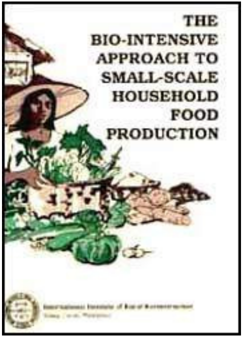
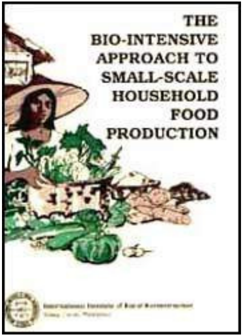


Bio-intensive Approach to Small-scale Household Food Production (IIRR, 1993, 180 p.)

Home"" """"> ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

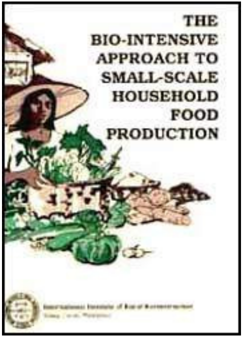


Bio-intensive Approach to Small-scale Household Food Production (IIRR, 1993, 180 p.)

International institute of rural reconstruction
Silang, Cavite, Philippines

Home"" """"> ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Bio-intensive Approach to Small-scale Household Food Production (IIRR, 1993, 180 p.)



Bio-intensive Approach to Small-scale Household Food Production (IIRR, 1993, 180 p.)

Introduction

Characteristics of the bio-intensive approach to small-scale household food production

THE big-intensive approach to small-scale household level food production differs considerably from the conventional gardening systems because of its stress on deep bed preparation, nutrient recycling, building up of the soil's biological base, diversified cropping, use of indigenous cultivars or locally adapted varieties and its emphasis on a balanced and integrated ecosystem. Here are some of the characteristics of the approach as developed and/or promoted by the author.

Sustainability

The big-intensive approach, as the name suggests, is a biological (as opposed to chemical) form of agriculture in which a small area of land is intensively cultivated, using nature's own ingredients to rebuild and then maintain the soil's productivity. At the heart of the approach is the effort to improve the soils' capability to nurture and sustain plant life. What a big-intensive gardener tries to do on his/her small plot is to simulate/replicate a natural forest (with the constant recycling of nutrients and maintenance of soil, moisture and microbial conditions). Many countries of the world (and China is particularly notable) have farmed biologically for thousands of years and have been able to sustain output levels over these years. In sharp contrast, the "efficient" but shortsighted approaches being used in many Western and third world countries have often been disruptive of the natural resource base. Farmers in many parts of the world are experiencing that they are having to use steadily increasing quantities of fertilizers and pesticides to sustain previous yield levels.

In the big-intensive approach being recommended here for small-scale plots, the soil is gradually improved and the composition of beneficial microbial life actually improves from season to season. The soil structure and humus content also greatly benefits. The nutrient content of the soil is built up after each crop rather than being depleted. A healthy soil means a healthy stand of plants, and that means fewer insects and less disease. In the big-intensive approach, yields continue to rise for the first few years and then tend to stabilize (at an overall higher yield). Such systems and the outputs (i.e., yields) are easily sustained at that level for many years with unchanging or even reduced levels of material and labor inputs.

Recycling of Plant and Animal Wastes and Residues

Every big-intensive gardener attempts to maximize the use of plant and animal residues and wastes. In an attempt to return to the soil much of what come out from it, material is recycled back to the soil. Typically, such material is transported away from the site where it came from in the first place and/or dumped in the garbage or burned. Organic matter must be resumed to the soil that helped build it.

A big-intensive gardener usually composts such plant and animal wastes before returning it to the soil. In addition, other materials (also produced at the soil's "cost") are added, such as ash, bone meal, etc. This replenishes the soil with what was taken from it. Soil requires food just as humans and animals do. Once again, the example of a natural forest and how it regenerates itself through continuous recycling (dead trees, fallen leaves decompose on the forest floor with help from forest animals and microbial life) is helpful in understanding the need for recycling nutrients in the backyard garden.

> Source: Gonsalves, J. F. Paper presented at the Asian Vegetable Research and Development Centre, Taiwan. VIP Gardening Workshop. April 25,1985

Today, soils in conventional farming are being literally mined with little or no recycling of organic matter. In the past, various approaches to permit regeneration such as leaving lands to fallow or the abandonment of swidden plots (slash and burn) for periods of 3 - 10 years were used to permit the regeneration of plant and animal life and rebuild the organic matter status. In other parts of the world (in recent years particularly in India), available chemical inputs were combined with animal manure which served to partially return the organic matter to the soil. In the big-intensive approach, organic matter is returned to the soils in the form of compost after each crop.

The cultivation of a range of crops (each of different rooting lengths) tends to retain organic residues in the soil at different depths (when plants are pulled out, rootless and root hairs invariably remain in the soil). Organic matter builds and sustains soil life. No amount of chemicals can do that job. Such organic manure helps "break up" sticky and hardened clays and hold together separate soil particles of sandy soil. Organic matter acts like a sponge that soaks up moisture and retains it for future plant use (at a level) in the soil where it is readily accessible to the plant.

The organic matter can contribute to the buildup of the soil's population of earthworms, which in turn improves the aeration and nutrient status of the soil. John Jeavons of Ecology Action indicates that earthworm castings are five times richer in nitrogen, seven times richer in phosphorus and 11 times richer in potassium than the soil they inhabit. When you consider that earthworms produce twice their weight in castings every day, that's a lot of nutrients added to the soil! The cultivation of a range of different crops having different rooting depths serves to tap different layers of the soil profile, thus, reducing soil exhaustion. In fact, different crops require different quantities of soil nutrients, e.g., leafy crops are heavy on nitrogen, root crops are heavy on phosphorus, fruit crops are heavy on potash and legumes in fact add nitrogen. Hence, crop rotation helps build a sustainable and stable soil.

Self-reliance in Production Inputs

As mentioned earlier, the big-intensive approach is characterized by a greatly reduced dependence on the expensive inputs that are generally used in conventional food production approaches. Many of these non-renewable inputs, such as chemical fertilizers and pesticides, are produced at high energy costs (usually petroleum-based). Instead of such energy- intensive chemicals inputs, plants and animal wastes and natural mineral substitutes are used. In the methods being advocated here, the inputs required are bones, wood ash, eggshells, mudpress (by-product of sugar mills) or compost, ipil-ipil (Leucaena) leaf meal or fish meal (only in places where they are readily available). Liquid manures or manure teas (fresh manure fermented in water) are used as "top-dressing" every 2-3 weeks during the first two months of a plant's life.

Locally available seed material is advocated rather than the purchase of hybrids and other 100% imported substitutes. Experience suggests that it is feasible to achieve a 100% self-reliance in recurring input needs. Other than hand tools, all material inputs are usually available locally or are within easy access. This reduces significantly or eliminates the need for cash outlays. It also provides and produces a sense of being able to control the required production resources. Finally, by emphasizing the use of local and biological resources rather than energy-intensive fossil-fuel based chemical imports, a small step is being made in the direction of conserving the world's nonrenewable resources.

repellent properties as well as applications in the preparation of home remedies for minor ailments. By encouraging the use of traditional medicinal plants with proven values such plants (and knowledge) are "conserved" for future generations. Indigenous vegetable varieties are not readily available in stores; a big-intensive gardener must attempt to retrieve such varieties. Remote and neglected provinces and villagers are good places to begin the search for these vanishing resources. Many indigenous varieties have special features which make them invaluable to the gardener (e.g. hairy stems and leaves which reduce insect problems staggered ripening of produce tolerance to partial shade longer storage quality etc.)

Pest Control

In the big-intensive approach the soil and not the insects is considered the primary source of the pest problem. The wide diversity of vegetables within a single bed tends to reduce insect infestation. In addition specific plants are raised because their odor helps repel insects from plants surrounding them. The use of indigenous and resistant varieties of vegetables also further reduces pest problems (the very fact that these indigenous varieties have been around for generations says something about their resistance to pests). Finally various organic (usually botanical) formulations can be prepared at home for use on small patches of crops. These formulations are generally prepared from locally available material and have no adverse affects on the environment and pose no health hazard to the gardener or the consumer of the sprayed vegetables.

Elimination of Pesticide-related Health Hazards

Every year hundreds of thousands of people are killed due to accidental poisoning by agricultural chemicals. However what is equally concerning is the cumulative deposit of chemicals in the human body (chronic toxicity) which do not result in Immediate deaths but may have long-term effects the origins and causes of which are usually difficult to trace. The lack of "controls" in developing countries often account for the importation of banned chemicals or the use of chemicals without required safety precautions. Pesticide residues in vegetables in markets of the developing world are frighteningly high. Adequate documentation is already available to suggest that the health hazards at the family level both in the developed and developing world are serious. Biointensive gardeners may not be able to solve all the chemical hazard problems but they can ensure that all their own vegetable harvests can be totally free from such hazards. Thus the produce harvested from such a garden is worth far more than its market value in money.

Improved Family Nutrition

One of the most important reasons for raising one's own vegetables using organic methods is the high nutritional quality of the produce. The nutritional value of a vegetable is greatly affected by the condition of the soil. The carbohydrate vitamin protein and mineral content are linked to the soil's mineral and trace-element content.

One needs a healthy soil in order to produce a healthy and nutrient-laden vegetable crop.

The emphasis on techniques that do not involve costly inputs tends to provide a greater assurance that vegetables produced this way will be consumed (at the minimum one knows that the vegetables are not being sold in order to recover the capital invested - no small concern of the poor). The emphasis on a diversity of vegetables improves the range of sources of food typically available. By growing a diverse selection of vegetables (as opposed to monocropping) the availability of nutrient-rich vegetables is spread more widely throughout the season. Also since only small quantities of many different kinds of vegetables are being produced the incentive to sell such produce is reduced (relative to the situation when only 1 or 2 crops are raised resulting in peak harvests.

Space Intensive

Given the use of big-intensive techniques, between 60 - 150 sq m of land area (depending on how much land is available) is all that is needed to meet the vegetable needs of a family. This makes the approach highly relevant to areas where there is a high population pressure on land resources or if people are landless. Landless people often have access to at least some backyard space. Also, organizations can often arrange for small community lots where each family can be allocated 60 - 90 sq m of intensive gardening.

In many parts of the world, particularly in the continent of Africa, while land might not be a limiting factor, other inputs such as water and fertilizers are usually severely restricted. Since big-intensive gardens almost always produce higher yields per unit area compared to conventional approaches, such intensive plots may be relevant even in areas where land per se is not limiting. The big-intensive plot is intensively used throughout the year. Plant spacings (i.e., very close) are such that, when plants are fully grown, their leaves barely overlap. Maximum use of space is achieved through companion cropping, succession cropping and multistoried cropping.

Labor-intensive rather than Capital-intensive

The bio-intensive approach is labor-intensive initially and, therefore, is best suited to smallscale, family-centered food production. It is also particularly relevant to the poorest section of society who generally lack the capital but often have underutilized family labor potential. Typically, each of the two beds (30 sq m each) recommended for a family takes 4-8 hours to prepare if the double digging option is chosen. If the other options to prepare raised beds are used, 50% less time is required. However, if the double digging option is chosen (in humid tropics such as the Philippines), a single onetime bed preparation is all that is required.

No subsequent digging will be necessary, (assuming the beds are always covered with some plants and/or mulch). Whatever the option, the amount of labor required declines from season to season.

Water Conservation

The big-intensive approach described in this kit uses significantly less water than conventional garden plots. The method of deep bed preparation and the fact that the soil in the bed remains loose (only the soil in the path between beds is subject to compaction) permits the absorption of most of the water which is applied or falls (in case of natural rainfall) on the bed itself. Once in the soil, the judicious quantity of compost which was added to the soil serves to retain moisture within the rooting zone. The closer spacing of plants recommended in the big-intensive approach reduces the evaporation of water from the soil surface as a result of the sun's action on the soil. Mulching (a layer of grass or straw applied onto the soil and between plants) serves to keep the moisture loss to the minimum. The close spacing of plants reduces further the loss of moisture as a result of the wind's action on the soil and plants.

Conservation of Plant Genetic Resources

The big-intensive approach, as developed by the author, puts strong emphasis on the use of indigenous vegetable varieties. Ideally, a home garden should aim at 100% dependency on such selected traditional seed varieties. The strategy which emphasizes indigenous cultivars not only provides a significant insurance against pests due to the diversity, inherent hardiness and pest tolerance (through years of evolution) but also serves to ensure that this valuable heritage of humankind is conserved for future generations. The best conservators and curators may not always be the seed banks but the farmers and gardeners themselves.

Another aspect stressed by the author is the inclusion of indigenous plants which have insect quantities that are far greater than the consumption needs of the family). Special emphasis is given to the nutritional aspect of vegetable gardening and preparation of produce with special emphasis on leafy vegetables (e.g., amaranth) and grain legumes (including winged bean) besides the crops more commonly grown. The emphasis on traditional varieties means that more than one plant part is usually edible (e.g., roots, leaves, flowers, pods, etc.). Certain plants are usually good contributors of energy (e.g., lima, pigeon pea, rice bean, hyacinth bean all consist of approximately 50% energy and 20% protein).

