achieve low productivity and incur land maintenance costs. By giving some land away (especially to a tax-deductible trust) they can concentrate on a smaller productive area. Good accounting advice will often dictate that land should be creatively gifted to such a trust (i.e. it benefits the giver; this is especially true of donors who have a large income from other sources).

• As a bequest: Some goodhearted older people will bequeath land, yielding up successive rights as they age, to younger landless people or to a land trust; this is form of public bequest, and is a fairly common occurrence to establish parks, wildlife areas, or demonstration and teaching farms. Trusts can also give to other trusts under a bequest basis.

• Because they want a village, or more people on the land: In modern times, nuclear families or individuals are socially very isolated on large farms. By establishing a land trust, they can legally encourage others to develop parts of the property, and so set up a socially rich area with multiple potential.

There are many more reasons why people gift land to trusts, so that (generally speaking) there are more lands available than there are reliable stewards to occupy them.

As with money, land ownership and thus land usage in society is unbalanced, except where tribal land councils still exist; even in tribes, cattle or resource ownership can become unbalanced (as in Botswana, where 9% of the people own 80% of the cattle) if crops and herds cease to be tribally owned and are privately owned on common lands.

## LAND ACCESS OFFICE

People often complain that they lack access to land resources; at the same time, we live in a delinquent or devastated landscape. How do we marry needs and land resources? The establishment of a regional office (a land access office—LAO) opens up the potential for offering a set of strategies enabling better land use, and suited to the finances and involvement of people using the service. A selection of strategies follow, and can be modified for local conditions:

- Landlease system within urban areas;
- Garden or farm club;
- City farms;
- Towns and cities as farms;
- Farm link system; and
- Commonwork.

Land lease system within urban areas (Oxfam Model): This is particularly suited to young families in rental accommodation. The regional office posts paired lists: List A is for those who want 200–1,000 sq. feet of garden to grow food. List B comprises those people (usually elderly or absentee landlords) who will lease either vacant land or the land around their houses on an annual, renewable basis. People list themselves and, as local land comes up, introduce themselves. The LAO prepares a standard lease specifying rental (if any), goods exchange, length and type of lease, access, and the names of the parties.

Thus, many young families get legal access to garden land, on an "allotment" basis. The regional office may need to map and actively seek land, and should make a small service charge for registration of leases.

<u>Garden or Farm Club</u>: These suit families with some capital to invest as shares, with annual membership (shares can be sold). A farm is purchased by the club or society on a public access route 12 hours from the city. This property is designed by the club or society to serve the interests of members, whether for garden, main crop, fuelwood, fishing, recreation, camping, commercial growing, or all of these. Depending on the aims and share capital, people can lease small areas, or appoint a manager. Rich clubs develop motel-style accommodation and recreational fisheries. Worker-based clubs usually develop private plots with overnight (caravan-style) accommodation for weekends. A management committee plans for the whole area (access, water, fences, rates, etc) and can be selected by the club.

Many such clubs exist in Europe, and some in Australia; they offer multiple use of one lot of land by many people. Membership in such clubs can be made saleable or transferable, and may increase in value over time.

<u>City Farms</u>: A local group of 100 or more families forms a *city farm association*, and invites local, state, or federal authorities (via their local representatives) to allot from 1-80 ha (preferably with a building) to a city farm. Such invitations are irresistable to those who hold office by virtue of local goodwill or votes.

On this land, the following activities are promoted:

- Demonstration gardens;
- Garden allotments (where space permits);
- Domestic animals (rabbit, pigeon, poultry, sheep, goats, cows, horses) kept and used as demonstration and breeding stock;
- Reycling centre for equipment, building materials (income-producing).
- Tool rental and access;
- Gleaning operations;
- Plant nursery;
- Seminars, demonstrations, training programmes, educational outreach; and
- Seed, book, plant, and general retail sales.

In New York alone, the "Open Space Coalition" counts 1,100 parcels of land as one or other form of city farm. The Federation of City Farms in the UK numbers some 46 active farms, and many more groups forming at any one time.

The essentials of a successful city farm is that it lies in an area of real need (poor neighbourhoods), that it has a large local membership, and that it offers a wide range of social services to the area. Many city farms become totally or mainly self-supporting from sales of goods or services, plus modest membership fees. The one essential is a long-term legally binding lease. Coalitions of such farms represent a large lobby or vote group in society, and are therefore politically respectable!

Each city farm has a small management group, and most have numerous volunteers, or a few paid staff.

<u>Towns and Cities as Farms</u>: A twist on the above, which can be operated by a city farm group. There are several ways to use cities as farms—many German towns carry on an active city forestry along roads and on reserves. From 60-80% of total city income is thus derived from city forest products.

Surplus city garden or food product is collected, sorted, packaged, and retailed. Some groups collect, grade, and sell citrus or nut crop, and many provide young trees to gardeners on contract for later product off the trees. Others range sheep, duck, or geese flocks for fire or pest control. All seem to make a very good income by treating the city as a specialist farm. A processing, shearing, or like facility may be needed by the group.

Nonprofit groups often collect unwanted food from orchards, canneries, etc. and distribute them to the poor, or sell at a small profit to keep running costs down. This is known as a "gleaning" system; many thousands of tons of unwanted food is so redistributed in the USA. Givers take a tax reduction on gift to a gleaning trust (any church or public trust).

<u>Farm Link</u> (Producer-consumer cooperative): These are appropriate to highrise or rental accommodation in an urban area. From 20-50 families link to one or more farms in the nearby countryside. Although they can purchase and manage a property, they usually come to an arrangement with an already established market gardener. Quarterly meetings are held between both parties to work out what products can be trucked direct from the farm to the families, who use the product and can retail any surplus to others.

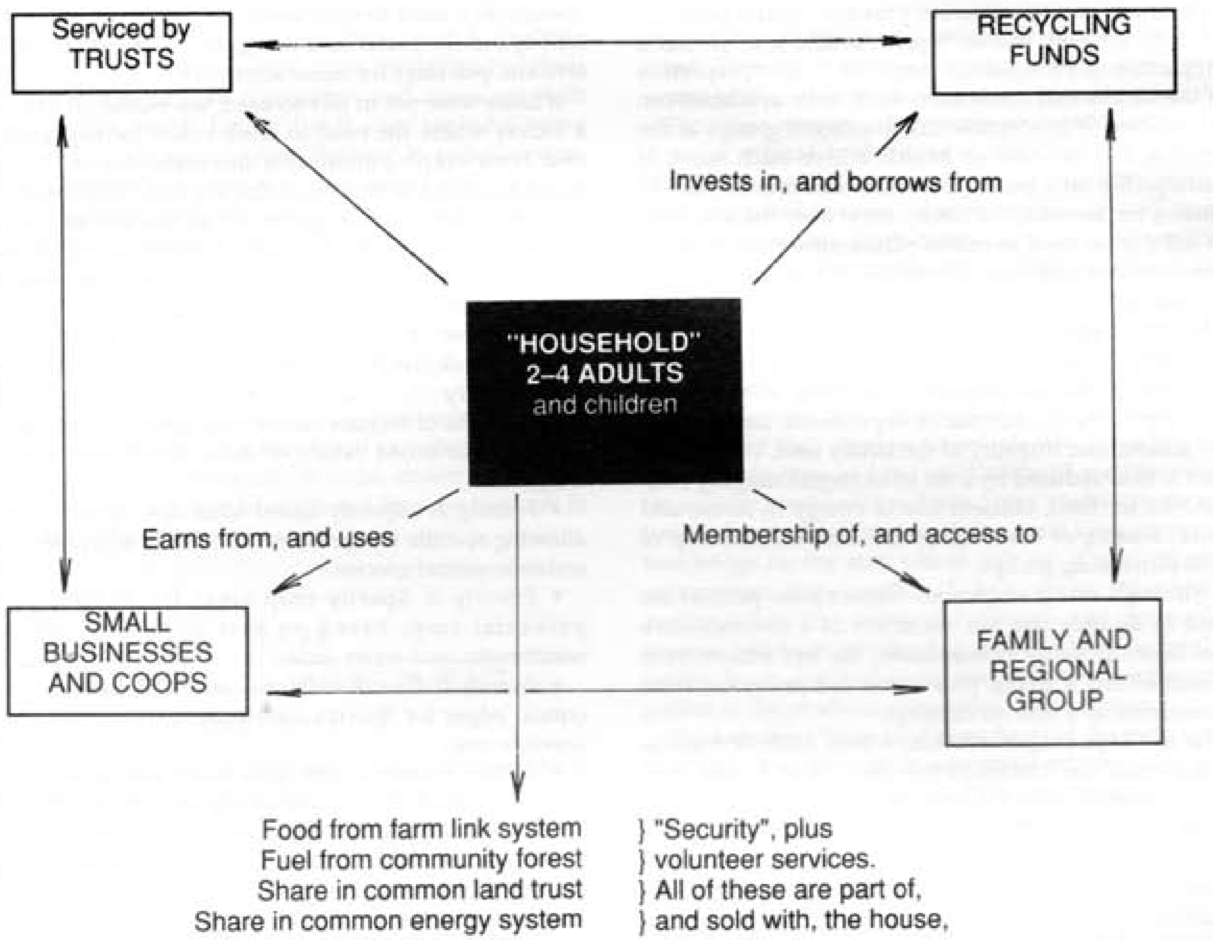
The farmer adjusts production to suit family needs, and as the "link" grows, the system can also accommodate holidays on the farm, educational workshops, and city help on the farm at peak work periods (planting and harvesting).

This strategy enables us to build compact urban areas while retaining farmlands that are uncluttered by settlement. The alternative (as in Australia, the USA, and increasingly in Europe) is for cities to become sprawling monstrosities of suburbs that reduce whole production areas to lawns and rotary clotheslines, and forests and trees to chopsticks and newspapers, while over-extending public utilies and creating insolvable transport and waste problems.

The system is best developed in Japan, although scattered examples operate elsewhere for products as diverse as fish and game, wheat and firewood. Benefits are numerous:

- Producers have an assured market at a mutually agreed price set a year ahead.
- Consumers can reduce costs to below wholesale by assisting with harvest.
- Townspeople can access farm facilities; this is valuable education for children.
- The system is convivial; in fact its main aims are to

**FIGURE 14.16**
**THE CONNECTIONS OF A HOUSEHOLD TO THE REGION**




develop *friendships*.

- Consumers control quality and quantity by pre-order and stated preferences.

Commonwork systems: Any trust, tribe or even an individual farmer can allow multiple land use by setting up a commonwork system, akin to the African *mahisa* or livestock loan system of Botswana.

Briefly, the land area is closely assessed for earth resources, wildlife, forest and aquaculture potential, small and large livestock (bees to bullocks), arable land and mixed orchard, and socio-educational potential. The local needs for primary processing, building, and consultancy or implementation services can also be researched.

This basic design work completed, the trust or owners can advertise locally for people to run any one of these enterprises with levels ranging from that of a hobby (developing a butterfly forage system) to a fulltime occupation income (a trout farm). Proper legal safeguards (lease documents) setting out rights of use, length of lease, responsibilities of the trust and lessee, and terms of payment (adjustable, but usually 10% of gross income) are drawn up to safeguard users. This 10%, credited to the donor, forms a capital fund together with any capital raised by the trust or the lessees (some as grants or gifts, some as business loans). The trust also needs income for maintaining services such as roads, fences, power, and to pay land taxes.

All lessees are selfemployed; land costs are minimal (their share of services) and land access is secure. As enterprises develop, the capital fund enables further research and development. It is ideal to plan so that any one enterprise (energy supply, bees, tree nursery) helps to supply others, as well as regional needs. More than one farm or trust can join in a commonwork system; the trust or land owners set broad conditions of sustainable use, and allot space or resources to enterprises, but the contributors to the capital fund vote in their own cash management group. Such a landuse system promises full and beneficial use of lands, and can take up much of the unemployment in a district.

However, commonworks need to be close to towns or on a public transport route, so that townspeople can participate; remote areas do not suit this system unless it is paired with a village development. Commonwork members are free to leave, sell out to new lessees, and eventually be refunded their 10%, less base maintenance and service costs, but plus any interest paid.