Income Generation

The dependence on home-grown vegetables usually results in a significant saving of cash resources. This can be used for nonfood needs of the family. However, the big-intensive approach can also be used as an income-generating project, through the production of vegetables for sale Lo nearby markets. Such ventures must be preceded by a well-designed educational campaign to ensure that at least a certain percentage of the harvest is utilized at home.

The cultivation of a wide variety of crops tends to insulate cultivators against the risk of (i) devastation of monocrops by pests and (ii) risk of price slumps resulting from overproduction of a particular crop. If the big-intensive approach is to be used as an income-generation project, the number of beds needs to be increased from two (each 30 sq m) to at least ten or twelve. If these are prepared during the slack period (e.g., after harvest), the bed preparation can usually be accomplished over a period of time and with no cash outlay: family labor or through mutual help in a village community. Since small quantities of a large number of vegetables are raised, the producer can market them locally or/and directly, thus, ensuring higher cash returns.

Risk-free

The use of readily available natural resources and the total reliance on family labor in the bigintensive approach reduce any financial risks to the family. The use of organic nutrient sources, the continuous improvement of soil and the growing of a highly diverse selection of vegetables (usually 8-10 in two beds) tend to reduce very significantly, pest problems. If pests do cause damage, only a portion of the crop is lost because of the diversity of crops grown. (The risks of monocropping are eliminated here.) If-a complete shift can be brought about to the use of traditional varieties (those that have been around for generations), the pest problems and therefore, the risks are negligible.

Ecologically Sound

The big-intensive approach suggests that human beings must work with nature rather than attempt to dominate and control it. Renewable sources of energy are used in this system. Every attempt is made to maintain an environmental balance. The non-use of increasing quantities of chemical-based inputs reduces the contamination of the environment with chemicals that tend to persist in the soil for many years after use (i.e., they are not big-degradable). The use of animal manures (in countries where they are not already being used, as in parts of the Philippines and Africa) can reduce environment sanitation problems and related health problems in rural areas. The big-intensive approach at the home-garden level can set people thinking about the "larger" environmental issues. It can get people to question what they may hitherto have accepted as an inevitable consequence of modernization and development.

Why household food security through gardens makes sense?

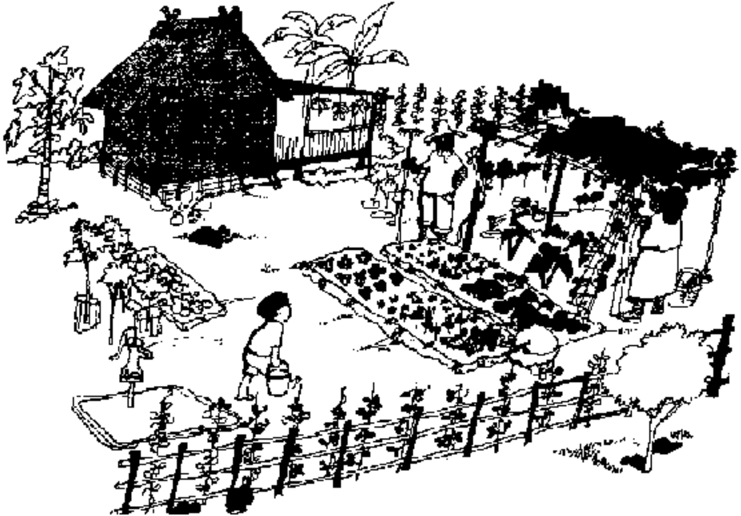
Rural people in many parts of the world have always used their house-yard space to grow food, but modem agriculturists have generally not recognized this.

Degradation of the agricultural and natural resource base requires the use of intensive small-scale biological approaches to vegetable production.

Garden produce is usually raised with the use of ash, compost, waste water and mulch. This provides an opportunity to recycle household waste and maintain sanitation.

Pesticide residues on vegetables have reached alarming proportions. Growing ones own is one way of ensuring pesticide-free and safe vegetables.

Food grown around homes and without the use of external inputs is usually consumed by the family. Fresh and higher quality vegetables with better nutritional values are harvested.



Information, education and communication approaches to household vegetable gardening

View the garden program as a multiagency activity and not the prerogative or responsibility of specialised agricultural agencies.

Conduct short appreciation courses for policymakers and agency heads using day-long garden tours and slide lectures accompanied by testimonials from gardeners.

Identify the landless, or populations with limited or ecologically marginalised land holdings, for whom food acquisition is currently a problem.

Select three or more project sites as opposed to a single one. Start with a few gardeners in each site.

Conduct short courses for gardeners (three days at maximum). In the first year of a new program, conduct follow-up courses every quarter.

In the second year and when scaling up, rely on cross-visits and garden tours conducted by experienced gardeners rather than on formal training.

Make available simplified, single-concept technical information sheets to gardeners, extension workers and agency staff.

Involve both the nutritionist and the agriculturist in the garden program.

Document and share experiences an an annual basis through written reports to agency staff.

With the advancement of the program, solicit more and more gardener involvement in training and monitoring. Give technicians the responsibility for trouble-shooting and training- orchestration.

In the third year, consider an interagency newsletter to exchange experiences between gardeners and across agencies.

Devote a minimum of three years and preferably five years to any major effort to introduce gardening.

The household as a production and consumption unit

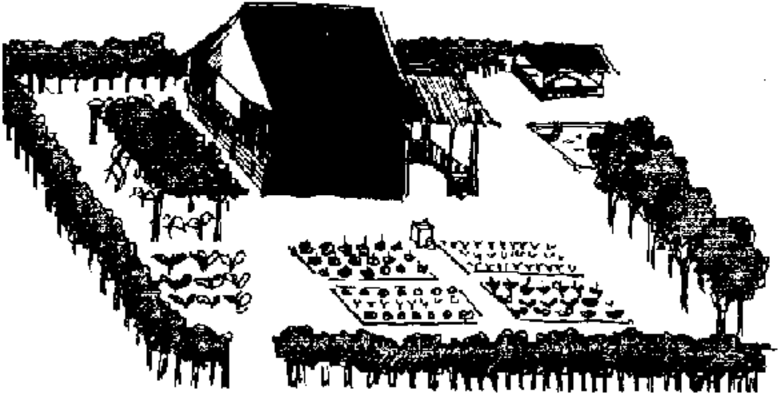
The household, seen as a production and consumption unit, has three subsystems:

A. The Household Subsystem: This is the socioeconomic unit concerned with the household structure and its composition: husband and wife, children, grandparents and often other family relatives. Different responsibilities (some culturally defined) are to be found with regard to food production and utilization and related decision-making. The access to, and control of, productive resources may differ from household to household.

B. The Production Subsystem: This refers more to the physical unit with an emphasis on homestead-level production (halaman sa bakuran) and, to a lesser degree, on field production (pulo or bukid). This subsystem is affected by the access to productive resources mainly land area, capital and other inputs. This includes production from backyard activities, such as small livestock, home gardens (including traditional sources such as the mixed backyard garden) and, sometimes, fish ponds. If the production from the main field is even partly consumed at home, that physical unit must also be considered (e.g., cereals or large animals).

C. The Consumption Subsystem: This is the biological unit and refers to the actual utilization of the food produced at the household level. Consumption is affected by factors such as: the total quantity of food produced; the numbers of consumers involved; the pressure to market the food (e.g., to repay capital costs); cultural values and attitudes to the kinds of food produced and not produced locally; patterns of distribution of food within the household system; and, food preparation and preservation practices (to prevent waste during peak production months).

Food consumption includes items that were not specially grown by the consuming unit or purchased but were either bartered, or scavenged (mamumulot), collected from other sources (e.g., fish, backyard trees or halaman sa bakuran) or procured as part of some culturally accepted norms (hunusan or share of harvests given to laborers assisting in the harvest).



The household as a production and consumption unit

Definitions of homegardens

1. Homegarden is an area of land, individually owned, surrounding a house and usually planted with a mixture of perennials and annuals. (TERRA, 1954)

2. A plot of land that has a residence on it, fixed boundaries and a functional relationship with its occupants. (Second Homegarden Seminar Indonesia, 1978)

3. A subsystem within larger food procurement systems which aims to produce household consumption items, either not obtainable through permanent shifting agriculture, hunting, gathering, fishing, livestock, husbandry or wage earners. (Anonymous)

4. A garden is defined as a supplementary food production system that is under the management and control of household members. A household garden can be consumption-or market-oriented, but at least some of the produce will be consumed by the household. As a supplementary production system, the household garden is secondary to both the primary source of household food, whether from field production or purchase and to household income, whether from sales of field produce, wage labour or other sources. (Soleri, D.; Cleveland, D. A. and Frankenberger, T. R., 1991)

5. Homegarden covers the production of vegetable for family use. It is an important but inexperienced way of providing a continuous supply of fresh vegetables for family table. Yields from the homegarden contribute to the family nutrition and may even provide additional income. (Soriano, J.M. and R.L. Villareal, 1969).

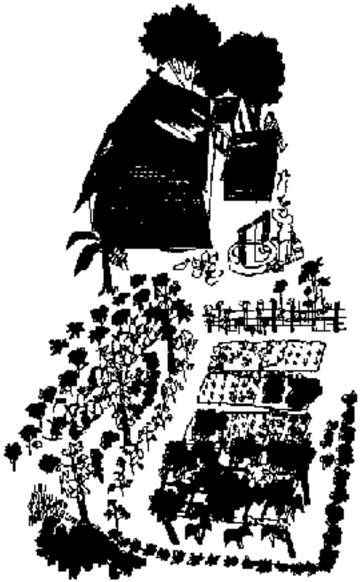
6. Homegarden is a land use with definite boundaries and a house, which is usually (but not always) a mixture of annual, perennial plants and animals and serves as variety of biophysical, economics and sociocultural functions for the owner. (Soemarwoto and Soemarwato, 1985)

7. A small area where vegetable-growing is being done. In this type of garden, planting is done regularly. Its primary purpose is to provide a continuous supply of nutritious but cheap good quality vegetables for home use. In certain cases, it also provides an extra income when excess vegetables are sold. (Aycardo, H. B. and C. R. Creencia, 1981)

8. Refers to garden within the household perimeter, including the garden located out in the field, the produce of which is normally intended for household consumption. (Eusebio, J. S., 1988)

9. An area within the home lot or elsewhere cultivated for home consumption. (Torres, E. B., 1988)

10. A piece of ground usually adjoining a dwelling where vegetables, fruits and ornamentals are cultivated. (Javier, F. B., 1988)



Definitions of homegardens

Vegetables throughout the year

You can fight malnutrition right in your backyard!

The Food Always In The Home (FAITH) gardening method is a nonconventional form of gardening that, with minimum capital and lots of-native enterprise, can assure needy families of a steady supply of nutritious food - and extra income. FAITH can provide the necessary protein, vitamin and mineral requirements needed by a family of six. It can also reduce the country's heavy reliance on chemical fertilizers that pose health hazards and wreak havoc on the environment.

The system was developed and popularized by the Mindanao Baptist Rural Life Center (MBRLC), a nongovernment organization working in Kinuskusan, Bansalan, Davao del Sur, Philippines since 1974.

While vegetables can be grown easily in the Philippines, Filipinos do not grow enough of them. The average per capita consumption of 12.4 kilograms of green and yellow vegetables is far short of the recommended allowance of 32.4 kilograms per year. (Medrana 1988)

Home gardening can reduce, by about 20%, a family's total daily food expenditures. (Tones 1987)

19%, or one out of every five of the country's pre-school population, is severely or moderately underweight.

16.8% of the country's school children (7 - 10 years) have weights that fall below the standard weight for their age.

The Ten Steps of FAITH Gardening

1. Locate the best site for the garden. Select a site with a good water supply (it is vital, particularly during the dry season), good soil drainage (if your land is flat, dig drainage channels or ditches around the planting site) and fertility (it must be fertile enough to make plants grow), sunlight availability (growing plants need sunshine to manufacture food), and good air circulation (the site

must have natural windbreaks).

2. Provide enough space. The ideal garden size is 96-100 square meters and has a dimension of 6 × 16 meters. This size is adequate to supply every day the fresh vegetables needed for a family of six.

3. Thoroughly prepare the plot. Prepare the land manually with a hoe and rake. Clean the site and save cut grasses and weeds for composting later on. Dig the land at least two times to a depth of 15 - 20 cm, harrowing with a rake and pulverizing clods between diggings. To provide good surface drainage, make raised beds 10 - 15 cm above ground level.

4. Fertilize with compost. Make compost baskets of wire or shape flexible bamboo strips around stakes to make round forms at least 30 cm high. Plant seeds/seedlings 5 - 8 cm away from the composts. Watering should be done inside the baskets - not directly to the plants.

5. Plant 1/3 of the section to early maturing vegetables. Divide the

garden into three sections. Set aside the first section for vegetables that you can harvest in 2-4 months, such as tomato, pechay, sweet corn, etc. Do not plant the whole section; reserve I/2 of the section for relay planting.