All occupations can be "open", available to all, but a proportion of occupations (adjusted to that proportion of the society that needs such work to be available) can be assigned to specifically disadvantaged groups at the time of life or state of health where such work is perhaps the only possible useful work one can do. In Turkey, for instance, the totally blind have the sole right to sell pigeon food in public places; this gives them an independent income. There are hundreds of such essentially minor incomes available in every society for otherwise-neglected groups or ages.

"Livings" are occupations which return a living wage to a family. The fair assessment of these rest in family size, especially the number of dependents, base costs in the society, and frugality of the family unit. The need to earn is *most* reduced by a set of strategies ranging from gardens for food, efficient use of energy in house and work, sharing of basic equipment, and membership of bulk purchasing groups.

Although many employees (unfortunate people) are paid to do only one job, members of a commonwork can take up many occupations, the net return from which afford a living plus some net profit for local investment as a tithe on earnings.

In the Mondragon system, actual cash or income differentials are limited in the ratio 1:4 or 5; that is to say, a sweeper cannot receive less than 25% of the total wage of a doctor; this is a good basis for adjusting any ethical sharing in any system. If people, via education, retraining, or selfhelp can improve their skills, their political mobility (*not* fixed castes) can allow them to improve their relative earning capacity, although not beyond a fair differential relative to their community.

In the concept of commonwork we have arrived at a new synthesis, a future model not only for farms but for complex small communities. Although tribal peoples had (and have) a clear idea of total ecologies—the sum of fire, regrowth, wallaby, and pioneer fire species—and although they had a word for this, there is no word-concept for a "total human family ecology" beyond "a living".

In my meaning of "a living", it is the beekeeper, the bees, their water, flowers, pollen, propolis, and the means to make the beehives. It is a clear legal access to forage, and a registered and secure bee site; and it is the right to sell or market product to pay for other life needs. In fact, it is a human ecological totality, provided with abstract and real self-reliance, and sufficient to pay for any tuition, travel, health service, and insurance needed by the family accessing a living.

This right, and many similar rights, overlay all landscapes, all societies, but can only be designed to be beneficial if that society (or that segment of society who want self-reliance) entrust their lands and lives to a public-interest deed of trust, and also trust each other to carry out a function. In fact, commonwork systems based on a social edifice of responsibility to and for others. For a nation-state, taxes were perhaps intended to supply social needs, whereas in fact they have always been used to raise armies and enrich a minority far beyond the needs of a living; to create wealth for a few, and privelege for bureaucrats.

If taxes were not in fact so used, we would all live in a society where the need to work would be negligible, and both employment and unemployment (thus, workers and owners) absent. Employment, like suburbs and institutions such as gaols, are as modern as lawns and politics; all ancient societies of people arranged life without any of these impediments, but only by seeing life as livings, and living things as basic to life.

A short list of developmental design programs for a commonwork land trust is as follows:

- *Priority 1*:: Maximise water storage by constructions of Keyline, swale, soil conditioning, ridge forestry, and broad canals or dams for diversion and irrigation.
- *Priority 2*: Specify forest sites and forest types, allowing specific forage forests for locally acceptable or endemic animal species.
- *Priority 3*: Specify crop areas for orchard and perennial crop, based on best soils, low slopes, windbreaks, and water access.
- *Priority 4*:: Specify complex access and trackways, critical edges for flowers, bee fodders, trellis systems, wayside crop.
- *Other*: Select a few caretaker house sites if necessary, and designate and stockpile earth materials if and as these are discovered in earth works. Check history and archaelogy, and keep a journal and open plan of all development.

Probable livelihoods for 100 ha, 40 or more families:

- Bees
- Poultry
- Ducks
- Fish species
- Forage systems
- Fuel forestry
- Structural forestry
- Cut flowers
- Nursery
- Methane and wind energy systems, solar systems (manufacture and power sales)
- Accommodation and tours
- Workshops and field days
- Training programmes
- Cooperative store
- Credit union
- Insurance
- Leasing
- Processing of raw materials to pottery, bricks, dried, pickled and smoked food products.

All of this asserts that we are not "just clerks" or "just housewives" but that we have many roles in any free society. Our freedoms are, in fact, a choice of those chains of responsibility or social duties with which we feel comfortable—not the freedom to do nothing, or to do what we like (to be self-serving)—but the freedom to choose among occupations—the portfolio of self-expression, work or duties that we in fact do evolve in non-hierarchical societies, villages, and tribes.

Thus, more formal cooperatives need to include retraining, education, and work mobility for their membership, or risk frustration and boredom with work. The work factor itself can include some proportion of time or output devoted to social services generally, so that everyone feels that they are contributing to their society as a whole. The very concepts of employment/unemployment deny this potential, and again frustrate people so that rebellion as strikes or riots follow. Guilds and unions (in the sense of trades) may actually reinforce this sense of irrevocable fate (no choice), as do caste systems in India.

Thus, in bioregional networks, commonworks, and intentional villages, the individual can choose a set of duties and occupations that fit skills, choice, and age. A few also develop special skills and become teachers in trades or disciplines.

## 14.13

## AN ETHICAL INVESTMENT MOVEMENT

Prior to 1980, very few innovative or consciously ethical (legally structured to be so) financial systems existed; today there are hundreds of such organisations, holding their own summits and handling, via their stockbrokers, in excess of 160 billion dollars annually (in the USA alone). Many other such organisations exist in Europe, Australia, New Zealand, India and southeast Asia.

In 1983, the Permaculture Institute, following seminars with the E. F. Schumacher group in the USA, started teaching in local community funding and ethical investment: "banking on the earth". Any local group is able to set up a resource list of data from existing models, to invite fund managers to visit their region to give seminars, and to adopt or devise local financial recycling systems, ethical brokerages, or non-monetary community exchange.

A local "earthbank" group is at first a research, teaching, or seminar convening organisation, but as local money systems are established, some members obtain employment by running financial, exchange, or barter systems. In the UK, USA, Australia, and Canada, annual seminars (in the UK called "The Other Economic Summit"—TOES) are now convened to hear from advisors and fund managers, and to supply education or materials to new groups. If no such summits exist in your area, convene one; we started with only 12 people in Australia, but 60–100 interested people and organisations now attend these seminars, and banks, insurance companies, cooperatives, and credit unions send representatives to assist new groups.

The rise of a large, popular, efficient set of services to divert public money to good ends (and get it back) is a reaction to (or revulsion with) the current misuse of money by governments, large aid agencies, and rapacious investors whose sole motive is profit, power, or greed. This movement is one of the truly new phenomena of this century, and its growth is exponential.

The large amount of investment capital redirected through ethical brokerages is the tip of an iceberg which involves many thousands of ordinary people who are members of guarantee circles, ethical credit unions, community loans trusts, common fund agencies for bioregions, or nonformal systems of labour and workday exchanges, barter systems, direct market systems, or no-interest, pre-purchase, "green dollar" systems.

Moreover, existing banks, credit unions, cooperatives, businesses, and allied groups are discussing the rewriting of their charters to include the values of earth care, people care, and the production of socially useful (or socially sensitive) products. Some credit unions and banks already have such a charter, and keep corporate watchdogs on the staff whose sole job it is to monitor companies for unethical behaviour. Not only corporations but volunteer groups and consumer groups produce monitoring publications on multinationals on a global scale, and publish "nonbuyers" guides of the products of unethical organisations.

The negative ("non-buy") emphasis of the early years involved disinvestment in companies which:

DO NOT CARE FOR THE EARTH, producing:

- Pollutants and dangerous wastes, waste product as excess packaging, and nonreturnable or not recyclable containers.
- Shoddy and quickly superseded products, unrepairable items, or those lacking good servicing and spares.
- Poisons, biocides, armaments, and dangerous materials (radioactive waste, mercury, asbestos, leaded petrol, chlorinated fluorocarbons in insulation or spray cans, radioactive paints and so on.

DO NOT CARE FOR PEOPLE, as assessed by:

- Dangerous foods or medicines.
- Have unsafe or polluted workplaces; this includes noise pollution.
- Deal in addictive substances or provide addictive services (alcohol, tobacco, gambling).
- Do not permit organised labour, do not deal with employees on a fair basis, nor pay fair wages.
- Exploit people directly via slavery, bonded labour, excessive profit margins, by forms of prostitution, racial and sexual discrimination, or harassment.
- Support or cooperate with regimes using torture or imprisonment without charge, dictatorships, corrupt regimes restricting voting, disenfranchising people by gerrymander, or by allowing votes only to certain groups.

DO NOT SHOW A PUBLIC CONSCIENCE

- Use bribery and price-fixing.
- Operate on excessive profits.
- Monopolise resources or markets.
- Do not themselves invest in ethical groups.

As the ethical investment movement matures, however, this negative approach is evolving into a very *positive* search for, and willingness to fund and support (or establish), enterprises which:

- Assist conservation and reduce waste (not *treat* waste and so grow to depend on more wastes!) or energy use.
- Grow clean food free of biocides or dangerous levels of contaminants.
- Are involved in community reafforestation.
- Build energy conserving houses or villages.
- Produce clean transport or energy systems.
- Assist people's self-reliance.
- Found cooperatives, self-employed ventures, or profit-sharing systems.
- Produce durable, sound, useful and necessary products.

Thus, local or bioregional funds can establish small or large enterprises necessary to that region, using money raised by residents. Brokers or enterprise trusts can direct surplus investment to socially and environmentally responsible industries and developments such as new, well-designed villages. All such ethical organisations state their criteria in their legal or informal charters.

RECOMMENDED TYPES OF INVESTMENTS

Investments need to be staggered in terms of ultimate return, so that some money is always on call. To these ends, a set of loans or investments can be scattered over short to longterm enterprises, e.g.

- Short Term: Loans for draught-proofing, insulation, attached glasshouse, clean water tanks, trickle irrigation, and dam building. All amortise in from 1–2 years, some in much shorter time (one winter). Also, loans can be given to good local industries with careful management and market assessment.
- Medium Term: Bee, chicken, and pig forage systems plus stock, large water catchments for aquaculture, irrigation; nurseries, subdivisions, tours and tourism, buying and selling farms after environmental rehabilitation; larger local industries or their expansion; clean power systems.
- Long Term: Town and city reconstruction or development; fuel crop and processing; small farm development; large-scale property retrofit; orchard establishment; research into new energy forms.
- Permanent: Forestry, and the purchase of natural remnant forest (shares can be traded as values increase over the long term); wildlife reserves and rainforest in good condition (as revalued property trusts dedicated to species preservation).

We can order investment value under some such simple system as follows:

1. Active e.g. a group of people investing in reafforestation, and working in that area.
2. Passive e.g. buying the products of an ethical company
3. Neutral e.g. funding a film which may have no message, ethical or otherwise.
4. Unethical e.g. retailing dangerous and persistent pesticides or herbicides.

This gives us a set of priorities based on "greatest effect and involvement". Category 4 above is, of course, not permitted by any ethical charter, and Category 3 need be funded only when other needs are satisfied.

We are acting at our best level, and have the greatest chance of success (or least chance of failure) when we are active workers in, and consumers of, the products or services that we fund. Within the "active" category (1 above), we can set priorities based on local or current problems in the biosocial context of the times. Today these would be:

Biological:

- The prevention of soil deterioration, i.e. *soil creation*
- The prevention of deforestation, i.e. *afforestation*
- Conservation of species, i.e. *creation of species reserves*

Environmental:

- Preserving the quality of air, i.e. *pollution control*
- Reduction of waste, i.e. *recycling and elimination of waste products*
- Cleaning up water i.e. *water storages and disinvestment in polluting industries.*

There is no implication in the above list that any investment fund should fund industries based on (*relying* on) the production of wastes.

Wherever a body of laws has been formed on the basis of the responsibility of people to their environment, a dynamic, long-maintained, and relatively harmless occupancy of the earth has resulted. I cannot think of any better examples than the long-term tribal occupancies of deserts, rainforests, and prairies.