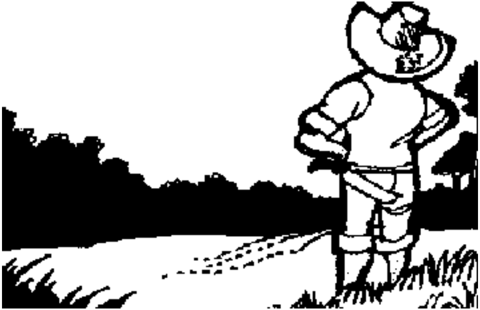
6. Plant another 1/3 to semi-annual vegetables; Set aside the second section for vegetables that are harvestable in 6-9 months. Examples: winged bean, bitter gourd, cucumber, ginger. As in the first section, plant ½ of this section and reserve the remaining half-portion for relay planting.

7. Plant the remaining 1/3 to annual vegetables. Set aside the last section for planting year-round vegetables like lima beans, upland swamp cabbage, basella, pigeon pea, etc. Reserve In of the section for relay planting.

8. Plant the surrounding area of the garden to permanent crops and semipermanent crops. Examples of these crops are papaya, pineapple, guava, yam beans, horseradish, banana and citrus.

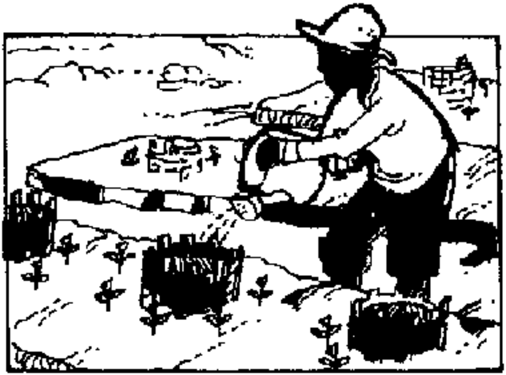
9. Plant reserved portions on time. This will further help ensure continuous and adequate supply of fresh vegetables in your home. In the third section of the garden, plant the reserved half-portion when the first crops in the other half are about 5 months old. In the second section, plant the reserved portion when the first crops are about 4 months old. In the first section, plant the reserved portion when the first crops start to flower.

10. Practice crop rotation when replanting. This is done to improve soil fertility and prevent the spread of pests and diseases. This means that you plant leguminous vegetables (like soybean, bush sitao) to garden plots where non-leguminous vegetables (such as tomato, eggplant, ginger) were previously planted and vice versa.

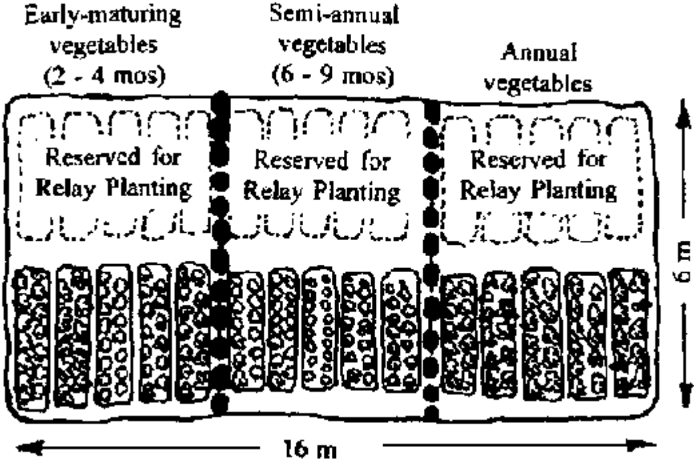


Locate the best site for the garden

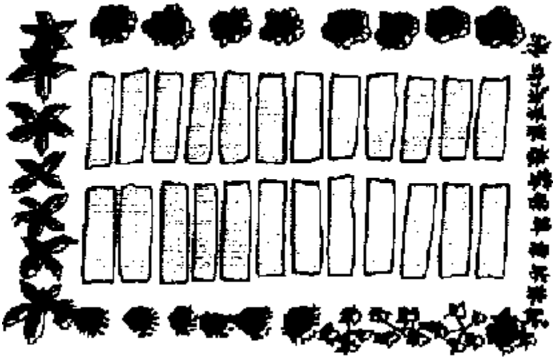
Thoroughly prepare the plot



Fertilize with compost



Plant 1/3 of the section to early maturing vegetables



Plant reserved portions on time

Before transplanting seedlings in the garden plots, "harden" them first for several days. This is done by exposing them gradually to strong sunlight in the field or by withholding water from them.

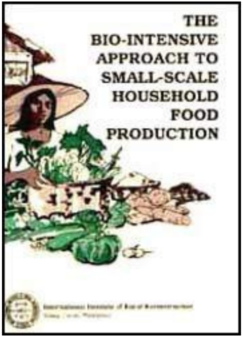
Cultivate or loosen the soil around the plants to enable their roots to expand and develop fully.

When you observe that your vegetable crops are no longer productive, you can rejuvenate plants like ladyfinger, lima beans, winged beans, eggplants sweet pepper and horseradish by cutting to a height of ½ to 1 foot above the ground.

Plants like cucumber, bitter gourd, bottle gourd, winged beans, string beans and snap beans need trellises or supports. Poles 2.4 - 2.7 meters in length are usually set in the ground to a sufficient depth in a tepee-like arrangement.

FAITH is not the final word in family gardening. This is only an attempt to develop a home garden that can provide adequate food with minimum cost, labor and land utilization. It is meant to be used as a guide.

> Source: Tacio, H. D., HR. Watson and W. A. Laquihon. (Undated). Mindanao Baptist Rural Life Center.

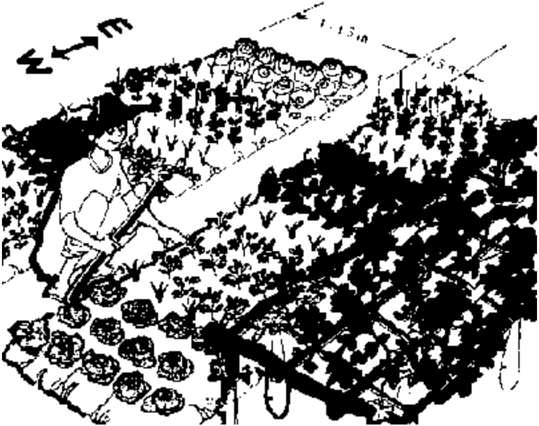

THE
BIO-INTENSIVE
APPROACH TO
SMALL-SCALE
HOUSEHOLD
FOOD
PRODUCTION

Common garden tools

Bio-intensive Approach to Small-scale Household Food Production (IIRR, 1993, 180 p.)

Starting a biointensive garden

Layout for a small-scale, household level vegetable production plot



Layout for a small-scale, household level vegetable production plot

TOTAL AREA: 400-500 sq ft (35 - 45 sq m)
OUTPUT: 3-6 Ibs (1 - 2.5 kg) per day for 300 days

Important Considerations

1. Orient the rows in an east-west direction to avoid shading of the crops by the trellis.

2. Beds should not be more than 1.5 m wide to permit working on either side-of the bed without trampling on it (thus avoiding compaction).

3. Each bed should be intensively planted. It should preferably contain at least one of each of the following categories: leaf, root, legume and fruit-bearing vegetables.

4. Aromatic herbs should be intercropped in between vegetables to repel insects.

Technological profile

Plot Size: Only 20-30 sq m of "growing bed" area

Bed Preparation:

a Raised, narrow (not more than 1.5 m), deep-dug (30 - 60 cm) beds
b. Use of compost or other organic alternatives such as mudpress (0.25 - 0.75 cu m/9 sq m)
c. High labor usage initially (2-6 hours/9 sq m)
d. In humid tropics: possibility of eliminating subsequent digging of beds
e. The use of narrow beds restricts compaction to the pathways only.
f. Continuous crop cover and mulch reduces compaction (within beds) from rainfall.

Bed Fertilization:

a 0.25 cu m of compost or mudpress (by-product of sugar mills), egg shells, bone-meal, wood or cane-trash ash, ipil-ipil leaves/fish meal

b. Use of liquid manures or manure teas (fermented water-manure mixtures)

c. Inclusion of nitrogen-fixing crops into the annual crop cycle.

Crop Planning:

a Crop rotation (root, leaf, legume and fruit crops) aimed at regenerating soils and breaking pest life cycles

b. Intensive planting to achieve maximum use of space and higher yields per unit area

c. Conservation of genetic resource through the promotion of local varieties (backyard curators)

d. Inclusion of culturally acceptable, nutritionally important vegetables (amaranth, rice bean, winged bean, etc.)

e. Diversification of diet through cultivation of a wide range of vegetables or multipurpose plants

f. Inclusion of short-duration crops to deal with wet season and/or dry-season food deficiencies

g. Cultivation of trellis-crops along side the growing beds

h. Perennial, polycultural, multistoried fence crops ("edible fences")

i. Cultivation of shade-tolerant crops under the trellis.

Water Conservation:

a Close spacing of crops reduces evaporation from the soil.

b. Mulching lowers soil temperature and reduces evaporation.

c. Deep tillage and organic matter in the soil encourages water entry and conservation within bed (reduces runoff).

d. Overall a 30-50% reduction of water needs can be expected.

Weeding:

a. Significant reduction of weeding time (70% of weeding time is eliminated.)

b. Significant reduction of the growth of weeds due to deep tillage, mulching and close spacing of crops.

Pest Control:

a Soil improvement; good drainage; balanced soil nutritional status; presence of beneficial fungi (mycorrhiza) is the basis for pest reduction.

b. Crowing a diversity of crops reduces insects.

c. Crop rotation breaks the life cycle of pests.

d. Inclusion of acclimatized, hardy pest-tolerant indigenous varieties

e. Use of medicinal plants that also have insect-repellent properties (as intercrops)

f. Removal of diseased plants/plant parts prevents the spread of infestation.

g. Use of botanical formulations as pest control sprays

h. Encouragement of predatory species of insects.

Average Yield: 0. 75 kgs /9 sq m/day

The rationale for deep-dug and raised beds

More plants can be accommodated/unit area.

Increased entry of rainwater into plots and less runoff.

Reduced evaporation of applied water due to the dense crop canopy.

Applied -water is stored in lower profiles of the plot and thereby conserved.

Improved earthworm activity and nitrogen-fixing bacteria due to improved soilmoisture organic matter status.

The plots are spared from the effects of too much rain and flooding-out of rooting zones.

Plants have deeper and well-developed root systems, mitigating or delaying the impact of drought.

Permanent pathways between plots reduce soil compaction (from walking) in the growing area.

While the initial bed preparation time is 5 - 6 hours/9 sq m, subsequent preparation is only 1/3 to ¼ the time.

Improved garden microclimate (lower soil and air temperatures).

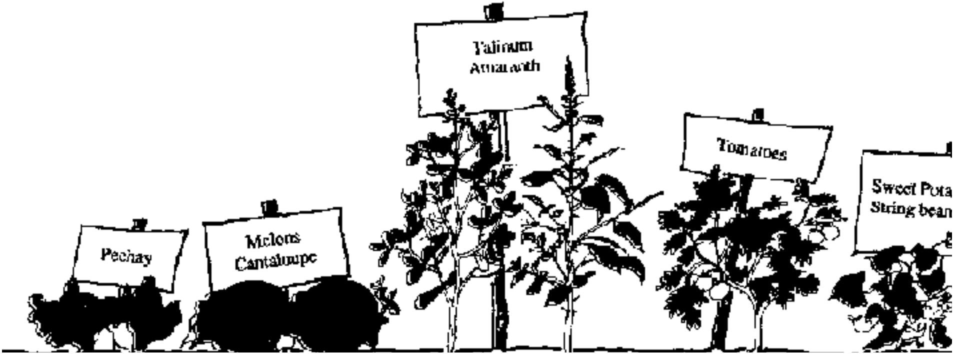
An improved garden ecosystem encourages garden predators, biotic life.

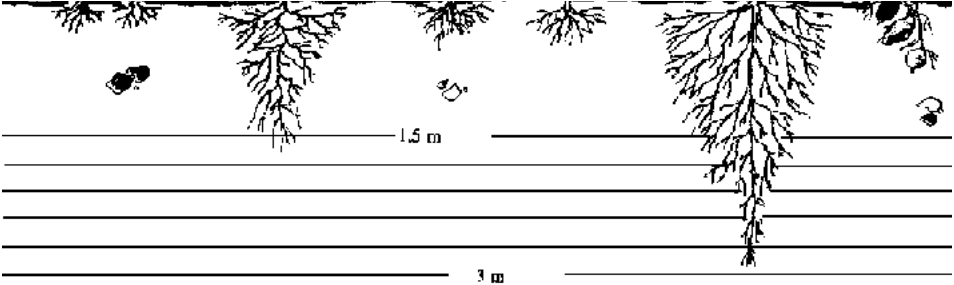
The rationale for deep-dug and raised beds

Why deep-dug beds are important?

Deep digging makes the soil loose and friable. This enables the plant roots to penetrate easily, so a steady stream of nutrients can flow into the stems and leaves.

Different plants have varying rooting depths, so extract nutrients and moisture from different points of the soil profile. The cultivation of different plants in the same part of the bed from season to season does not overburden the soil.



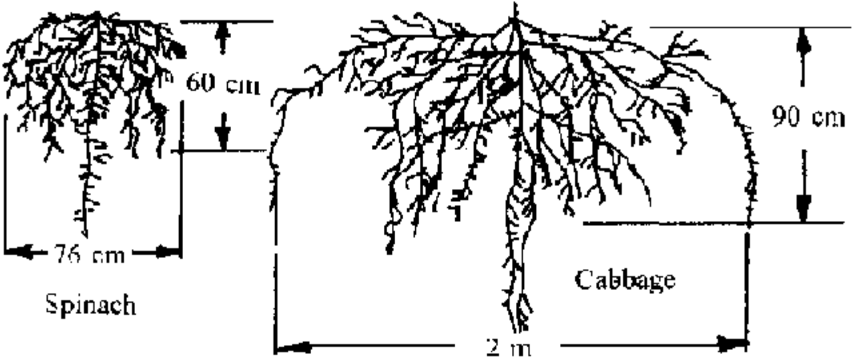


Why deep-dug beds are important?

Rooting Depth of Different Vegetables

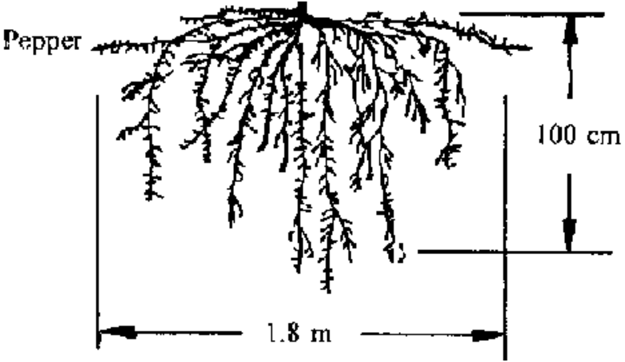
Tapering Taproot of a Spinach Plant. Other crops such as celery, chicory, Chinese cabbage, collard, endive, kale, lettuce, mustard, parsley, sunflower and Swiss chard have about the same type of mot system.

Root System of a Transplanted Cabbage Plant. Brocolli, Brussels sprouts, cauliflower and kohlrabi took somewhat the same when they are transplanted.



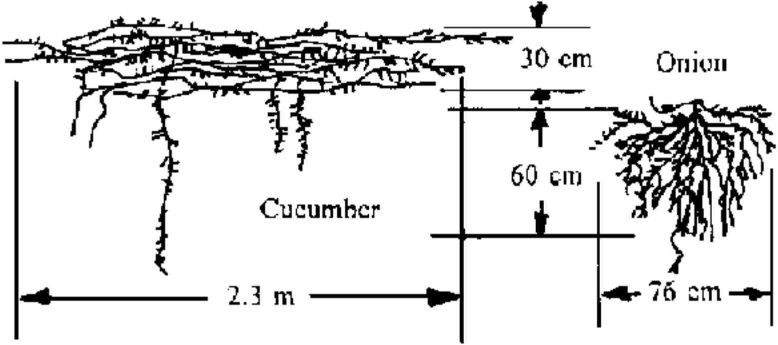
Root System of a Transplanted Cabbage Plant

Short Taproot of a Pepper Plant. Roots of eggplant, okra and tomato are comparable



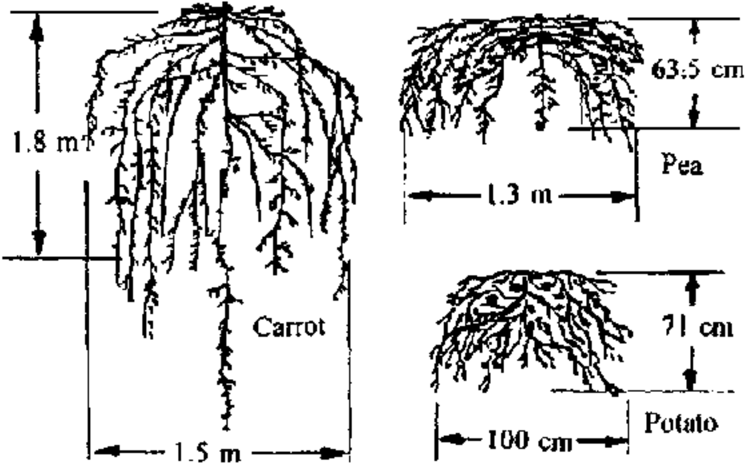
Short Taproot of a Pepper Plant

Thin Taproot of a Cucumber Plant. Cantaloupe, pumpkin, squash and watermelon have similar roots.



Thin Taproot of a Cucumber Plant

Fibrous Root System of an Onion. Garlic, leek and corn also have true fibrous roots.



Fibrous Root System of an Onion

Short Taproot of a Carrot. Parsnip and salsify roots are very similar, but the storage roots of beet, radish, rutabaga and turnip are shorter and rounder.

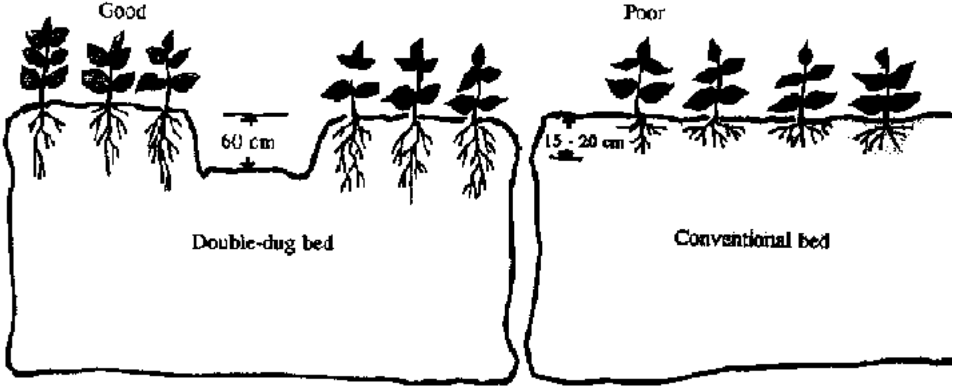
Wide-spreading Root System of a Pea Plant. Beans are similar.

Root System of a Potato Plant. Plant grown from a seed potato. Sweet potato and peanut roots look somewhat similar

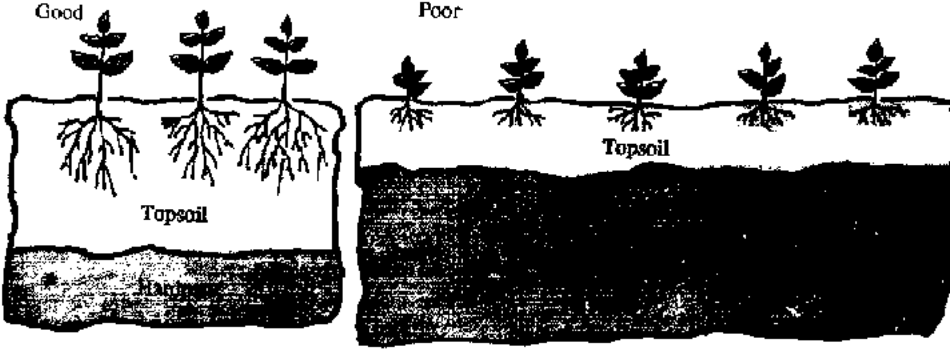
> Source: Wallace, D. et al. 1980. Getting the Least From Your Garden. Rodale Press, Emmaus, Pennsylvania.

Development of rooting systems

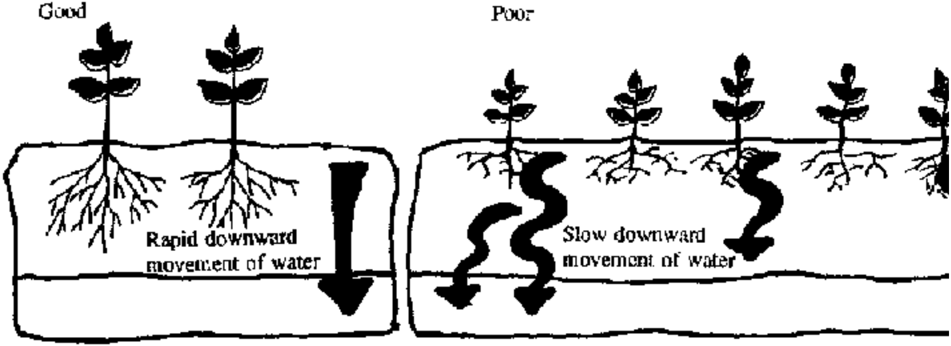
Root distribution depends upon the



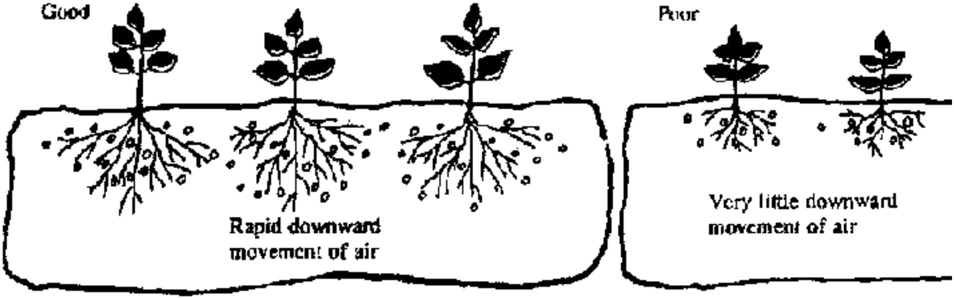
(1) depth of the plowed or dug area.



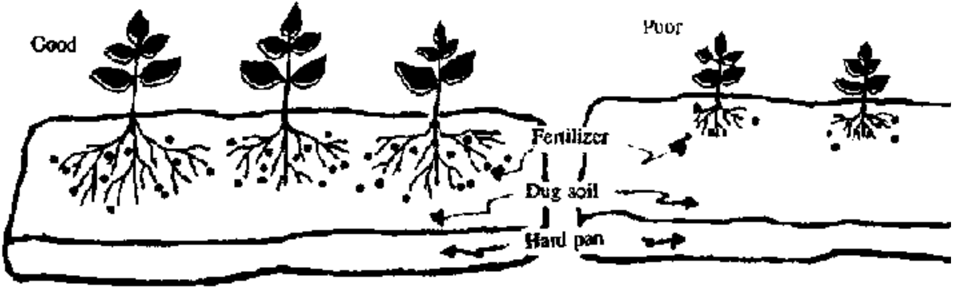
(2) depth of top soil.



(3) downward movement of applied water or rain.



(4) amount of air available.



(5) depth of placement of fertilizer or other nutrients.

Raised-bed garden technologies

1. Measure about 1 m by 6 m bed area. (The length can be altered depending on the availability of land.) Divide the bed temporarily into sections, 75 cm wide using wooden stakes as guide.

2. Spread evenly a 8-cm thick layer of compost over the bed.

3. Dig a trench 30 cm deep and 75 cm wide at one end of the bed.

Place the soil from this trench on one end of the bed.

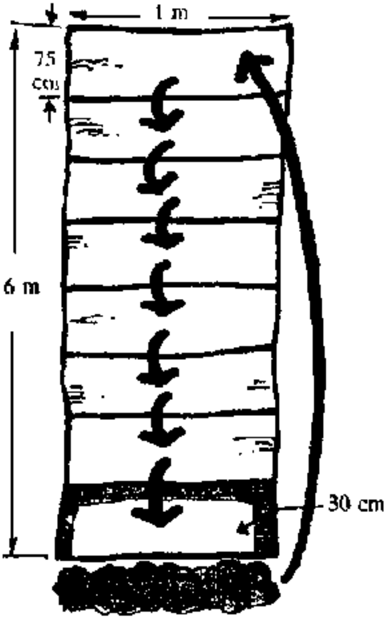
4. Dig a second trench adjacent to the first one. Cover the first trench with the soil coming from this trench.

5. The process is repeated until it reaches the other end of the bed. Fill the open trench at the other side of the bed with the soil previously dug out from the first trench. (See step 3.)

6. Apply the following into the bed: 2.5 cm compost or decomposed manure or mud press, 1 kg wood ash, 1 kg bone meal, 0.5 - 1.5 kg fish meal or dried leaves of leguminous trees and 1 kg Ibs of any of the following: crushed egg shells, snail shells, etc.

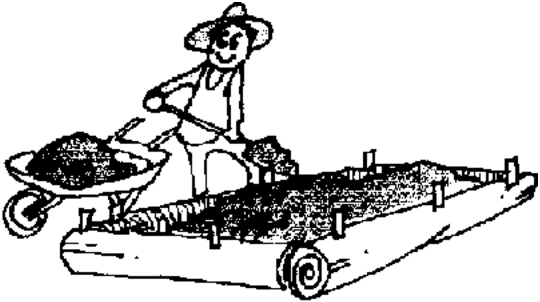
7. Mix these plant foods thoroughly into the top 15-cm layer of the soil. Level the bed. It is then ready for planting.