But wherever a body of laws has been formed based on our "rights" to property, to protect material resources and accumulations, and to permit destruction of the public resource, we will not only destroy whole environments and species, but in the end ourselves.

It is already unlawful to clear forests in South Australia, to light fires in many areas, or to destroy protected wildlife, trees, or reserves in many countries; but we can murder with impunity by using biocides, destroy whole forests with acid rain, destroy the ozone layer, and risk sea level rise without penalty. Many organisations are demanding that this too changes, and that those responsible are charged with the damage, as people bereft of social conscience; we may yet live to see a class of corporate criminals brought to book for their conscious crimes.

Auditing is the periodic assessment of the validity of any financial enterprise or investment strategy. Whereas conventional financial systems propose a single economic criteria to such audits, I propose that we of the alternative nation apply three criteria:

1. The economic audit: "Where did the money go? Was it honestly used? Is the system economically viable?" (*The European audit*)

2. The ethical audit: "Was the enterprise concerned with its ethical (people care) accounting? Did the enterprise benefit people in the long run? " (*The Iroquois audit*)

3. The environmental audit: "Were the activities life-enhancing? Is the earth therefore more productive in terms of life forms? "(*The Pitjatjantjara or "life increase" audit*)

Active and Passive Investment Involvement

Many investors never see or experience the systems they fund via brokerages. As the ethical investment process evolves, many more projects involving investors as residents, builders, primary producers, or suppliers of goods and services can be developed. Bioregional funds do, in fact, offer their investors a chance to at least define the sort of goods they want produced in their region, at the quality level they would prefer. As an example, the development of a permaculture village does just that; the shares (not identical units) actually fund the whole development, including a common development fund, a local revolving loan fund, commercial and light industrial leases; areas are also set aside for primary producers, regional markets, recreation, conservation, and energy reserves. The process of village development has been outlined herein; in such developments every resident can be a participant at most levels.

We should, I feel, discourage passive investment; all brokers can introduce investors and producers in a mutually supportive web. There is no inducement greater than self-interest, and self-interest dictates that every investor should use, assist in, and consume the products and services they invest in. Investment centres should be active in person-to-person introduction—even investment parties!

Analysis of those sections of society and managed funds that prop up the whole investment system means identifying the source of such funds. Retirement funds (superannuation), union funds, insurance funds, and common trust funds are all large sources of investment monies; it is wise, therefore, to include representatives of or contributors to such funds in earthbank societies, and to invite them to ethical investment conferences.

After all, why should coal miners' union funds pay for the takeover that closes down their colliery, rather than the forest development funds that offers them retraining as foresters (and forests will be needed forever!) Only the corruption of fund managers would prevent such sensible provision for future work, and corruption cannot be exposed without investor pressure. Why should an insurance company have money in motor vehicle manufacturers producing unsafe or faulty vehicles? Why,should we fund our own destruction when the alternative is wide open for profitable, ethical development?

Proportional Investment

If one has $100, how should this be spread about to do the most good with the least risk? This is a matter of personal choice or good advice, but some sensible propositions area:

- 10% to risk ventures (new ideas, new ventures).
- 10%20% to a local S.H.A.R.E. programme or credit union as community development funds.
- 10%20% in any existing clean public power utility.
- 20%40% in a social investment fund.
- 10% to a public interest investment (school, hospital, research centre).

Thus the risk is spread widely, home and regional assets funded, and public services supported. This can also alter as new opportunities arise, but like self-employment, money should cover a wide portfolio of ventures.

Investment Sources

A good many people inherit, earn, or win sums of money from $1,000-100,000 surplus to their present needs. They do not want to invest in their own destruction by supporting polluting or addictive industries, and instead seek socially responsible investment. Another class of investors are members of churches and organisations which profess an ethic of peace and goodwill. These groups also need to place surplus funds in organisations which work towards their aims. Various lay bodies such as the Sierra Club, Friends of the Earth, and organic growers have funds to place in investment for at least short periods, and cannot always trust the local banks, which invest in adversary systems or which do not reveal their investment policy publicly.

In fact, everybody who uses a bank to store money is an investor by default, and if unaware of the bank's investment strategy, may most probably be investing (via the bank) in systems which are creating local problems or global disorder. Thus, it is necessary to locate or found ethical investment groups and put our money with them.

About 70% of the total "free world" investment is American, and of the 70%, the majority (or about 40% of the total) is in the hands of women, who tend to inherit as well as save. It is obviously important for womens' groups to direct this money to life-enhancing enterprises. Thus, at least one of our "minority" groups can invest in their own salvation, and also change the world, not only without losing money but in fact getting more return from regenerative investment than from the death system. For example, as stated in *CoEvolution Quarterly*, Summer '83, p. 91, investment returns for public utilities supplying power were as follows:

Nuclear based stocks appreciated ...........24%
Mixed groups (some nuclear) ..................52%
Non–nuclear power utilities .......................82%

Dividends for those groups were 30%, 59% and 81% respectively. It is now certain that socially responsible investment pays. We can also *make it cost to be socially irresponsible* by withdrawing investments from unethical groups. Socially sensitive investments not only pay better, but are basically an insurance against (rather than susceptible to) stock market crashes, as local facilities are always important in hard times, and local investments do not crash.

As money begins to flow to regional and socially responsible funds, even those people not personally persuaded of the need to invest in the future will have cause to think about investing in unethical systems from which public and financial support is being withdrawn. Pursued vigorously as a strategy, reinvestment in ethical systems can change the total direction of capital flow towards beneficial systems.

Some Strategies for Investment in the Environment

Recently third-world debt (heavily discounted by the creditor bank as a poor investment, so that one can buy $1,000,000 of debt for $120,000 of cash) has been purchased by conservationists (via a tax-deductible trust such as the World Wildlife Fund, or one of many conservationist societies). For this debt, the trust asks not for repayment of capital and interest in hard currency, but in forest or wetland assets in the debtor country.

In this way, everybody benefits: the banks, the debtor nation, the environment, and the purchasers; moreover the wildlife and forest reserves so purchased can be sensitively developed for nature, tourism and research rather than being cut down for debt repayment. The whole world benefits from forests, and such benign strategies need to be operated on the widest possible scale. This is not so difficult, as almost every world nation except perhaps Japan, Botswana (diamonds), and Nauru (rock phosphate) is today a debtor nation and few have any hope of repaying their debts—such is the stupidity of governments and banks that invest in corruption and exploitation (note that ethical funds don't share in the stock market crashes if they hold real assets that support *self-reliance*).

It is also possible to deposit funds with a tax-deductible trust, which purchases critical or species-rich areas discounted by farmer debt or by misuse or overcutting (salted and eroded lands). By putting aside a sum for management, income can be made from wildlife reserves, seed, or new forests. In the case of capable farmers, they can themselves be appointed as co-managers, and many would gladly accept this role in restoration and earth care. Many good farmers are made bankrupt by trying to restore land to health!

Investors can do the same for a public (for-profit) trust that reassesses its share prices annually. As a property is developed with lakes, forests, and wildlife, so its value increases, and the increased share value can be traded. It is in such restoration work that management teams (some of them co-investors, by an issue of shares for labour) can test their rehabilitation skills, as outlined in this book and elsewhere in the land restoration literature.

Company takeovers or raids are often used to enrich ruthless individuals by "assetstripping"—selling off a public company's assets and keeping the profits, regardless of the effects on the work force or national economy. However, the same methodology can be used by conservationminded takeover teams, who "strip" polluting companies, and develop land and urban assets to serve the needs of the society and of nature. Many failing logging companies have vast areas of degraded lands suited to small forest farm operations, and would-be forest farmers would love to manage a small area of forest properly, as would many theoretical botanists and academics who have long known how to develop a forest for eternal yield, but never had the land or capital to do so.

By these and other methods, the public can start to go to work via the normal financial and market procedures of the capitalist world to set their environment in order, to preserve species, and to educate and train an effective work force in assuming control for good purposes.

## TOTAL APPROACHES TO FINANCE IN SOCIETY

Margrit Kennedy (in a manuscript *Toward an Ecological Economy: money, land and tax reforms*, Oct. 1987) is convinced that an interest-free financial system is not only the sole sustainable medium for exchange, but that such a "no growth" fiscal system encourages and preserves all natural resources. It would at one stroke abolish the condition where the third world and the poor in affluent countries pay out more in interest than it has received in loans, prevent the growth of a minority wealthy elite, and stabilise resource use.

In everything we use there are hidden interest costs: about 12% of garbage collection charges, 38% of drinking water charges, and 77% of social housing charges are accountable as interest. The gains go to the rich or lenders, and the losses to the poor or borrowers even though the earth may provide the wealth of their labour (the *production sphere*). This wealth is removed by interest charges in the fiscal or *circulation sphere*. Thus, wealth used by unethical investment strategies is rapidly transferred via global stock or money markets to most efficiently exploit the poor; a wry comment on the people devising or running such systems.

The gross imbalance of wealth promotes "big" spending in capital-consuming but publicly paid investments (big dams, big power stations, big housing corporations) where governments refer the costs to the people. In the end, only military (waste) funding can use all this misbegotten wealth. So, sensible smallscale and cost-effective solutions are prevented or actively discouraged by governments and fiscal managers alike.

With no or very low interest rates, people buy goods at a *steady* rate, and industries do not need to be geared to cope with the fluctuations in market caused by the swings inherent in a global money supply which starves some regions and floods others with only a profit motive in mind. These goods or services need about a 5% *maintenance cost*, just to pay for repairs or people to run the system. It only needs any town, region, or nation to set up such a constant system to put right many social and ecological ills. This was, in fact, the system tried successfully by some small Austrian towns in the 1930's depression; as such systems strengthen and grow, so regions can stabilise and pay for all their essential longterm resources.

At any rate, the present system is in the process of collapse, and the new barter systems are expanding; the only question we have is if the life support systems of earth will still be intact, or whether sanity in fiscal affairs will be delayed until no human survival is possible on a polluted earth.

## 14.14

## FUTURES

I have borrowed, in part, from the publications of the infant world regional and familial alliances to detail (as a thematic structure) those global problems and local disturbances that will concern all of us over the next few decades. These are:

• ENVIRONMENTAL DETERIORATION.

A. Desertification, under the topics of:

1. Deforestation.
2. Water balance disturbance.
3. Soil salting and collapse.
4. Overgrazing.

• POLLUTION.

A. Of the atmosphere, leading to acid rain and climatic change.

B. Of soils via chemical waste.

C. By radioactives in the soil and food chains.

D. Of inland and fresh waters.

E. Of the estuaries and marine systems.

F. Of food by biocides, radiation.

• THE EXTINCTION OF NATURAL SYSTEMS AND SPECIES.

A. By rainforest destruction.

B. By desertification of arid area borders.

C. By clearing for agriculture.

D. By draining wetlands.

• CLIMATIC CHANGES.

A. Heating of earth by carbon dioxide and gaseous pollutants in the global atmosphere.

1. Rising sea levels
2. Reduction of stratospheric ozone.
3. Intensification of local ozone at ground level.
4. Acidic particles leading to acid rain.

• SOCIO-POLITICAL AND ECONOMIC CONCERNS.

A. The use of torture and imprisonment for repression of people; arrest or detention without charge or public trial.

B. The continuous oppression of minority ethnic, language, cultural, or tribal peoples.

C. Corruption, and the misuse of public monies by selfinterest groups.

D. Replacement of crafts and skills with machines and mass production.

E. Intolerable employment; unsafe, unhealthy, waste-productive .

F. Essentially short-term solutions to long-term, chronic problems.

G. Cash resources sequestered via addiction and crime.

• DIRECTLY HUMAN CONCERNS

A. Meaningful work (employment in right livelihood).

B. Adequate nutrition.

C. Adequate and easily maintained (low-energy shelter.

D. Access to a land base for sustenance.

E. Access to finance for development.

• RESEARCH AND SCIENTIFIC CONCERNS

A. The perversion of science to assist war, torture, oppression.

B. The lack of common, practical translation of scientific findings to those who can use the information.

C. The ineffectiveness of researchers in applying findings and obtaining feedback.

D. Setting priorities for research via morbidity and global analyses, and funding such priorities.

E. The monopolisation of socially useful inventions by patents, especially in seed and technology.

In every one of the above categories, *effective solutions to the stated problems exist*, have been applied, and have solved that problem locally or even nationally. Some are imperfect and need adjustment, others work in the context of specific cultures or landscapes, while a lesser number are effective across the whole range of specific phenomena. But in almost every case, "case histories" of solutions are not locally available over the range of current problems. Any such library of solutions needs an educational outreach. Educational programmes themselves need orientation to practical problem-solving using successful models.