> Note: The same natural amendments are added to all the other options of bed preparation.


1 m
75 cm
6 m
30 cm

Raised-bed garden technologies

For rocky and waterlogged areas, soil can be taken from other sources and formed into a bed using artificial sidings like banana trunks, coconut trunks, wood planks, etc.

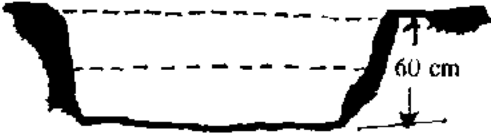


For rocky and waterlogged areas

For very hard soils, initial digging of 15 cm can be made. Then beds can be raised further by getting soil from the sides of the bed.

For very hard soils

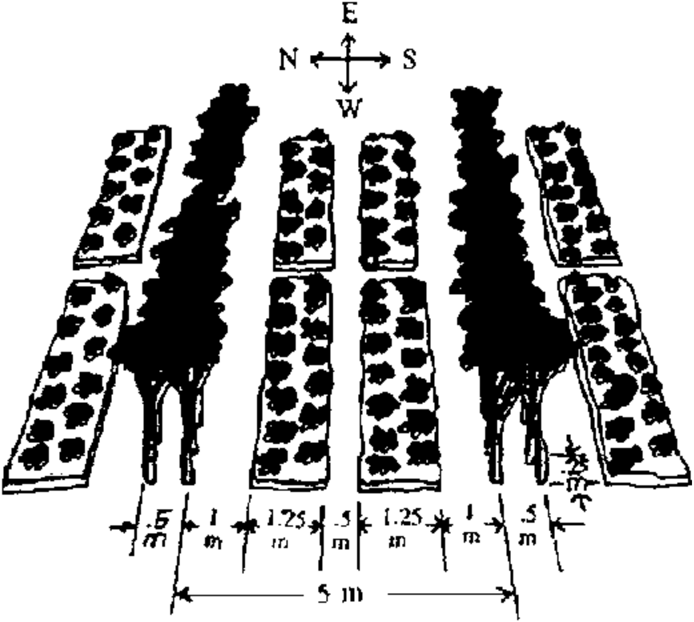
Double digging is one way of upgrading the soil structure by improving soil aeration and waterholding capacity at the lower depths of the soil. Instead of 30 cm, the soil is dug 60 cm deep.



Double digging is one way

Integrated alley cropping bio-intensive garden

Integrated alley cropping is a form of intercropping vegetable plots between rows of fast-growing trees or shrubs. It is applicable in areas where animal manure/compost is not available. Its main purpose is to provide a steady and reliable source of organic material to crops. Since these hedgerows are legumes which fix atmospheric nitrogen. they add a continuous supply of this element as well as valuable organic matter.


E
N
S
W
.5 m
1 m
1.25 m
.5 m
1.25 m
1 m
.5 m
.25 m
5 m

Integrated alley cropping bio-intensive garden

Important Considerations

1. Select fast-growing and nitrogen-fixing trees/shrubs that can withstand frequent pruning.

2. Some potential alley-cropping tree hedgerow species: Gliricidia septum Calliandra calothyrsus Flemingia macrophylla Cassia siamea

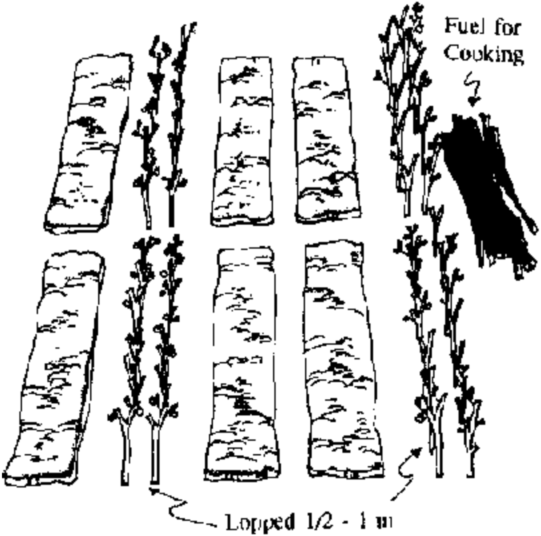
3. Orient the rows in an east-west direction to avoid shading of the crops by the hedgerows.

4. Rows of trees/shrubs should have a minimum space of 5 m to allow more space for vegetable crops.

5. Soil should be dug and loosened to a minimum depth of 30 cm.

6. Plant tree/shrub seeds and vegetables crops at the same thee.

7. Pruning is first done after the trees are 9-12 months old. Trees are cut 0.5 m above ground level.



Hedgerows Lopped and Incorporated into Beds

Procedure

1. Cut the trees when they are about three meters in height or the stem diameter is more than one centimeter. Subsequent cuttings are done whenever leaves are needed or die trees begin to shade the garden plots. Leave one branch/tree longer to ensure regrowth in the event of very dry weather.

2. Place cut branches of tree hedgerows (within leaves) over the entire bed.

3. Leave them in place for two days. This will allow the leaves to wilt and hasten defoliation.

4. Shake branches or use hand to remove remaining leaves. There should at least be a 8-cm layer of leaves over the entire bed. (The branches can be used as fuel for cooking.)

5. Incorporate leaves into the soil to a depth of 15 cm.

6. Allow leaves to decompose for 10-14 days. If possible redig the bed once or twice to turn over the incorporated materials.

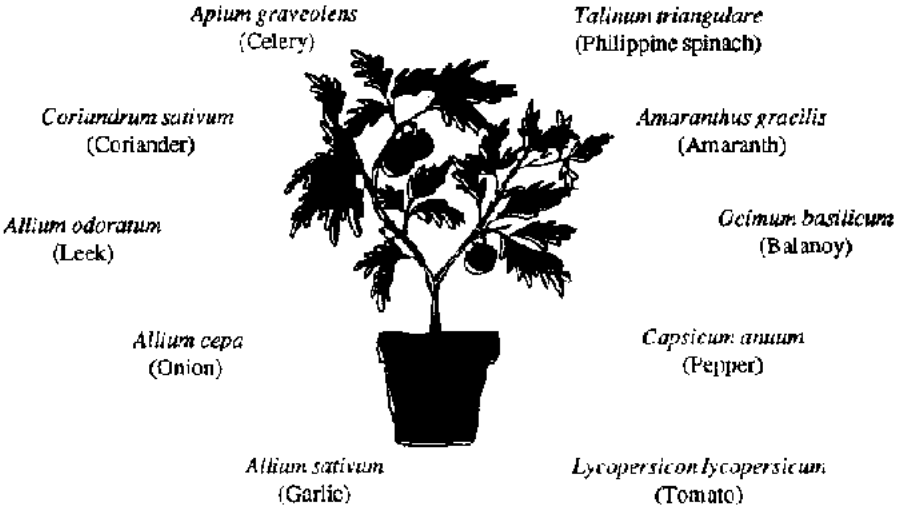
7. After another 10-14 days apply necessary soil supplements like 1 kg of wood ash 1 kg of eggshells and 1 kg of crushed bones (where these are available). (Rates mentioned are for a 9 sq m bed area.)

8. Shape the bed and plant.

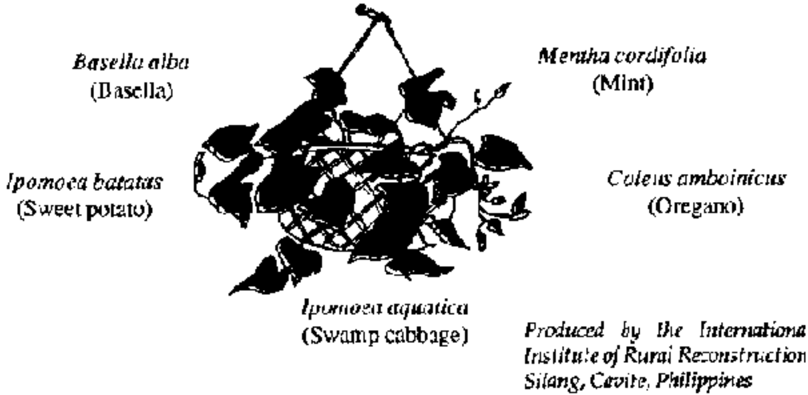
Pot-garden technologies

Containerized gardening is very appropriate in areas where space is limited. It is one of the important features in urban gardening. A lot of vegetable crops can be grown with their roots contained. They can perform as well as when they are in the ground.

A general poking mixture for most plants is: 1 part garden soil, 1 pan coarse sand and 1 pan compost. Whatever container is used, it is important that it drains freely - It should have hole(s). Enough coarse gravel should be placed in the bottom of the container so that the dim will neither sift through the holes nor clog them.



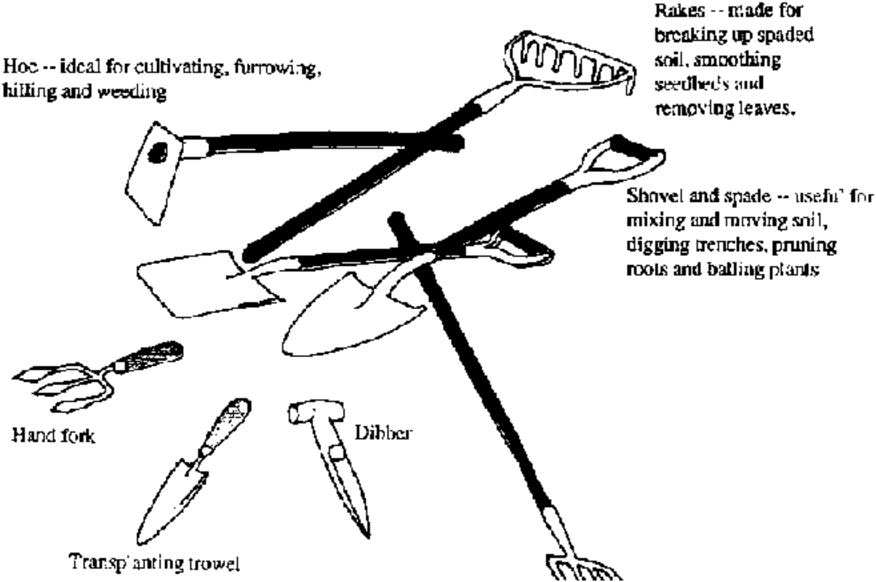
Herbs and some leafy vegetables (shrubs) are best grown in pots:

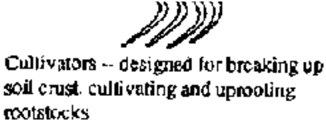


Productive vine crops can be grown in hanging baskets.

Common garden tools

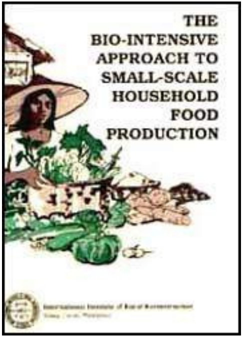
The ease of gardening depends largely on the use of right tool in the right way. The proper tools will also make the work more productive.


Rakes -- made for breaking up spaded soil, smoothing seedbeds and removing leaves.
Hoe -- ideal for cultivating, furrowing, hilling and weeding
Shovel and spade -- useful for mixing and moving soil, digging trenches, pruning roots and balling plants
Hand fork
Dibber
Transplanting trowel



Common garden tools

Home"" """"> ar.cn.de.en.es.fr.id.it.ph.po.ru.sw



Bio-intensive Approach to Small-scale Household Food Production (IIRR, 1993, 180 p.)

Soil management

Know your soil

Which crops will do well in your garden soil? Aside from trial and crop failure - an expensive proposition at best - testing the soil is the only way to find out. Generally, there are three soil types:

Neutral Soil (pH 7)

Most common vegetables, fruits and flowers do best on soils that have a pH of 6.5 to 7 - slightly acid to neutral.

Soils in this pH range offer the most favorable conditions for microorganisms that convert atmospheric nitrogen into a form available to plants.

This also creates the best environment for bacteria that decompose plant tissue and form humus.

All of the essential mineral nutrients are available to plants at this level.

This soil has good filth because a good crumb structure is easily maintained.

Neutral Soil

Alkaline Soil (pH 7-11)

Very alkaline soil robs nutrients from growing plants.

It ruins soil structure.

It also breaks humus apart and causes a concentration of salts which inhibit or prevent plant growth.

Alkaline Soil

Recommendations:

1. Alkaline pH can be lowered to the neutral range by adding organic materials.

2. If the garden is located in an area with low rainfall, the high soil pH is probably linked to accumulated salts. These can be flushed below the root zone of sensitive plants (such as beans, carrots, onions and peppers) by watering regularly with non-saline water.

Acid Soil (pH 1 to 6.5)

Bacteria that decompose organic matter cannot live when the soil is too acidic.

Organic matter level gradually declines, resulting in poor soil structures.

Manganese and aluminum can become toxic to plants because these elements are very soluble in highly acidic soils.

Worse, strong acidity limits nutrient availability to plants.

Acid Soil

Recommendations:

1. pH can be raised by working in bone meal, pulverized egg shells, clam shells, oyster shells or a form of fineground agricultural lime. Unleached hardwood ashes are another

good material for neutralizing acidic veils.