Modifying all climatic and plant data given herein is the global warming effect and stratospheric ozone loss now expected to continue for the foreseeable future. This will mean increased air and seawater temperatures, the extension of typhoons and monsoon rains away from the equator towards Latitudes 20-25°, drier winters in western coastal and southwest Mediterranean climates, and a general increase in carbon dioxide, hence increased plant growth in the semiarid areas of tropical deserts.

As a background to any trends such as global warming, the basic 11year (22 year) sunspot cycle, and more importantly the 18.6 year lunar cycle (the latter affecting the shift north or south of cyclonic systems, the former affecting incoming radiation) will continue to determine drought and wet years. Such factors are now firmly tied to food crises and drought in most continents (*New Scientist* 8 Oct 87, p. 28).

The lunar atmospheric tide is the overriding effect, and the chief collator of such data (Robert Currie, State University of New York, Stonybrook, N.Y. USA) warns of agricultural shortages in the northern hemisphere in 1990–1992. These years will be wet in the southern hemisphere, and we can expect a repeat in the year 2009 or thereabouts. Thus, governments and farmers can plan to reduce herds, store grains, increase tree crop, enlarge or increase water storages and swales, and select plant crop species for such regular or cyclic variations. At present, Africa is in drought, and Europe in a flood cycle; every 9+ years this reverses.

It is now time to diversify bioregional resources to afford a flexible response to these changes. Such preparations may mean that several strategies need to be applied, including;

• Assessment of the local and national relief, and sea level rise effects in every region. For example, most low islands may be at some risk, while lowlying cities and coasts can be either evacuated or protected (at great cost).

• Extension of hurricane–proof housing design to Latitudes 30° north and south.

• Preparation for much hotter climactic factors both in gardens and homes (from 8–12 °C warmer in meso–thermal areas, from 1–5°C warmer in the tropics), thus far greater attention to high tree and palm canopy, insulation, building ventilation, and shadehouses.

• Increases of 16–25%in ultraviolet radiation, hence a change in human activity, and clothing. Animal breeds, resistant to heat effects, need to be selected now.

• A generally more mixed ecology with many more forest components in both urban and rural areas, including species from warmer regions.

As for future occupational changes and migrations, there will need to be far more emphasis on home gardens or city farms, specialist crop, forestry, and local processing for regional needs, as no one can ensure continued agricultural food supply or industrial crop sustainability.

Just to halt or modify the worst aspects of the current atmospheric trends, there is no doubt that any nation wishing to survive will redirect public and private investment monies into sustainable practices, and ban many substances and industries. For example:

• Biocide residues will be disallowed in food, water, and soils, and thus only sophisticated biological controls will apply on farms. Many chlorine products will be discontinued, as well as plastics such as polystyrene.

• Padi rice and feed–lot beef will be disallowed or eliminated as major pollutants, and supplemented with less polluting alternatives (e.g. potatoes, free range beef, chicken flocks).

• Coal burning for power and industry, and fossil fuel use generally will be greatly curtailed, thus solar, tide, hydroelectric, wave, wind, and biogas systems will come into general use. "Clean" fuels will be in global demand especially solar-electric vehicles and wind–assisted freight systems (ships and balloons, or dirigibles).

• Community forestry will be of critical importance in bioregions, cities, and in arid or salted areas.

• Farm tenure could be tied to good husbandry, not "yield", and disallowed if soil losses exceed soil creation on site, or water sources are polluted. Thus, annual cropping or plough culture will greatly decrease, and with it a host of problems.

• Wise government will ban cattle, goats, and sheep from delicate arid or highland areas, and accept the high yields of adapted wildlife under careful mangement.

• Any activity producing acid rain or persistent radioactives will be eliminated or minimised.

There will need to be a global response to environmental refugees, especially from atolls, low coasts, estuaries, and coastal cities (due to sea level rises). These will need to be housed in new, well–designed, low–energy inland villages or self-reliant settlements, minimising transport and fossil fuel uses. Moreover, many of these strategies will need to start now, and many sensible people and regions are already moving in these directions. Books such as this one will be needed for planners and designers, and general media services (radio, television, educational services) will have a key role to play in avoiding chaos and directing a well–orchestrated series of changes via positive advice and documentary education. New approaches to total bioregional policy planning by coalitions of scientists, planners, conservationists, and cooperating essential industries can replace short–term, nationalistic political processes.

Factors such as coastal seawater contamination of groundwaters, increased flood damage, coastal erosion, profound changes in fisheries and agriculture, and social disruption are foreseen as inevitable for a century to come, but if all the causative factors continue unabated, worse and more rapid changes can occur over the next 30 years.

Essential industries (small steel, cement, pipe, glass, and workshop-based enterprises, plus energy industries) will need to be relocated inland, and extensive road rerouting plus barge or water transport services will be needed; areas that will become islands will need efficient water or air transport.

As we cannot predict effects on fisheries or crops, diverse planning will be needed to establish inland aquacultures, forests, and gardens; economic species should be collected and preserved for future changes.

Above all, people need now to be well–informed so that they can act for themselves, or in concert, and we should all prepare for selfreliance and regional interdependence. As the problems are truly global, global concern and action will be needed.

I believe that only group or community (bioregional) survival is meaningful and possible; individual survival is meaningless, as is survival in fortresses. Thus, we must plan for total regions, and include all the skills of a global society.

The profound change we must all make is internal; everybody needs to realise that there is no group coming to their rescue, that it is only what each of us does that counts; thus, those who cooperate with others, and take on a task relevant to all people, will be valued above those who seek personal survival.

## 14.15
## AID AND ASSISTANCE IN AREAS OF NEED

In 1946, the ecologist Aldo Leopold (in *A Sand Country Almanac*, Oxford University Press) foresaw two seemingly inevitable trends: one is the exhaustion of the wilderness as a resource in itself, although a remnant may be preserved in museums or as a genetic resource, and "the other is the world-wide hybridisation of cultures through modern transport and communication...the question arises whether certain values can be preserved that would otherwise be lost." Thus, in developing permaculture, we have the following factors in mind:

- We need to cultivate or construct the resources that we use, not plunder a failing wilderness.
- All remaining genetic resources are to be preserved, as far as possible on their native sites (this includes cultivated plants).
- We need to accept that the hybridisation of culture does occur, but at the same time preserve the values in all cultures that assist human happiness, responsibility, sharing, conservation, and good management. That is, we need to put an ethical or value base to our actions.

Many of us offer aid to areas of need, and there are numerous non-governnment organsiations (NGO's) at work in the area of aid; some are supported by churches, others by civil institutions, and many are groups of people organised locally for self-help. Aid is a necessary but delicate affair; some forms of aid can produce dependency, facilitate further inequities in a society, destroy or impair cultural values, decrease the yields of the environment, upset delicately balanced nutritional habits, or actually destroy sustainable local ecologies or agricultural systems.

Perhaps we can approach the matter of successful aid by defining what such a success would entail; by setting criteria for judging "success". Thus, successful aid should:

- Address real and basic problems of the region (nutrition, drought relief, land and resource inequality) and to recognise that political and financial action may be necessary.
- Devise strategies to offset the effects of such problems, and to educate a group of local people to apply trials of those strategies.
- Assess trials for side effects and sustainability.
- Leave a local group able to further extend or educate others in such strategies.
- Provide modest support services and monitoring; above all, to record and circulate case histories to other non-government organisations.

Problem areas are no place for fools, amateurs, or people who will not listen to others or assess results. For example, many alkaline desert soils lack available zinc; whole grains and seed legumes may exacerbate metabolic zinc loss. Thus, traditional diets need to be examined and supported if they provide sources of zinc from meats, bone, ashes, or animal testicles. A new stove or cooker may prevent the incorporation of ashes in the diet, or a new diet may create a severe deficiency. There is no substitute for thorough analysis of soils and foods, the use of trace elements or soil additives, respect for traditional methods of food preparation, and an excellent education to accompany the project. Some of the factors that greatly assist effective aid are therefore:

- Excellent research, and excellent teaching locally; local teachers to be encouraged for the long term.
- Courtesy and respect for traditional diets and methods, cultures and languages.
- Honest, modest, and practical (achievable, affordable) advice as to *trials* of new systems.
- Feedback assessed, and flexibility of approach maintained (no one solution).
- Congruence in lifestyle and advice of advisers; advisers or educators should adopt their own advice! It is also important to teach models based on successful trials, not theoretical models.
- Effort to reach all sections of society.
- A positive, cheerful, enthusiastic approach to projects, inspiring by example.

The core of successful aid lies in modest trials, careful extension, and provision for widespread education, so that after aid has ceased (or ended a phase) local people can continue the education process, maintain any system (financial, technological, or agricultural), and can call for additional modest resources if necessary.

Many problems are very long-term, and short-term aid (typical of emergency programmes) is not able to address these; drought has an 18-20 year periodicity, and needs to be coped with by food storages on good years, emergency food and forage from tree crop, pre-drought reduction of herds, widespread rainfall harvesting systems, and a well-informed public assisted by appropriate policy such as equable adjustment of livestock herd size, and government aid to establish drought refuges *locally* for essential livestock and for people.

All these strategies need careful long-term planning, and firm policy implementation; these need to be in place over several decades before fine-tuning is possible. As political rule can change so rapidly, and is often repealed by opposing rulers, planning for the very long-term is possible only as a resident regional involvement. "Advisors" are short-term, and if they do not leave a corps of well-informed people, are of ephemeral effect; even such a basic technology as a water tap needs a trades-person capable of descaling vents and reseating valves, or replacing washers over the long term.

In catastrophes, only residents are effective over the short term; it is they who need, and can effectively use, relief housing and supplies. Outside aid is far less effective except in the matter of supply of *requested* resources; in areas of India where drought was offset by storage of hardy crops such as ragi (a sorghum), the introduction of exotic wheat varieties has meant that ragi is often unavailable for storage. Eucalypt monoculture for rayon fibre (textiles) has obliterated many ragi fields, and in total this may add up to a deferred catastrophe. Aid-financed deep wells and pumps in the same region have enabled large livestock herds and more annual cropping at the cost of a rapidly falling water table. So "improvements" in short-term finances ( to large landowners or industrialists) add up to a greatly impoverished population and environment; in short, desertification due to "improvements".

### Aid as Joint Enterprises

What is a joint enterprise? It is a mutual agreement, written and legal, that two groups, one third world (TW) and one western world (WW), work out for a mutual ethical enterprise. Accounting is:

- *Financial*: Most of the cash is from the WW group to establish a small manufacturing industry (seed production, craft, publishing, modest technological). The TW group supplies mainly skills and labour equivalents based on *local* average incomes. Jointly, costs are accounted up to product sale level, then net profits are *equably split* (profit minus costs and agreed-on cash reserves for future materials and expansion).
- *Ethical*: The product is life-enhancing and benefits people and the global ecology.
- *Social*: The product does not impoverish a local resource, or benefit an already rich group. The social effects are consistently assessed and accounted.

**Note**: All forms of accounting are assessed annually, and the results circulated to all investors or co-owners.

It is probable that the WW group sets up sales, ads, investment in the first place, and acts for the enterprise in *their* country, thus generating capital. The TW group sells locally and supplies mainly labour and skills, but also teaches skills to the WW people. Both groups set aside 10–15% of nett profit as research and development funds, or fund socially needed health and education. Trade is always reciprocal.

The *long-term aim* is to:

- Satisfy needs of both groups in a specific area.
- Set up reciprocal beneficial trade and travel.
- Teach others how to do this.
- See that both ends of the arrangement have their essential needs supplied.
- Reduce the need for trade goods, and increase the information flow.

The *main aim* is to make friends with each other; to draw closer together socially. This is the primary written rule "To become friends for mutual enrichment".

For example, a dryland group in the WW sends a convener to a host group in the dryland TW, and assesses local needs, both ways. A mutual decision is reached on an enterprise, e.g. seed growing. *Both* grow and exchange seed, set up a single seed catalogue and packaging system, agree to split profits, make arrangements for reciprocal travel, and devise ways to be closer friends.

### A FINAL LIMIT TO DEVELOPMENT.

Few economic systems, including those outlined in this section, give thought to some ultimate end. Even if we do achieve the goals of global community self-management, we are as much in danger of destroying the world by producing goods endlessly in Mondragon cooperatives, communist, or capitalist factories, or as individuals. There are certain rules for earth care which lie beyond the economic realm. I believe we should always tend towards minimising the spread of people and their works on the face of the land.

When we replace agriculture with gardens, then we should close down, as a priority, the most distant or most damaging agricultures. We can retain as land stewards the very few broadscale graziers and managers who now use vast tracts of land or who crop huge monocultural acreages. Better still, we can make foresters of our farmers. Some of them are already on this path.

*If* we close down farms and wasteproduct factories, we need to greatly enlarge true wilderness, for it is the ultimate grace to give room on earth to all living things, and the ultimate in modesty to regard ourselves as stewards, not gods.

## 14.16

## REFERENCES AND RESOURCES

Kennedy, Margrit, 1987 *Toward an Ecological Economy: Money, Land, and Tax Reforms*. Ginsterweg 45, D3074, Steyerberg, West Germany.

Max Neef, Manfred, *From the Outside Looking In: experiences in barefoot economics*, Dag Hammarskjold Foundation, Sweden, 1982.

Mollner, Terry 1982, *Mondragon Cooperatives and Trusteeship* (the design of a non-formal education process to establish a community development program based on Mahatma Ghandhi's theory of trusteeship and the Mondragon cooperatives), Doctoral thesis, University of Massachusetts USA. Copies available for $20 + postage from The Trusteeship Institute, Inc, Baker Road, Shutesbury MA 01072 USA. (Highly recommended reading for community groups and organisers.)

Morehouse, Ward 1983, *Handbook of Tools for Community Economic Change*, Intermediate Technology Group of North America Inc, PO Box 337, CrotononHudson, New York 10520 USA. (Available from the publisher. A basic explanation of land trusts, self-management, community banking, self-financing social investment, and S.H.A.R.E . programs. Highly recommended.)

Peters, T., and R. Waterman, *In Search of Excellence*, Harper & Row, 1983. (Has principles of good enterprise based on existing companies.)

Sale, Kirkpatrick, "Bioregionalism: a new way to treat land", *The Ecologist 14* (4), pp 167–173, 1984. (partly on cultural, but mainly on landscape, factors: that is, an *ecoregion*.)

Tukel, George 1982,*Toward a Bioregional Model*, Planet Drum Foundation 1982, PO Box 31251, San Francisco, California, USA. (This short treatment sees "bioregion" as watershed; while valid, many tribal and urban bioregions may not fit this model.)

Turnbull, Shann, *New money sources and profit motives for democratising the wealth of nations*, The Company Directors Association of Australia Ltd., 27 Macquarie Place, Sydney 2000, Australia. (A basic reference for a reformist economy. Shann Turnbull is involved with planning new systems. *And* he is an old caving companion of mine.)

Turnbull, Shann, *OPTIONS: Selecting A Local Currency*, The Australian Adam Smith Club, June 1983.

For some contacts in the US (or elsewhere) I have listed below public service organisation with good advice. They also need *your* input as new ideas and services, or new investment opportunities arise in your area.

To start your own money handling, write to and get a publications list from: The E.F. Schumacher Society, Box 76A, RD 3, Great Barrington, Massachusetts 01230. This group accumulates and publishes on successful community financial strategies for no-capital enterprises (pre-selling), local SHARE programmes, and how to print your own currency, as well as other strategies. If you have worked one of these strategies, notify them, and give a clear account of your system. This will reach alternative people via their conferences and publications.

C.E.L.T. (Cooperative Enterprise Loan Trust): people's banking and seminars advisory services; includes S.C.O.R.E. Service Corps of Retired Executives. P.O. Box 6855, Auckland, New Zealand.

Directory of Socially Responsible Investments, 1984 et sequ. Was $5 from The Funding Exchange, Room A, 135E 15th St. New York, NY 10003.

L.E.T.S. (Local Employment Trading System): organised credit/debit non-currency systems. Kits, games, software, information from: Micahel Linton. Landsman Community Services Ltd., 375 Johnston Ave., Courtenay, B.C. CANADA, V9N 2Y2, or the Maleny and District Community Credit Union, 28 Maple St., Maleny QLD 4552, Australia.

S.H.A.R.E (Self-Help Association for a Regional Economy) PO Box 125, Gt. Barrington, MA 01230, USA).

To report on dirty business locally or regionally, and to find out who has dirty work afoot elsewhere, contact:
1. The Interfaith Center for Corporate Responsibility (I.C.C.R.), a coalition of churches, issuing a newsletter *The Corporate Examiner*, which reports on local topics and their follow-ups. They also offer a phone advice service from their New York office (Phone: 2128702295). The newsletter is $35 per year, 11 issues, from ICCR, Room 556, 475 Riverside Drive, New York, N.Y. 10115.

2. Council on Economic Priorities (non-government research). Newsletter $25 per year, 10 issues, 84 Fifth Avenue, New York, N.Y. 10011.

*Good news* should be remitted to:
Good Money ($36 per year, 6 issues), from the Center for Economic Revitilization, Inc., Box 363, Worcester, Vermont 95682. This is probably the best source for investors who want to make their money work well.

# APPENDIX

## LIST OF PLANTS MENTIONED IN TEXT BY COMMON NAME

Acacia, *Acacia spp.*
African boxthorn, *Lycium ferrocissimum + spp.*
African marigold, *Tagetes erecta, T. minuta*
Agapanthus, *Agapanthus africanus*
Agave, *Agave spp.*
Aggie's pants, *Agapanthus africanus*
Albizia, *Albizia spp.*
Albizia, coast, *Albizia lophantha*
Alder, *Alnus spp.*
Alfalfa, *Medicago sativa*
Allspice, *Pimentia dioica*
Aloe, *Aloe spp.*
Alyssum, *Alyssum spp.*
Amaranth, *Amaranthus spp.*
Apple, *Malus pumila*
Apricot, *Armeniaca vulgaris*
Arrowhead, *Sagittaria spp.*
Arrowroot (Queensland), *Canna edulis*
Arrowroot (West Indian), *Maranta arundinaceae*
Arum lily, *Arum; Zantedeschia spp.*
Aspen, *Populus tremuloides +spp.*
Asparagus, *Asparagus officinalis*
Aster, *Aster spp.*
Aubergine, *Solanum melongena*
Autumn olive, *Elaeagnus umbellata*
Avocado, *Persea americana*
Azolla, *Azolla spp., A. filicoides*
Balsa, *Ochroma pyramidae*
Bamboo, *Bambusa, Phyllostachys, Arundinaria, Dendrocalamus*, and allied genera.
Banana, *Musa paradisiaca + spp.*
Banana passionfruit, *Passiflora mollissima*
Banksia, *Banksia spp.*
Baobab, *Adansonia digitata*
Barley, *Hordeum vulgare*
Basil, *Ocimum basilicum*
Basswood, *Tilia spp.*
Beach convulvulus, *Ipomoea pes-caprae*
Beach pea, *Lathyrus littoralis*
Bean, broad, *Vicia faba*
  common, *Phaseolus vulgaris*
  Dolichos, *Lab-lab purpureus*
  fava, *Vicia faba*
  four-winged, *Psophocarpus tetragonolobus*
  Goa, *Psophocarpus tetragonolobus*
  lima, *Phaseolus lunatus*
  mung, *Vigna radiata*
  phasey, *Macroptilum lathyroides*
  soya, *Glycine max*
  tepary, *Phaseolus acutifolius*
  velvet, *Lab-lab purpureus*
  yam, *Pachyrrhizos tuberosus*
Beet, *Beta vulgaris*
Bell pepper, *Capsicum annuum*
Birch, *Betula spp.*
Black nightshade, *Solanum nigrum*
Black walnut, *Juglans nigra*
Blackboy, *Xanthorrhea australis + spp.*
Blackwood, *Acacia melanoxylon*
Blue bush, *Mairana spp.*
Blue gum, *Eucalyptus globulus*
Blueberry, *Vaccinium spp.*
Boobialla (Dune), *Acacia sophorae*
Bower vine, *Tetragonia implexicona*
Bracken fern, *Pteridium aquilinum*
Brambles, *Rubus fruticosus + spp.*
Breadfruit, *Artocarpus altilis*
Breadroot, *Psoralea esculenta*
Broccoli, *Brassica oleracea*
Bromeliad, *Fam. Bromeliaceae*
Buckthorn plantain, *Plantago cornopus*
Buckwheat, *Fagopyrum esculentum*
Buddleia, *Buddleia spp.*
Busy Lizzie, *Impatiens mallerana*
Cabbage, *Brassica spp.*
Calapo, *Calopogonium mucunoides*
Calliandra, *Calliandra spp.*
Camass lily, *Camassia quamash*
Canary Island date, *Phoenix canariensis*
Candle nut, *Aleurites spp.*
Canistel, *Lucuma rivicoa*
Cape gooseberry, *Physalis peruviana*
Cape weed, *Arctotheca calendula*
Capsicum, *Capsicum annuum*
Carob, *Ceratonia siliqua*
Carrot, *Daucus carota*
Cashew, *Anacardium occidentale*
Cassava, *Manihot esculenta*
Cassia, *Cassia spp.*
Casuarina, *Casuarina spp.*
Casuarina, coastal, *Casuarina equisetifolia*
Cat tails, *Typha spp.*
Catchfly, *Lychnis, Silene*
Catmint, *Nepetea cataria*
Catnip, *Nepetea cataria*
Cauliflower, *Brassica oloeracea*
Cedar, *Cedrus spp.*
Celery, *Apium graveolens*
Centro, *Centrosema pubescens*
Chayote, *Sechium edule*
Cherry, *Prunus cerasus, P. avium*
Chestnut, *Castanea spp.*
Chicory, *Cichorium intybus*
Chilli pepper, *Solanum frutescens*
Chinese gooseberry, *Actinidia chinensis*
Chinese water chestnut, *Eleocharis dulcis*
Chinquapin, *Castanea pumila*
Chives, *Allium schoenoprasum*
Choko, *Sechium edule*
Cilantro, *Coriandrum sativum*
Cinnamon, *Cinnamomum zeylandicum*
Citrus, *Citrus spp.*
Cleavers, *Galium aparine*
Clover, *Trifolium spp.*
Cocksfoot, *Dactylis glomerata*
Cocoa, *Theobroma cacao*
Coconut, *Cocos nucifera*
Coffee, *Coffea spp.* incl: *C. robusta, C. arabica*
Comfrey, *Symphytum spp., S. officinale*
Common reed, *Phragmites communis*
Convulvulus, *Convulvulus spp.*
Copperburrs, *Bassia spp.*
Cordgrass, *Spartina spp.*
Coriander, *Coriandrum sativum*
Corn, *Zea mays*
Cotton, *Gossypium spp.*
Cowpea, *Vigna sinensis*
Cranberry, *Vaccinium macrocarpon + spp.*
Crocus, *Crocus sativus*
Crotolaria, *Crotolaria spp.*
Cucumber, *Cucumis sativus*
Cucurbit Fam., *Cucurbitaceae*
Cumbungi, *Typha spp., T. angustifolia*
Currants, Black, *Ribes nigrum*
  Gold, *Ribes aureum*
  Red, *Ribes rubrum*
Custard apple, *Annona spp.*
Cypress, *Cupressus spp.*
Daffodil, *Narcissus spp.*
Daikon radish, *Raphanus sativus*
Dun pea, *Pisum sativum arvense*
Dandelion, *Tarascum officinale*
Derris, *Derris spp., D. elliptica*
Desmodium, *Desmodium spp.*
Dill, *Anethum graveolens*
Dock, *Rumex spp.*
Douglas fir, *Pseudotsuga spp.*
Drumstick tree, *Moringa oleifera*
Duck potato, *Sagittaria spp.*
Durian, *Durio zibethinus*
Eggplant, *Solanum melongena*
Elderberry, *Sambucus spp.*
Elephant garlic, *Allium schoenoprasum var.*
Endive, *Cichorium endivia*
Erythrina, *Erythrina spp.*
Fennel, *Foeniculum vulgare*
Fenugreek, *Trigonella foenum-graecum*
Field daisy, *Bellis perennis, Aster spp.*
Fig, *Ficus carica + spp.*
Filbert (nut), *Corylus avellana + spp.*
Firs, *Pseudotsuga* and *Abies spp.*
Fuchsia, *Fuchsia spp.*
Ginger, *Zingiber officinale*
Gingseng, *Aralia quinquefolia*
Gladioli, *Gladiolus spp.*
Globe artichoke, *Cynara scolymus*
Glycine, *Neonotonia wightii*
Glyricidia, *Gliricidia sepium*
Gooseberry, *Ribes uva-crispa + spp.*
Goosefoot, *Chenopodium spp.*
Gorse (Furze, Whin), *Ulex europaeus*
Gourds, *Lagenaria spp.*
Granadilla, *Passiflora quadrangularis*
Grape, *Vitis vinifera*
Grape hyacinth, *Muscari neglectum*
Grass, banna, *Pennisetum purpureum*
  barley, *Hordeum maritimum*
  beach, *Ammophila spp., A. arenaria*
  bent, *Agrostis spp.*
  blady, *Imperata cylindrica*
  Buffalo, *Buchloe dactyloides*
  Cocksfoot, *Dactylis glomerata*
  elephant, *Pennisetum spp.*
  guinea, *Panicum maximum*
  kangaroo, *Themeda australis*
  kikuyu, *Pennisetum clandestinum*
  lemon, *Cymbopogon citratus*
  makarikari, *Panicum coloratum*
  napier, *Pennisetum purpureum*
  pampas, *Cortaderia sellowiana*
  panic, *Panicum spp.*
  para, *Brachyaria mutica*
  perennial rye grass, *Lolium perenne*
  purple pigeon, *Setaria porphyrantha*
  rhodes, *Chloris gayana*
  rice, *Oryzoides hymenopsis*
  sea barley, *Hordeum maritimum*
  signal, *Brachyaria spp.*
  sudan, *Sorghum halapense*
  tall wheat, *Agropyrum elongatum*
  vetiver, *Vetivaria zizanoides*
  Wimmera rye, *Lolium rigidum*
Grasstree, *Xanthorrhea australis + spp.*