2. If soil test reveals magnesium deficiency, use the dolomitic form of lime. If calcium is low, choose the calcitic type.

3. Spread the liming material after the soil has been plowed, tilled or spaded deeply. Do not plow the lime under since it leaches down into the soil too rapidly.

4. It is best not to apply lime with other fertilizers.

5. Do not apply lime around acid-loving plants or in any area where runoff water may carry the lime downhill to such plants.

6. When using ground limestone, do not expect a tremendous difference on the first year of application. Changes can be seen only on the second year. Repeat liming every fourth or fifth year, depending on the results

of soil tests.

Reference:

Quick Ways To Better Soil. 1990. Organic Gardening Magazine.

Discovering your soil type firsthand

IF IT LOOKS	AND FEELS	AND IS	IT'S	AND NEEDS ..
hard-baked, crusty and perhaps even deeply cracked when it dries out scarce in pore spaces holding air and water devoid of individual particles	harsh and rock hard when dry sticky, greasy or rubbery when wet	hard to work very slow to absorb water to dry out likely to form large, congealed lumps if worked when wet	CLAY. If other kinds of particles are present in quantity such soil can be classified as stony clay, sandy clay or silty clay.	substantial additions of organic ma to open channels for aeration and drainage. Some good choices: com manure, leaf mold, rice hulls, peat coarse sand, sawdust and wood ch lime to improve its texture and free locked up soil nutrients for the use plants. leguminous green manure crops.
loose and friable quite porous full of large, irregularly shaped mineral particles more or less devoid of	grainy and gritty crumbly and won't hold its shape when squeezed	easy to work fast drying low in nutrients because soluble plant foods are lost through leaching	SANDY. Depending on the size and texture of the particles, such soil may be classified as coarse, medium, fine or loamy sand.	continual augmenting with large am of organic matter to hold water and nutrients within the range of plant r plentiful applications of peat moss, compost, leaf mold or sawdust in to layer green manures to build structure.

larger pieces or granules				
very dark brown full of organic matter in varying stages of decay granular and porous	like moist peat moss when squeezed slow to decompose	easy to work low in minerals	MUCK or PEAT. Peat is not fully decomposed. Muck is the same soil in a more advanced state of decay. It tends to be waterlogged and lacking in lime but rich in nutrients such as nitrogen.	layers of gravel or drainage tiles to improve drainage lime added as needed
full of crumbs of various sizes quite porous	spongy, compacting readily into a ball when it is squeezed, but falling apart readily when prodded or floury and talcum-powdery when dry and only moderately plastic when moist	easy to work very productive well-drained yet able to retain moisture as it is needed well-aerated retentive of nutrients	LOAM. A mixture of sand, silt and clay, this close-to-ideal soil combines the best qualities of light and heavy growing media. Depending on the kind and size of the particles that predominate, a sample may be categorized as coarse, sandy medium sand, fine sand; silty, stony silt; or clay loam.	regular infusions of organic matter maintain its already excellent fertili structure.

Discovering your soil type firsthand

Soil modifiers

Dolomitic lime

A good source of calcium and magnesium to be used when both are needed. Do not use lime to "sweeten" a compost pile as doing so will result in a serious loss of nitrogen. A layer of soil will discourage flies and reduce odors.

High Calcium Lime (Calcite)

A good source of calcium when magnesium levels are too high. Oyster shell flour lime is a good substitute.

Gypsum (Calcium Sulfate)

Used to correct excess levels of exchangeable sodium. Apply only upon recommendation of a professional soil test.

Crushed Eggshells

High in calcium, especially good for cabbage family crops. Eggshells help break up clay and release nutrients tied up-in alkaline soils. Use up to 1 kg/12 sq m.

Manure (All Types)

A good source of organic matter in the garden. The nutrient levels in each manure will depend on proper management of the curing process and on the amount of straw or sawdust in the manure. Optimally, do not use more than 62 kg of aged manure per year (about 12.7 mm layer). It is best to use manure that contains little undecomposed sawdust. Approximately 23 kg of dry manure applied per 12 square meter can lower the pH one point.

Manures-Solids (Approximate)	**N**	**P**	**K**
Chicken-Fresh	1.50%	1.00%	0.50%
Chicken-Dry	4.50%	3.50%	2.00%
Dairy Cow	0.56%	0.23%	0.60%
Horse	0.69%	0.24%	0.72%
Pig-Fresh	0.50%	0.32%	0.46%
Sheep	1.40%	0;48%	1.20%
Steer	0.70%	0.55%	0.72%

Compost

A good compost is the most important component of garden beds. It aerates soil, breaks up clay, binds together sand, improves drainage, prevents erosion, neutralizes toxins, holds precious moisture, releases essential nutrients and feeds the microbiotic life of the soil, creating healthy conditions for natural antibiotics, worms and beneficial fungi. Use 25 mm of compost each year (124 kg/12 sq m) or up to 75 mm in a first-year garden. Manure may be substituted for compost the first year if you do not have a ready supply of compost.

Source: Jeavons. J, 1991 How to grow more vegetables.

Nutrient composition of various organic materials

Organic Matter	**% Nutrient Content**		
Animal Wastes	**N**	**P**	**K**
Cattle	1.50	1.00	0.94

Water buffalo	1.09	0.82	0.70
Horse	159	1.65	0.65
Sheep	2.02	1.75	1.94
Pig	2.81	1.61	1.52
Rabbit	2.40	1.40	0.60
Chicken	4.00	1.98	2.32
Duck	2.15	1.13	1.15
Bat	1.00-12.00	2.25-16.00	
Crop Residues			
Tobacco stem	3.70	0.65	4.50
Tomato stem	0.35	0.10	050
Wheat straw	0,49	0.11	1.06
Rice straw	0.58	0.10	1.38
Corn stover	0.59	0.31	1.31
Cotton stalks $ leaves	0.88	0.15	1.45

Peanut roots	1.18	0.07	1.28
hulls	1.75	0.20	1.24
Cowpea stems	1.07	1.14	2.54
roots	1.06	0.12	1.50
Sugarcane trash	0.35	0.04	0.50
Banana skin (ash)	-	3.25	41.76
Banana stalk	-	2.34	49.40
N-fixing Trees (Leaves)			
Leucaena leucocephala	4.29	0.19	1.37
Acacia ferruginea	2.96	0.13	0.88
Acacia arabica	2.61	0.17	1.20
Gliricidia sepium	1.81	1.80	21.85
Sesbania acullata	2.18	-	-
Sesbania speciosa	2.51	-	-
Crotolaria juncea	1.95	-	-

Crotolaria usaramoensis	3.30	-	-
Vigna sinensis (cowpea)	3.09	-	-
Melitotus indica	3.36	0.22	1.27
Pisum sativum (pea)	1.97		
Desmodium trifolium	2.93	0.14	1.30
Calopogonium mucunoides	3.02	-	-
Water hyacinth	2.04	0.37	3.40
Azolla sp	3.68	0.20	0.15
Algae	2.47	0.12	0.37
Other Composting Materials			
Ground bone (burned)		34.70	
Eggshell	-	0.43	0.29
Feathers	-	15.30	
Molasses	0.70	-	4.50
Wood ashes	-	1.00-1.50	1.00-3.00

Compost			
Municipal*	0.40- 1.60	0.10-0.40	0.20-0.60
Garbage**	0.40-4.00	0.20- 1.30	0.20-2.10
Garden	1.40-3.50	0.30- 1.00	0.40-2.00

* Includes garbage, paper, household and yard trash
** Food wastes

Composting

This process involves decomposition of a mixture of organic materials to form "smaller bits" of matter called compost. This process does not solely refer to waste disposal; it also relates to the return of wastes to the soil as part of the cycle of life.

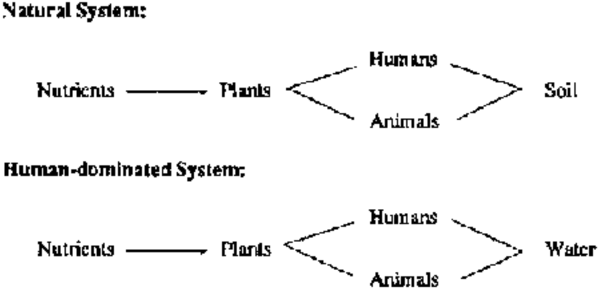


Figure 1: Most human intervention results in wastes dumped in waterways rather than resumed to the land.

Decomposers:

Majority of decomposers are microorganisms. Macroorganisms such as earthworms, termites and other insects also help break down organic materials.

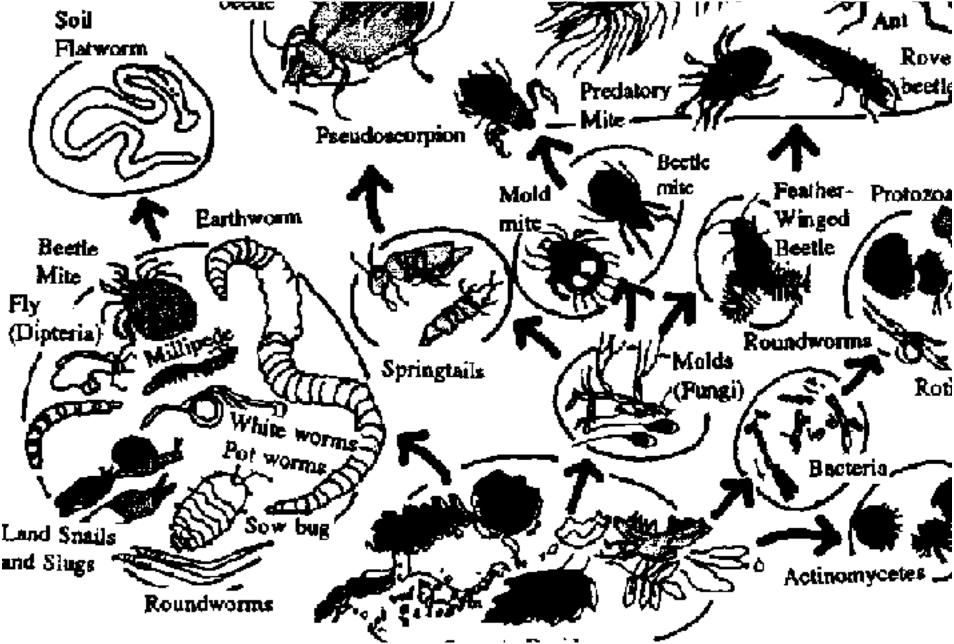

Soil
Flatworm
Pseudoscorpion
Predatory
Mite
Ant
Rove
Earthworm
Beetle
Mite
Fly
(Dipteria)
Millipede
White worms
Pot worms
Land Snails
and Slugs
Sow bug
Roundworms
Springtails
Mold
mite
Beetle
mite
Feather-
Winged
Beetle
Roundworms
Molds
(Fungi)
Bacteria
Actinomycetes

Figure 2: Food web of the compost pile (D. Dindal)

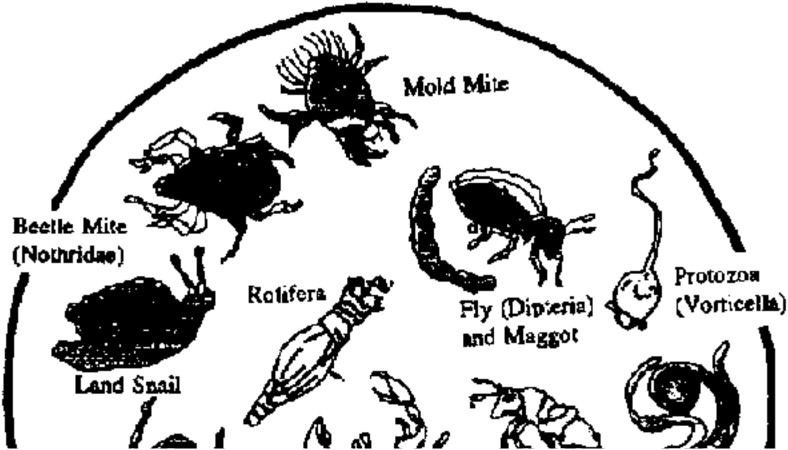
Composting Parameters

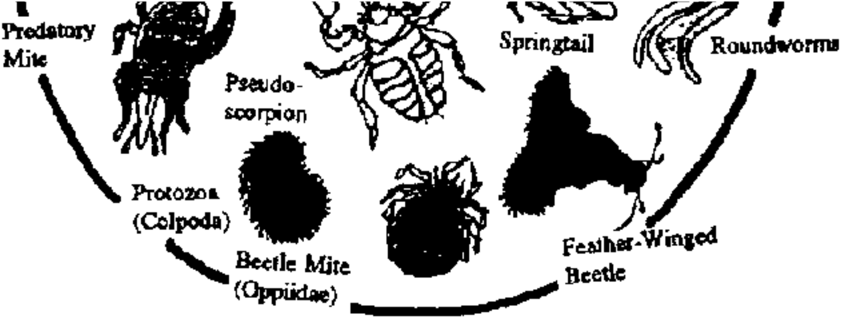
1. Composting materials

a. Good quality compost contains high organic matter content and a minimum of non-organic material. Some compostable wastes, particularly from industrial areas, can contain high levels of metals such as copper, lead, nickel and zinc and should therefore be removed. Other non-organic materials such as glass, plastics and artificial fibers should also be removed.

b. Succulent and young plants can be decomposed much faster than old and tough ones because they are high in water and contain relatively more sugars.

c. If possible, use materials that are high in N. such as residues from leguminous plants because they are preferred by microorganisms since they provide both C and N. They are also easier to break down. The insects, worms, bacteria and fungi found in the compost pile do the work of composting.