Greenleaf desmodium, *Desmodium intortum*
Guava, *Pisidium guavaja*
Haifa white clover, *Trifolium spp.*
Haole koa, *Leucaena leucocephala*
Hau (Hawaiian hibiscus), Hibiscus *rosa-sinensis*
Hawthorn, *Crataegus oxycanthus + spp.*
Hazelnut, *Corylus avellana + spp.*
Heather, *Calluna, Erica, + spp.*
Hickory, *Carya ovata*
Honey locust, *Gleditsia triacanthos*
Honeysuckle, *Lonicera spp.*
Horseradish, *Armoracia rusticana*
Horseradish tree, *Moringa oleifera*
Huckleberry, *Gaylussacia, Vaccinium*
Huskberry, *Physalis peruviana*
Hyacinth, *Muscari neglectum*
Ice plant, *Carpobrotus + allied genera*
Impatiens, *Impatiens mallerana*
Indian water chestnut, *Trapa spp., T. natans*
Inga, *Inga spp., I. edulis*
Iris, *Iris spp.*
Jacaranda, *Jacaranda spp.*
Jak fruit, *Artocarpus spp.*
Jerusalem artichoke, *Helianthus tuberosus*
Jicama, *Exogonium brachteatum*
Jujube, *Ziziphus jujuba*
Juniper, *Juniperus spp.*
Kale, *Brassica oleracea*
Kang kong, *Ipomoea aquatica*
Kenya white clover, *Trifolium semipilosum*
Kiawe (Hawaii), *Prosopis pallida*
Kiwi fruit, *Actinidia chinensis*
Kiwi, hardy, *Actinidia arguta*
Kniphofia, *Kniphofia spp.*
Knot weed, *Polygonum spp.*
Lab–lab, *Lab–lab purpureus*
Lantana, *Lantana camara*
Laurel, *Laurus nobilis*
Lavendar, *Lavendula spp.*
Leatherwood, *Eucryphia billardierii*
Leeks, *Allium Ampeloprasum*
Legumes, Fams: *Fagaceae, , Papilionaceae*
Lentils, *Lens culinaris*
Leucaena, *Leucaena leucocephala*
Levant garlic, *Allium schoenoprasum var.*
Lettuce, *Latuca sativa*
Lignum vitae, *Guaiacum sanctum*
Lime (basswood), *Tilia spp.*
Lime (West Indian), *Citrus aurantiifolia*
Lippia, *Phyla (Lippia) nodiflora*
Loquat, *Eriobotrya japonica*
Lotus, *Nelumbo nucifera*
Lucerne, *Medicago sativa*
Lupin, *Lupinus alba + spp.*
Lychee, *Litchi chinensis*
Macadamia nut, *Macadamia spp.* esp: *M. integrifolia*
Macro, *Macrotyloma spp.*
Mahogany, *Swietenia mahogani*
Maize, *Zea mays*
Mango, *Mangifera indica*
Mangroves, *Several genera of trees; , Rhizopora spp.*
Mariposa lily, *Calochortus nuttallii + spp.*
Matsudana willow, *Salix matsudana*
Medlar, *Mespilus germanica*
Melia, *Melia azedarach*
Melons, usually *Cucumis melo*
Mesquite, *Prosopis spp.*
Mile–a–minute vine, *Mikania spp.*
Milk vetch, *Astralagus*
Millet, *Various genera.*, includes *Pennisetum, Panicum, Setaria, Paspalum*
Mirror plant, *Coprosma repens*
Monkeypod, *Samanea saman*
Mulberry, *Morus spp.*
Muscari, *Muscari neglectum*
Mustard, *Brassica nigra, B. hirta*
Nasturtium, *Nasturtium var.*
Neem tree, *Azedarachta indica*
Nettle, *Urtica dioica*
New Zealand hemp, *Phormium tenax*
Nutgrass, *Cyperus rotundus, Eleocharis , sphacelata + spp.*
Oak, *Quercus spp.*
Oak, Holm, *Quercus ilex*
Oak, silky, *Grevillea robusta*
Oats, *Avena sativa*
Oca, *Oxalis crenata*
Okra, *Abelmoschus esculentus*
Olives, *Olea europea*
Oncoba, *Oncoba spinosa*
Onion weed, *Allium triqetrum*
Onions, *Allium spp. especially A. cepa*
Onions, multiplier , *Allium aggregatum group*
Oxalis, *Oxalis spp.*
Paeony, *Paeonia spp.*
Palm, *Mauritia spp.*
- betelnut, *Areca catechu*
- borassus, *Borassus flabellifer + spp.*
- Butia, *Butia capitata*
- date, *Phoenix dactylifera*
- doum, *Hyphaene thebaicus*
- jelly, *Butia capitata, B. yatay*
- nypa, *Nypa fruticans*
- oil, *Elaeis guineaensis*
- rattan, *Dendrocalamus, Calamus,* and related genera
- salak, *Salacca spp.*
- sugar, *Arenga pinnata*

Pangola, *Digitaria decumbens*
Papaya, *Carica spp., C. papaya*
Parsley, *Petroselinum crispum*
Parsnip, *Pastinaca sativum*
Passion fruit, *Passiflora spp.*
Peach, *Amygdalus persicae*
Peanut, *Arachis hypogaea*
Pear , *Pyrus communis + spp.*
Peas, *Pisum spp., P. sativum*
Pennisetum, *Pennisetum spp.*
Pepino, *Solanum muricatum*
Pepper, black (vine), *Piper nigrum*
- chilli, *Solanum frutescens*
- sweet, *Solanum annuum*

Perennial rye grass, *Lolium perenne*
Persimmon, *Diospyrus kaki*
Philodendron, *Philodendron selluum*
Photinia (red–tipped), *Photinia spp.*
Pigeon pea, *Cajanus cajan*
Pigface, *Mesembryanthemum spp.*
Pine, Araucaria, *Araucaria spp.*
- Australian, *Callitris spp.*
- Canary Island, *Pinus canariensis*
- Norfolk Island , *Araucaria heterophylla*
- Oregon, *Pseudotsuga spp.*
- Stone, *Pinus edulis*

Pineapple, *Ananus comosus*
Pineapple guava, *Feijoa sellowiana*
Pistachio, *Pistachia vera + spp.*
Plantain, *Plantago spp.*
Plantain (Cooking banana), *Musa spp.*
Plum, *Prunus domestica + spp.*
Pomegranate, *Punica granatum*
Pongamia, *Pongamia pinnata*
Poplar, *Populus spp.*
Potato, *Solanum tuberosum + spp.*
Pride of India, *Melia azedarach*
Pride of Madeira, *Echium fastuosum*
Prosopis, *Prosopis spp.*
Puccinela, *Puccinela spp.*
Puero, *Pueraria phaseoloides*
Pultenea, *Pultenea spp.*
Pumpkin, *Cucurbita maxima*
Pussy willow, *Salix caprea*
Pyrethrum daisy, *Pyrethrum spp., , P. cinerariifolium*
Quillaja, *Quillaja saponaria*
Quince, *Cydonia oblonga*
Quinoa, *Chenopodium quinoa*
Raintree (Canary Is.), *Ocotea foetens*
Raintree (Indian), *Samanea saman*
Rape, *Brassica napus*
Raspberry, *Rubus idaeus + spp.*
Raspberry jam acacia, *Acacia acuminata*
Rattle pod, *Crotolaria spp.*
Red ink vine, *Rhagodia baccata*
Redwood, *Sequoia sempivirens*
Red–hot poker, *Kniphofia spp.*
Reed grass, *Phragmites spp.*
Reedmace, *Typha spp., T. angustifolia*
Rhubarb, *Rheum rhaponticum*
Rice, *Oryza sativa*
River red gum, *Eucalyptus camaldulensis*
Roly–poly, *Bassia Quinquenerva*
Rosella, *Hibiscus sabdariffa*
Rose (hedgerow), *Rosa multiflora*
Rosemary, *Rosmarinus officinalis*
Rosewood, *Tipuana tipu, Pterocarpus spp.*
Rosewood (Burmese), *Pterocarpus indicus, P. erinaceus*
Round rushes, *Juncus effusos + spp.*
Rubber hedge (Africa), *Euphorbia tirucalli*
Rubber tree, *Hevea braziliensis*
Rue, *Ruta graveolens*
Russian olive, *Elaeagnus angustifolia*
Rye, *Secale cereale*
Safflower, *Carthamus tinctorius*
Sage, *Salvia officinalis*
Salt bushes, *Atriplex spp.*
Salvia, *Salvia spp.*
Samphire, *Crithmum, Salicornia + spp.*
Sand–leek, *Allium scorodoprasum var.*
Sapote, *Diospyros. Casimiroa, , Calocarpum, Lucuma spp.*
Sea grape, *Coccolobus uvifera*
Sea grasses, *Posidonia, Zostera spp.*
Sedge, *Scirpus spp., S. validus, Cyperus spp.*
Service berry, *Amelanchier canadensis*
Sesbania, *Sesbania spp.*
Shallot, *Allium aggregatum* group
Shiitake (fungus), *Lentinus edodes*
Shungiku, *Chrysanthemum spp.*
Siberian pea shrub, *Caragana aborescens*
Silk sorghum, *Sorghum almum*
Silky oak, *Grevillea robusta*
Silver beet, *Beta vulgaris (a spinach)*
Silverberry, *Actinidia arguta*
Silverleaf Desmodium, *Desmodium uncinatum*
Siratro, *Macroptilium atropurpureum*
Sisal, *Aloe sisalana*
Sissoo, *Dalbergia sissoo*
Skunk cabbage, *Symplocarpus foetidus*
Snow pea, *Pisum sativum + spp.*
Sodom apple, *Solanum spp.*
Sorrel, *Rumex acetosa*

Spinach, *Spinacia oleracea*
St. Johns wort, *Hypericum*
Stinking Roger, *Tagetes erecta, T. minuta*
Strawberry, *Fragaria vesca + spp.*
Stylo, Townsville, *Stylosanthes guianensis*
Sugar beet, *Beta vulgaris*
Sugar cane, *Saccharum officinarum*
Sunflower, *Helianthus annuus*
Sunroot, *Helianthus tuberosus*
Sweet potato, *Ipomoea batatus*
Swiss chard, *Beta vulgaris* (a spinach)
Tagasaste, *Chaemocytisus palmensis*, (was *Cytisus proliferus*)
Tamarack, *Larix americana*
Tamarind, *Tamarindus indicus*
Tamarisk, *Tamarix apetala and spp.*
Tapioca, *Manihot esculenta*
Tares, *Vicia spp.*
Taro, *Colocasia esculenta*
Taupata, *Coprosma repens*
Tea, *Camellia sinensis*
Teak, *Tectona grandis*
Tephrosia, *Tephrosia candida*
Thyme, *Thymus spp., T. vulgaris*
Til, *Ocotea foetens*
Tipuana tipu, *Tipuana tipu*
Tobacco, *Nicotiana tabacum + spp.*
Tobacco bush, *Nicotiana spp.*
Tomato, *Lycopersicon lycopersicum*
Tropical acacia groups, *Acacia auriculiformis*,
*A. mangium + spp.*
Tumbleweed, *Amaranthus spp., Sisymbrium spp.*
Tumeric, *Curcuma domestica*
Tung and oil nuts, *Aleurites moluccensis*
Turnip, *Brassica rapa*
Vanilla, *Vanilla planifolia*
Verbena, *Verbena spp.*
Vetch, *Vicia spp.*
Violet, *Viola odorata*
Wallflowers, *Cheiranthus cheiri*
Walnut, *Juglans regia*
Wandering jew, *Tradescantia albiflora*
Water chestnuts, *Eleocharis, Trapa spp.*
Water hyacinth, *Eichornia crassipes*
Water lettuce, *Pista spp.*
Water lily, *Nymphaea spp.*
Water mint, *Mentha aquatica*
Water plantain, *Alisma plantago-aquatica*
Watercress, *Rorippa amphibia + spp.*
Watermelon, *Citrullus vulgaris*
Wattle, green, *Acacia mearnsii*
silver, *Acacia dealbata*
Waxberry, *Myrica cordifolia + spp.*
Wheat, *Triticum spp., T. aestivum*
White acacia, *Acacia albida*
White cedar, *Melia azedarach*
White clover, *Trifolium repens*
Wild rice, *Zizania lacustris*
Willow, *Salix spp.*
Wood fungi, *Pleurotus spp.*
Wormwood, *Artemesia absynthium*
Yam, *Dioscorus spp.*
Yatay, *Butia capitata, B. yatay*
Yucca, *Yucca spp.*

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# LIST OF PLANTS MENTIONED IN TEXT BY SPECIES NAME

*Abelmoschus esculentus*, Okra
*Abies spp.*, Firs
*Acacia spp.*, Acacias
*A. acuminata*, Raspberry jam acacia
*A. albida*, White acacia
*A. auriculiformis*,
*A. mangium + spp.*, Tropical acacia groups
*A. dealbata*, Silver wattle
*A. mearnsii*, Green wattle,
*A. melanoxylon*, Blackwood
*A. sophorae*, Boobialla (dunes)
*Actinidia arguta*, Silverberry, hardy Kiwi
*A. chinensis*, Kiwi fruit, Chinese gooseberry
*Adansonia digitata*, Baobab
*Agapanthus africanus*, Agapanthus, Aggie's pants
*Agave spp.*, Agave
*Agropyrum elongatum*, Tall wheat grass
*Agrostis spp.*, Bent grass
*Albizia spp.*, Albizia
*A. lophantha*, Coast Albizia
*Aleurites moluccensis*, Tung and oil nuts
*spp.*, Candle nut
*Alisma plantago-aquatica*, Water plantain
*Allium aggregatum* group, Multiplier onions
*A. Ampeloprasum*, Leeks
*A. ascolonicum*,
*A. aggregatum* group, Shallot
*A. schoenoprasum*, Chives
*A. schoenoprasum var.*, Elephant,garlic levant garlic
*A. scorodoprasum var.*, Sand-leek
*A. spp.* especially *A. cepa*, Onions
*A. triquetrum*, Onion weed
*Aloe spp.*, Aloe
*A. Sisalana*, Sisal
*Alyssum spp.*, Alyssum
*Amaranthus spp.*, Amaranth, tumbleweed
*Amelanchier canadensis*, Service berry
*Ammophila spp.*,
*A. arenaria*, Beach grass
*Amygdalus persicae*, Peach
*Anacardium occidentale*, Cashew
*Ananus comosus*, Pineapple
*Anethum graveclens*, Dill
*Annona spp.*, Custard apple
*Apium graveolens*, Celery
*Arachis hypogaea*, Peanut
*Aralia quinquefolia*, Gingseng
*Araucaria spp.*, Araucaria pine
*A. heterophylla*, Norfolk Island pine
*Arctotheca calendula*, Cape weed
*Areca catechu*, Betelnut palm
*Arenga pinnata*, Sugar palm
*Armeniaca vulgaris*, Apricot
*Armoracia rusticana*, Horseradish
*Artemesia absynthium*, Wormwood
*Artocarpus spp.*, Jak fruit
*A. altilis*, Breadfruit
*Arundinaria spp.*, Bamboo
*Asparagus officinalis*, Asparagus
*Aster spp.*, Aster, daisies
*Astralagus spp.*, Milk vetch
*Atriplex spp.*, Salt bushes
*Avena sativa*, Oats
*Azedarachta indica*, Neem tree
*Azolla spp., A. filicoides*, Azolla
*Bambusa spp.*, Bamboo
*Banksia spp.*, Banksia
*Bassia spp.*, Copperburrs
*B. Quinquenerva*, Roly-poly
*Bellis perennis*, Field daisy
*Beta vulgaris*, Beets, sugar beet, silver beet, swiss chard
*Betula spp.*, Birch
*Borassus flabellifer + spp.*, Borassus palm
*Brachyaria spp.*, Signal grass
*B. mutica*, Para grass
*Brassica napus*, Rape
*B. nigra, B. hirta*, Mustard
*B. oleracea*, Broccoli, cauliflower, kale,
*B. rapa*, Turnip
*B. spp.*, Cabbage
Fam. *Bromeliaceae*, Bromeliad
*Buchloe dactyloides*, Buffalo grass
*Buddleia spp.*, Buddleia
*Butia capitata*, Butia palm, jelly palm
*B. yatay*, Yatay
*Cajanus cajan*, Pigeon pea
*Calamus spp.*, Rattan palm
*Calocarpum spp.*, Sapote
*Calliandra spp.*, Calliandra
*Callitris spp.*, Australian pine
*Calluna spp.*, Heather
*Calochortus nuttallii + spp.*, Mariposa lily
*Calopogonium mucunoides*, Calapo
*Camassia quamash*, Camass lily
*Camellia sinensis*, Tea
*Canna edulis*, Arrowroot (Queensland)
*Capsicum annuum*, Bell pepper, capsicum
*Caragana aborescens*, Siberian pea shrub
*Carica spp., C. papaya*, Papaya
*Carpobrotus* + allied genera, Ice plant
*Carthamus tinctorius*, Safflower
*Carya ovata*, Hickory
*Casimiroa spp.*, Sapote
*Cassia spp.*, Cassia
*Castanea spp.*, Chestnut
*C. pumila*, Chinquapin
*Casuarina spp.*, Casuarina
*C. equisetifolia*, Coastal casuarina
*Cedrus spp.*, Cedar
*Centrosema pubescens*, Centro
*Ceratonia siliqua*, Carob
*Chaemocytisus palmensis*, Tagasaste (was *Cytisus proliferus*)
*Cheiranthus cheiri*, Wallflowers
*Chenopodium* spp., Goosefoot, fat hen
*C. quinoa*, Quinoa
*Chloris gayana*, Rhodes grass
*Chrysanthemum spp.*, Shungiku
*Cichorium endivia*, Endive
*C. intybus*, Chicory
*Cinnamomum zeylandicum*, Cinnamon
*Citrullus vulgaris*, Watermelon
*Citrus spp.*, Citrus
*C. aurantiifolia*, Lime (West Indian)
*Coccolobus uvifera*, Sea grape
*Cocos nucifera*, Coconut
*Coffea spp.*, Coffee
*Colocasia esculenta*, Taro
*Convolvulus spp.*, Convolvulus
*Coprosma repens*, Taupata, mirror plant
*Coriandrum sativum*, Coriander, cilantro
*Cortaderia sellowiana*, Pampas grass
*Corylus avellana + spp.*, Hazelnut, filbert
*Crataegus oxycanthus + spp.*, Hawthorn
*Crithmum spp.*, Samphire