Composting materials

2. Particle size - The smaller the size of the particles of organic material, the greater surface area available for attack by the microorganisms. If the particle size is very large, the surface area for attack is smaller, and the reaction will then proceed slowly or may stop altogether. It is necessary to chop or shred bulky material to reduce the particle size to a range of 10-50 mm.

3. Moisture- All organisms require water for life. The optimum

moisture content of ingredients for composting is 50-60 percent. At too low a moisture content, the biological reactions in a compost heap slow down considerably. Excess water on the other hand, leads to waterlogging of the spaces between the particles of the materials. The maximum practical moisture content depends on the structural wet strength of the materials. For practical purposes the material should be as damp as a squeezed-out sponge.

4. Aeration -An adequate supply of air to all parts of a compost heap is essential in order to supply oxygen for the organisms and to flush out the carbon dioxide produced. Absence of air (anaerobic conditions) will lead to the development of different types of microorganisms causing either acidic preservation or putrefaction of the heap, producing bad odors.

Aeration is achieved through the natural movement of air into the compost heap, by turning the material over regularly.

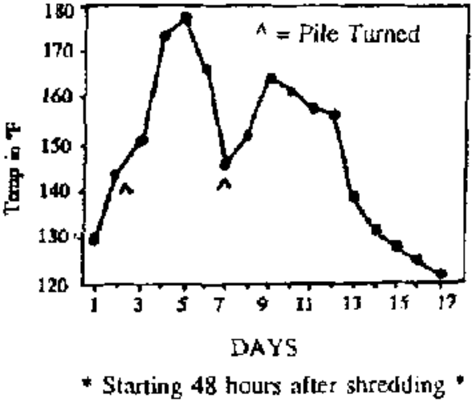
5. Temperature - When organic material is gathered together for

composting, some of the energy released by the breakdown of the material is given off as heat. This causes a rise in temperature. The higher the temperature within certain limits, the faster the activity of microorganisms.

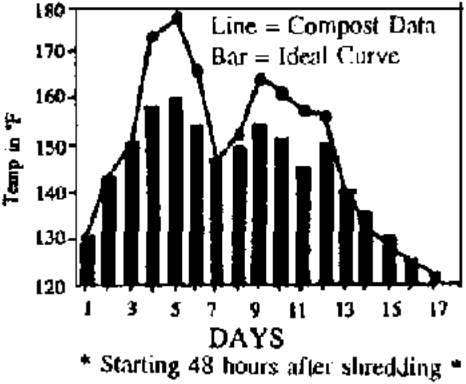
At the beginning of the process the material is at ambient temperature. In the first stage, warming up, the microorganisms present on the materials multiply rapidly and the temperature rises. During this period all the very reactive compounds such as sugars, starches, and fats are broken down. When the temperature reaches 160°F the fungi stop working and the breakdown is continued by actinomycetes and spore-forming strains of bacteria. The breakdown slows and the temperature peak is reached. At this period, the heap is losing as much heat as the microorganisms produce.

When cooling down, the straws and stalks are decomposed, mainly by fungi. This is because as the temperature falls below 160° F the fungi re-invade from the cooler regions of the heap and attack less reactive compounds such as hemicelluloses and cellulose, breaking them down into simpler sugar compounds, which become available for all the other microorganisms. The actinomycetes also help during this period. At the end of the cooling down period most of the available food supply has gone, competition starts among the microorganisms, antibiotics are released, and larger soil organisms, especially worms, move in for a few weeks.

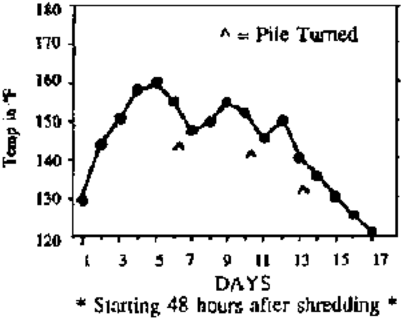
The increase in temperature is one of several factors in the composting process which act against the survival of pathogenic organisms. Table 1 shows that the common pathogens which cause diseases in humans and domestic animals are readily destroyed at temperatures of 55 to 60°C for periods of a few minutes to a few hours under the moist conditions used in composting.



Experimental Compost Data



Temperature Comparison



Ideal Temperature Curve

Table 1. Pathogen survival in composting and agricultural application of human wastes

Organism	Survival in: Composting	Agricultural Application
Enteric viruses	Killed rapidly at 60°C	May survive up to 5 months on soil

Salmonellae	Killed in 20 hours at 60°C	On soil, S. typhi up to 3 months; other species up to 1 year
Shigellae	Killed in 1 hour at 55°C or in 10 days at 40°C	Up to 3 months
E. cold	Killed rapidly above 60°C	Several months
Cholera vobrio	Killed rapidly above 55°c	Not more than 1 week
Leptospires	Killed in 10 minutes at 50°C	Up to 15 days on soil
Hookworm ova	Killed in 5 minutes at 50°C and 1 hour at 45°C	Up to 20 weeks on soil
Ascaris ova	Killed in 2 hours at 55°C 20 hours at 50°C and200 hours at 45°C	Several years
Schistosome ova	Killed in 1 hour at 50°C	Up to 1 month, if damp

Source: Health Aspects of Excreta and Sillage Management, World Bank, 1980.

6. Acidity (pH)-Compost material becomes slightly acidic at the start of composting due to the simple organic acids produced at the initial phase of decomposition. The heap then turns slightly alkaline after a few days as proteins are attacked and ammonia is released. Highly alkaline conditions will lead to excessive loss of nitrogen as ammonia; accordingly it is wise not to add lime to a heap. Highly acid initial conditions may lead to a failure of the heap to warm up. If careful attention is paid to the mixing of materials, moisture content and aeration, there is no necessity to influence the pH of the process. The amount of ammonia lost from a compost heap can be reduced by adding a little soil, about 1% of the weight of the heap.

7. Nutrients-The composting process depends upon the action of microorganisms which require a source of carbon to provide energy and material for new cells, together with a supply of nitrogen for

cell proteins. Nitrogen is the most important nutrient and, in general, if sufficient nitrogen is available in the original organic matter, most other nutrients will also be available in adequate quantities. It is desirable that the ratio of carbon to nitrogen (C/N) is in the range of 30-35/l in the initial mixture. If it is much higher, the process will take a long time before sufficient carbon is oxidized off as carbon dioxide, if it is lower, then nitrogen, which is an important fertilizer component of the final compost, will be given off as ammonia. The simplest method of adjusting the C/N ratio is to mix together different materials of high and low carbon and nitrogen contents. For example, straw materials which have a high C/N ratio can be mixed with materials such as manures which have low C/N ratio.

References:

Bautista, O.K. et al. 1983. Introduction to Tropical Horticulture. pp. 205-206

Cosico, W.C. 1985. Organic Fertilizers: Their Nature, Properties and Use. pp. 39 - 50

Dalzell, H.W. et al. 1987. Soil Management: Compost Production and Use in Tropical and Subtropical Environments. FAO Soils Bull. 56: 22-27,162.

Composting methods

Conventional method of compost preparation

1. Choose a spot that is at least partially protected from rain.

2. Gather the crop residues, animal manures and other wastes and bring them to the preparation site.

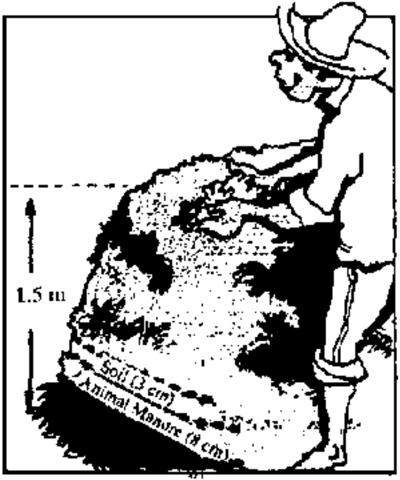
3. Pile the crop and other plant residues (15 cm thick) first. For the next layer, spread the animal manure to a thickness of about 8 cm, followed by about 3 cm of good soil. Pile another layer of the materials in the same sequence and repeat until a height of about

1.5 meters of the compost pile is attained.

4. Water the pile until it is sufficiently moist. Water regularly.

5. Turn over or mix the pile with spading fork after 3 weeks, then again after five weeks.

6. Harvest the compost in three to four months.



Conventional method of compost preparation

The 14-day method of composting

1. Chop the vegetative materials/plant wastes (dry or green or

both).

2. Thoroughly mix these with an equal amount of fresh manure.

3. Pile the mixture into a heap measuring at least 1 m × 1 m × 1 m. (However, 1 m is the maximum height.)

4. Cover the heap with banana leaves or damaged burlap sacks.

5. By the third or fourth day, the inside of the heap should be heated up. If not, mix more manure into it.

6. On the same day (3rd or 4th), turn the heap inside out so that the materials from the center will appear outside and vice versa.

7. Turn the heap every two days thereafter.

8. In 14 - 18 days, the compost should be ready for use.

The 14-day method of composting

Composting in triple-compost bin

Making three compartments permits us to keep adding to our compost pile. The compartment at left is ready for the fields while the others are still rotting.

1. Fill compartment one with composting materials.

2. Add a small amount of soil or animal manure.

3. Continue in this way till the compartment is full.

4. After a month, empty the contents of compartment one into compartment two, mixing, watering and breaking up the compost in the process

5. Cover the second compartment with a layer of soil, which has to be kept humid and loose.

6. Once compartment one is empty, the process of filling it should

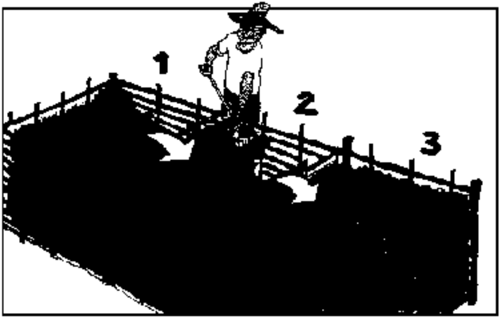
begin again as before.

7. After another month, fill compartment three with the contents of compartment two, airing the contents well without turning over.

8. Cover the third compartment with a layer of soil.

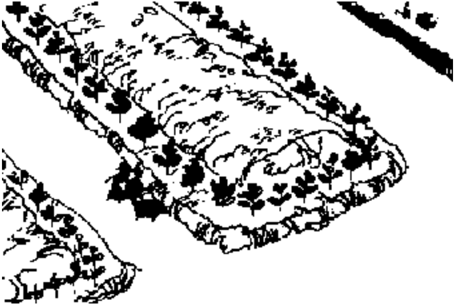
9. Fill compartment two with the contents of compartment one and cover with soil.

10. Fill compartment one with refuse and the cycle goes on.

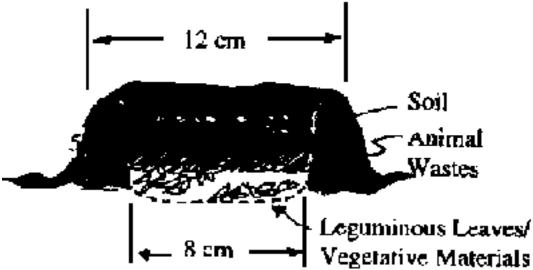


Composting in triple-compost bin

Deep bed composting



Garden Layout



Cross-section of Composting Bed

Bed Construction

Lay out garden beds at least 12 cm wide.

Dig trench 8 cm wide and 5 cm deep along center line of bed. Place spoil (dirt from trench) on both sides of trench.

Bed Construction

Addition of Organic Materials

Place 15 - 30 cm layer of leguminous leaves and other vegetative materials.

Spread layer of animal wastes over vegetative materials.

Cover with layer of soil. Use ½ of spoil pile along side of trench.

Pile another layer of the materials in the same sequence, returning all of spoils in or on trench.
Shape bed by raking.

Planting

Soak bed thoroughly with water.

Plant seeds or transplant seedlings around the trench.

After harvesting, remove the contents of the trench and work the compost into the soil around the trench. Place new compost materials in the trench for the next crop.

Semi-sunken composting

1. Clean the area selected for building the compost pile. Dig a hole one-half meter deep.

Clean the area

2. Cut composting materials into small pieces. Mix them with

manure at 5:1 ratio.

Cut composting materials into small pieces

3. Place the mixture in the hole until it reaches one to two meters above the ground. Use a shovel or your hands to keep the edges square.