*Crocus sativus*, Crocus
*Crotolaria spp.*, Crotolaria, rattle pod
*Cucumis sativus*, Cucumber
*C. melo*, Melons
Fam. *Cucurbitaceae*, Cucurbits
*Cucurbita maxima*, Pumpkin
*Cupressus spp.*, Cypress
*Curcuma domestica*, Tumeric
*Cydonia oblonga*, Quince
*Cymbopogon citratus*, Lemongrass
*Cynara scolymus*, Globe artichoke
*Cyperus spp.*, Sedges
*C. rotundus* , Nutgrass
*Dactylis glomerata*, Cocksfoot (grass)
*Dalbergia sissoo*, Sissoo
*Daucus carota*, Carrot
*Dendrocalamus spp.* , Bamboos, Rattan palm
*Derris spp.*, *D. elliptica*, Derris
*Desmodium spp.*, Desmodium
*D. intortum*, Greenleaf desmodium
*D. uncinatum*, Silverleaf desmodium
*Digitaria decumbens*, Pangola
*Dioscorus spp.*, Yam
*Diospyros spp.*, Sapote
*D. kaki*, Persimmon
*Durio zibethinus*, Durian
*Echium fastuosum*, Pride of Madeira
*Eichornia crassipes*, Water hyacinth
*Elaeagnus angustifolia*, Russian olive
*E. umbellata*, Autumn olive
*Elaeis guineaensis*, Oil palm
*Eleocharis sphacelata + spp.*, Nut grass
*Eleocharis dulcis*, Chinese water chestnut
*Erica + spp.*, Heather
*Eriobotrya japonica*, Loquat
*Erythrina spp.*, Erythrina
*Eucalyptus camaldulensis*, River red gum
*E. globulus*, Blue gum
*Eucryphia billardierii*, Leatherwood
*Euphorbia tirucalli*, Rubber hedge (Africa)
*Exogonium brachteatum*, Jicama
*Fagaceae* Family, legumes
*Fagopyrum esculentum*, Buckwheat
*Ficus carica + spp.*, Fig
*Feijoa sellowiana*, Pineapple guava
*Foeniculum vulgare*, Fennel
*Fragaria vesca + spp.*, Strawberry
*Fuchsia spp.*, Fuchsia
*Galium aparine*, Cleavers
*Gaylussacia spp.*, Huckleberry
*Gladiolus spp.*, Gladioli
*Gleditsia triacanthos*, Honey locust
*Gliricidia sepium*, Glyricidia
*Glycine max*, Soya bean
*Gossypium spp.*, Cotton
*Grevillea robusta*, Silky oak
*Guaiacum sanctum*, Lignum vitae
*Helianthus annuus*, Sunflower
*H. tuberosus*, Sunroot, Jerusalem artichoke
*Hevea braziliensis*, Rubber tree
*Hibiscus rosa-sinensis*, Hau (Hawaiian hibiscus)
*H. sabdariffa*, Rosella
*Hordeum maritimum*, Sea barley grass
*H. vulgare*, Barley
*Hypericum spp.*, St. Johns wort
*Hyphaene thebaicus*, Doum palm
*Impatiens mallerana*, Busy Lizzie, Impatiens
*Imperata cylindrica*, Blady grass
*Inga spp.*, *I. edulis*, Inga
*Ipomoea aquatica*, Kang kong
*I. pes-caprae*, Beach convulvulus
*I. batatus*, Sweet potato
*Iris spp.*, Iris
*Jacaranda spp.*, Jacaranda
*Juglans nigra*, Black walnut
*J. regia*, Walnut
*Juncus effusos + spp.*, Round rushes
*Juniperus spp.*, Juniper
*Kniphofia spp.*, Kniphofia, Red–hot poker
*Lab–lab purpureus*, Dolichos bean, velvet bean, lab–lab
*Lagenaria spp.*, Gourds
*Lantana camara*, Lantana
*Larix americana*, Tamarack
*Lathyrus littoralis*, Beach pea
*Latuca sativa*, Lettuce
*Laurus nobilis*, Laurel
*Lavendula spp.*, Lavender
*Lens culinaris*, Lentils
*Lentinus edodes*, Shiitake mushroom
*Leucaena leucocephala*, Leucaena, Haole koa
*Litchi chinensis*, Lychee
*Lolium rigidum*, Wimmera ryegrass
*L. perenne*, Perennial rye grass
*Lonicera spp.*, Honeysuckle
*Lucuma spp.*, Sapote
*L. rivicoa*, Canistel
*Lupinus alba + spp.*, Lupin
*Lychnis, Silene*, Catchfly
*Lycium ferrocissimum + spp.*, African boxthorn
*Lycopersicon lycopersicum* , Tomato
*Macadamia spp.*
esp. *M. integrifolia*, Macadamia nut
*Macroptilium atropurpureum*, Siratro
*M. lathyroides*, Phasey bean
*Macrotyloma spp.*, Macro
*Mairana spp.*, Blue bush
*Malus pumila*, Apple
*Mangifera indica*, Mango
*Manihot esculenta*, Cassava, tapioca
*Maranta arundinaceae*, Arrowroot (West Indian)
*Maurantia spp.*, Palms
*Medicago sativa*, Lucerne, alfalfa
*Melia azedarach*, Melia, white cedar, Pride of India
*Mentha aquatica*, Water mint
*Mesembryanthemum spp.*, Pigface
*Mespilus germanica*, Medlar
*Mikania spp.*, Mile–a–minute vine
*Moringa oleifera*, Horseradish tree, drumstick tree
*Morus spp.*, Mulberry
*Muscari neglectum*, Hyacinth, grape hyacinth, muscari
*Musa paradisiaca + spp.*, Banana, plantain (cooking banana)
*Myrica cordifolia + spp.*, Waxberry
*Narcissus spp.*, Daffodil
*Nasturtium var.*, Nasturtium
*Nelumbo nucifera*, Lotus
*Nepeta cataria*, Catmint, catnip
*Neonotonia wightii*, Glycine
*Nicotiana spp.*, Tobacco bush
*N. tabacum + spp.*, Tobacco
*Nymphaea spp.*, Water lily
*Nypa fruticans*, Nypa palm
*Ochroma pyramidae*, Balsa
*Ocimum basilicum*, Basil
*Ocotea foetens*, Til, Raintree (Canary Islands)
*Olea europea*, Olive
*Oncoba spinosa*, Oncoba
*Oryza sativa*, Rice
*Oryzoides hymenopsis*, Rice grass
*Oxalis spp.*, Oxalis
*O. crenata*, Oca
*Pachyrrhizos tuberosus*, Yam bean
*Paeonia spp.*, Paeony
*Panicum spp.*, Millets, pani grass, panic
*P. coloratum*, Makarikari grass
*P. maximum*, Guinea grass
*Papilionaceae* Family , Legumes
*Pastinaca sativum*, Parsnip
*Paspalum spp.*, Grasses, millets
*Passiflora spp.*, Passion fruits,
*P. mollissima*, Banana passionfruit,
*P. quadrangularis*, Granadilla
*Pennisetum spp.*, Pennisetum, Elephant grass, millets
*P. clandestinum*, Kikuyu grass
*P. purpureum*, Banna grass, Napier grass
*Persea americana*, Avocado
*Petroselinum crispum*, Parsley
*Phaseolus acutifolius*, Tepary bean
*P. lunatus*, Lima bean
*P. vulgaris*, Common beans
*Philodendron selluum*, Philodendron
*Phoenix canariensis*, Canary Island date
*P. dactylifera*, Date palm
*Phormium tenax*, New Zealand hemp
*Photinia spp*, Photinia (red–tipped)
*Phragmites spp*, Common reed, reed grass
*Phyla (Lippia) nodiflora*, Lippia
*Phyllostachys spp.*, Bamboo
*Physalis peruviana*, Cape gooseberry, Huskberry
*Pimentia dioica*, Allspice
*Pinus spp.*, Pines
*P. canariensis*, Canary Island pine
*P. edulis + spp.*, Stone pine
*Piper nigrum*, Black pepper (vine)
*Pisidium guavaja*, Guava
*Pista spp.*, Water lettuce
*Pistachia vera + spp.*, Pistachio
*Pisum spp.*, Peas
*P. sativum var.*, Snow pea
*P. sativum arvense*, Dun pea
*Plantago spp.*, Plantain
*P. cornopus*, Buckthorn plantain
*Pleurotis spp*, Wood fungi
*Polygonum spp.*, Knot weed
*Pongamia pinnata*, Pongamia
*Populus spp.*, Poplar
*P. tremuloides*, Aspen
*Posidonia spp.*, Seagrass
*Prosopis spp.*, Prosopis, mesquite,
*P. pallida*, Kiawe (Hawaii)
*Prunus cerasus*, *P. avium*, Cherry
*P. domestica*, Plum
*Pseudotsuga spp.*, Firs, Oregon pine/douglas fir
*Psophocarpus tetragonolobus*, Four–winged bean, Goa bean
*Psoralea esculenta*, Breadroot
*Pteridium aquilinum*, Bracken fern
*Pterocarpus indicus*,
*P. erinaceus*, Rosewood (Burmese)
*Puccinela spp.*, Puccinela
*Pueraria phaseoloides*, Puero
*Pultenea spp.*, Pultenea
*Punica granatum*, Pomegranate
*Pyrethrum spp.*,
*P. cinerariifolium*, Pyrethrum daisy
*Pyrus communis + spp.*, Pear
*Quercus spp.*, Oak
*Q. ilex*, Holm oak

*Quillaja saponaria*, Quillaja
*Raphanus sativus*, Daikon radish
*Rhagodia baccata*, Red ink vine
*Rheum rhaponticum*, Rhubarb
*Rhizopora spp.*, Mangroves
*Ribes uva-crispi*, Gooseberry
*R. aureum*, Gold currant
*R. nigrum*, Black currant
*R. rubrum*, Red currant
*Rorippa amphibia + spp.*, Watercress
*Rosa multiflora*, Rose (hedgerow)
*Rosmarinus officinalis*, Rosemary
*Rubus fruticosus + spp.*, Brambles
*R. idaeus + spp.*, Raspberry
*Rumex spp.*, Dock
*R.acetosa*, Sorrel
*Ruta graveolens*, Rue
*Saccharum officinarum*, Sugar cane
*Sagittaria spp.*, Arrowhead, duck potato
*Salacca spp.*, Salak palm
*Salicornia + spp.*, Samphire
*Salix spp.*, Willow
*S. caprea*, Pussy willow
*S.matsudana*, Matsudana willow
*Salvia spp.*, Salvia
*S. officinalis*, Sage
*Samanea saman*, Monkeypod, raintree (Indian)
*Sambucus spp.*, Elderberry
*Scirpus spp.*, *S. validus*, Sedge
*Secale cereale*, Rye
*Sechium edule*, Chayote, choko
*Sesbania spp.*, Sesbania
*Sequoia sempivirens*, Redwood
*Setaria spp.*, Millets
*S. porphyrantha*, Purple pigeon grass
*Sisymbrium spp.*, Tumbleweed,
*Solanum spp.*, Sodom apple
*Solanum annuum*, Sweet pepper
*S. frutescens*, Chilli pepper
*S. melongena*, Eggplant, aubergine
*S. muricatum*, Pepino
*S. nigrum*, Black nightshade
*S. tuberosum + spp.*, Potato
*Sorghum almum*, Silk sorghum
*S. halapense*, Sudan grass
*Spartina spp.*, Cordgrass
*Spinacia oleracea*, Spinach
*Stylosanthes guianensis*, Stylo, Townsville
*Swietenia mahogani*, Mahogany
*Symphytum spp.*,
*S. officinale*, Comfrey
*Symplocarpus foetidus*, Skunk cabbage
*Tagetes erecta*, *T. minuta*, African marigold, stinking roger
*Tamarindus indicus*, Tamarind
*Tamarix apetala + spp.*, Tamarisk
*Tarascum officinale*, Dandelion
*Tectona grandis*, Teak
*Tephrosia candida*, Tephrosia
*Tetragonia implexicona*, Bower vine
*Themeda australis*, Kangaroo grass
*Theobroma cacao*, Cocoa
*Thymus spp.*, *T. vulgaris*, Thyme
*Tilia spp.*, Basswood, lime
*Tipuana tipu*, Tipuana tipu, rosewood
*Tradescantia albiflora*, Wandering jew
*Trapa spp.*, *T. natans*, Indian water chestnut
*Trifolium spp.*, Clover
*T. semipilosum*, Kenya white clover
*T. repens*, White clover
*T. spp.*, Haifa white clover
*Trigonella foenum-graecum*, Fenugreek
*Triticum spp.*, *T. aestivum*, Wheat
*Typha spp.*, *T. angustifolia*, Reedmace, cat tail, cumbungi
*Ulex europaeus*, Gorse, furze, whin
*Urtica dioica*, Nettle
*Vaccinium spp.*, Blueberry, huckleberry
*V. macrocarpon + spp.*, Cranberry
*Vanilla planifolia*, Vanilla
*Verbena spp.*, Verbena
*Vetiveria zizanoides*, Vetiver grass
*Vicia faba*, Fava bean, broad bean
*Vicia spp.*, Vetch, tares
*Vigna radiata*, Mung bean
*V. sinensis*, Cowpea
*Viola odorata*, Violet
*Vitis vinifera*, Grape
*Xanthorrhea australis + spp.*, Blackboy, grasstree
*Yucca spp.*, Yucca
*Zantedeschia spp.*, Arum lily
*Zea mays*, Corn, maize
*Zingiber officinale*, Ginger
*Zizania lacustris*, Wild rice
*Ziziphus jujuba*, Jujube
*Zostera spp.*, Seagrass

Permaculture (**perma**nent agri**culture**) is the conscious design and maintenance of agriculturally productive ecosystems which have the diversity, stability, and resilience of natural ecosystems. It is the harmonious integration of landscape and people providing their food, energy, shelter, and other material and non-material needs in a sustainable way. Without permanent agriculture there is no possibility of a stable social order.

Permaculture design is a system of assembling conceptual, material, and strategic components in a pattern which functions to benefit life in all its forms.

The philosophy behind permaculture is one of working with, rather than against, nature; of protracted and thoughtful observation rather than protracted and thoughtless action; of looking at systems in all their functions, rather than asking only one yield of them; and of allowing systems to demonstrate their own evolutions.

The publishing team in the shade of *Pennisetum purpureum*, right to left: Bill Mollison (author, photographer); Reny Mia Slay (typescript, editor); and Andrew Jeeves (design, illustration, layout).

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