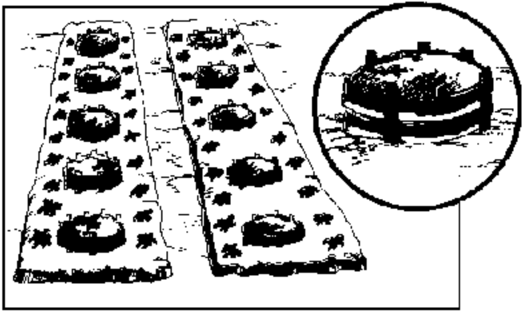
Place the mixture in the hole

4. Cover the pile with straw or smear it with mud to protect it. Add a layer of soil on top of the pile and make a series of holes on top of the finished pile. The compost should be ready is 1 to 2 months.

Cover the pile

Basket composting

Basket composting is the process by which decomposable home garbage, garden and farm waste and leguminous leaves are allowed to rot in baskets half-buried in garden plots as a method of producing organic fertilizer.



Basket composting

Benefits

1. Basket compost can be used immediately without waiting for the usual 34 month period as is necessary in other methods of composting.

2. Baskets hold the composting materials in place, hence minimizing nutrient depletion by runoff.

3. Stray animals and fowls are prevented from scattering the compost materials.

4. Since garbage and wastes are collected and utilized, home and surroundings will become cleaner.

5. It serves as reservoir and collector of the moisture and nutrients.

6. More nutritious vegetables can be produced at less cost.

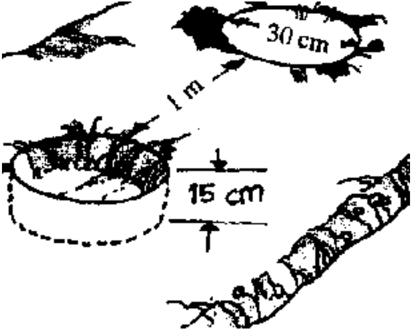
Preparation of Materials

Preparation of Materials:

Long bamboo strips, 2-3 cm in width.
Bamboo stakes at least 30 cm in length.
Home organic garbage, farm and garden wastes, leguminous leaves.
Manure.

Preparation of Garden Plots

Clean garden site, save weeds and grasses for composting.
Dig at least 30 cm deep and raise the bed.
Dig holes along the center of the plots at least 15 cm in depth and 30 cm in diameter.
Space them 1 m apart

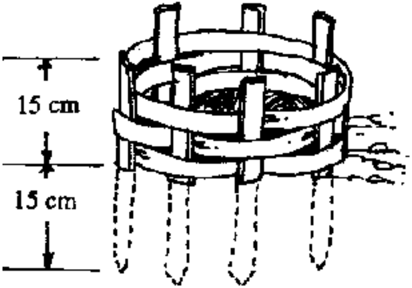


Preparation of Garden Plots

Construction of Baskets

Drive 7 stakes around the holes; uneven number of stakes (5,7 or 9) makes perfect brace for weaving.

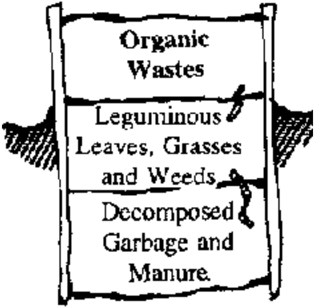
Weave the long strips of bamboo around the stakes to form a basket. Without bamboo strips, closely space the stakes (about 1 cm apart).



Construction of Baskets

Addition of Organic Wastes

Place the most decomposed garbage and manure into the basket first.
Place the undecomposed materials like leguminous leaves, grasses and weeds next.
Fill to the brim with other organic wastes.
Earthworms maybe added to speed up decomposition.

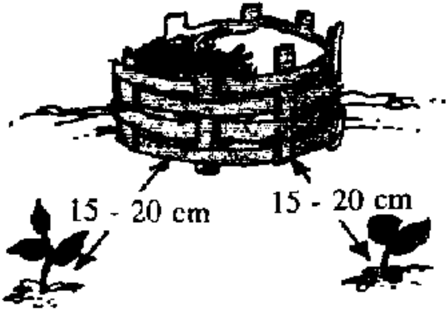


Addition of Organic Wastes

Planting and Care and Maintenance

Plant seeds or transplant seedlings around the basket. The distance from the basket should be 15 - 20 cm to prevent the decomposing materials from "burning" the plants.

Water the seedlings while young. Eventually just water the basket. The plant roots will later move toward it.

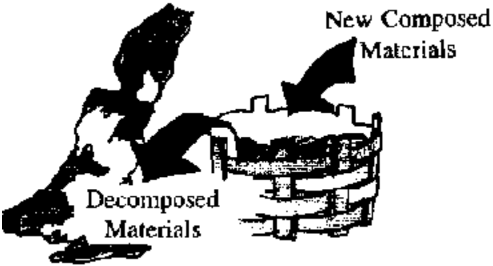


Planting and Care and Maintenance

Incorporation of Decomposed Materials into the Soil

After harvesting, composts are already used up. Remove the decomposed materials from the basket and incorporate them into the soil while cultivating.

Add new composting materials to the basket for the next plants.



Incorporation of Decomposed Materials into the Soil

Reference

Laquihon, W. A. and H. R. Watson. 1983. A Manual on FAITH Garden. MBRLC, Bansalan, Davao del Sur, Philippines.

Liquid fertilizer

Liquid fertilizer is made by immersing a sackload of fresh animal manure in a drum of water and allowing it to ferment. When used to water the plants, the "tea" makes possible the easy nutrient extraction by the plants. Depending on the availability of materials, animal manure can be substituted with fresh leaves of nitrogen-fixing trees like Leucaena (ipil-ipil) and/or Gliricidia (kakawate) or with green grass clippings and/or fresh weeds.

Preparation

1. Fill the burlap bag ¾ full of wet manure or fresh leaves or compost.

2. Tie the open end then place the bag info the empty drum (regular size, 55 gallon capacity).

3. Place a big stone to hold the bag down.

4. Fill the drum with water. Cover.

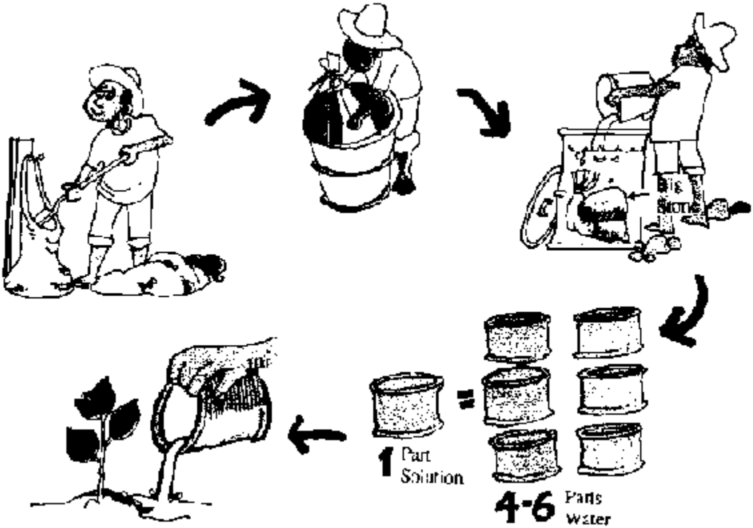
5. After 3 weeks, remove the bag from the drum.

6. Dilute solution at a ratio of 1 part liquid fertilizer to 4-6 parts fresh water.

7. Apply the liquid fertilizer around the base of the plant (avoid any direct contact with the plant) 2-3 weeks after germination or Immediately after transplanting. Repeat after 3-4 weeks.

8. Start over again with fresh materials following steps 1-6.

9. Smaller quantities of liquid fertilizer can be produced in smaller containers (if a 55-gallon drum is not available), using the same ratios.



Preparation

Fish emulsion as plant food for bio-intensive garden

Made from a blend of saltwater fish wastes, fish emulsion is a thick, gooey concentrate with about five percent nitrogen and small but significant amounts of trace minerals. It also contains a lot of fish oil. Most of the nitrogen in fish emulsion is present as amino acids from the breakdown of protein or as ammonia and nitrate. These amino acids can easily be absorbed by the leaves or roots. Diluted in water, fish emulsion can be either sprayed on leaves or poured around the base of plants.

Significant Findings from Research

1. Fish emulsion applied once a week to greenhouse soil stimulated vegetative growth and delayed flowering and fruit ripening in tomatoes by over a week. (Virginia Polytechnic Institute of State University in Blacksburg, Virginia)

2. Fish emulsion fertilizer added to the soil reduced nematode population. (Biological Testing and Research Laboratory, California)

Preparation

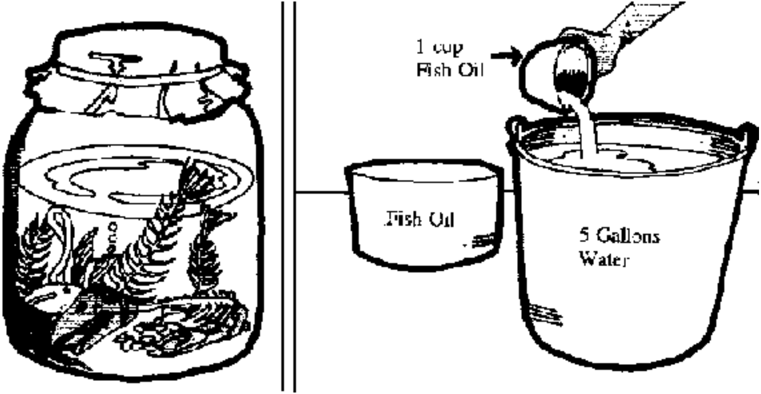
1. Put any kind of scrap fish or unused fish-parts in a glass jar or plastic container. Fill with water.

2. Cover the top with a cloth, securing firmly to keep out insects and animals.

3. Place the container in a storage bin and let it ferment for two to three months.

4. After this period, a layer of mineral-rich oil will float on top, water underneath and the bones and scales on the bottom. Skim off the oil and store in a container.

5. When ready to use, dilute one cup of oil with five gallons of water. The remaining sludge may be sun-dried and then mixed with the soil.



Preparation

Green manuring

Green manuring is of special relevance to small gardens. It is a practice of using plants as source of organic matter incorporating them into the soil for decomposition before the planting of crops.

Garden fertility can be sustained entirely on the nutrients from green leaves.

Nitrogen-fixing trees

Sources of Green Manures

1. Nitrogen-fixing trees - trees that fix nitrogen from the atmosphere. These can be intercropped with the main crop or used as fence. The leaves are incorporated into the soil or used as mulch.

Benefits

a. increases soil nitrogen
b. helps control weeds when used as intercrop
c. serves as windbreak/controls erosion
d. provides feed for livestock and firewood for the home
e. increases available moisture by improving infiltration and reducing runoff

f. reduces cost of inputs such as fertilizers and herbicides
g. improves soil structure
h. may also provide cash income

Characteristics of N-fixing trees ideal for green manuring

a. should be fast-growing
b. high production of herbage
c. high nitrogen content
d. fast decomposition of leaves
e. tolerant to pruning
f. pest-resistant
g. tolerant to a wide range of soil conditions

Characteristics of Some Nitrogen-fixing Trees

	Herbage	**Tolerance to**	**Adaptability**			
Scientific	**Common**	**Growth**	**Dry Matter**	**Water**	**Low**	**S**

Name	Name	Rate	Drought Yield	(t/ha.)	logging	Fe
Calliandra calothyrsus	Calliandra	fast	3.70	very good	poor	goo
Desmodium rensonii	Rensonii	fast	2.50-4.00	fair	fair	goo
Flemingia macrophylla	Flemingia	moderate	2.65	good	fair	goo
Gliricidia septum	Kakawate	moderate	2.60	good	fair	goo dra slig aci
Leucaena diversifolia	Acid ipil-ipil	fast	6.00-9.00	good	fair	goo

Leucaena leucocephala	Ipil-ipil	fast	7.00-24.00	very good	poor	goo
Sesbania grandiflora	Katuray	moderate	15.0022.50	very good	very good	ver goo

References:

FAO-RAPA. 1988. Nitrogen-Fixing Trees for Wasteland. FAO, Bangkok.

Friday, K. 1989. Species Choice for SALT. Lecture Notes. Peace

Corps Philippines.

NFTA. 1986. Sesbania - A Treasure of Diversity. NFT Highlights 86 04, Nitrogen-fixing Tree Association, Waimanalo, Hawaii, 2 pp.

NFTA. 1989. Flemingia macrophylla - A Valuable Species in Soil Conservation. NFT Highlights 89-04, Nitrogen-fixing Tree Association, Waimanalo, Hawaii, 2 pp.

NFTA. 1989. Gliricidia Production and Use. Nitrogen-fixing Tree Association, Waimanalo, Hawaii, 44 pp.

Cover crops

2. Cover crops are creeping and bushy plants with dense vegetative growth, grown mainly to cover and protect the soil.

Benefits

a. provide large quantities of nitrogen (more than 200 kg N/ha)

b. Some cover crops like Centrosema, Pueraria and Crotalaria develop deep root systems on acid soils and may, therefore, help to recover nutrients leached to the subsoil.

c. increase soil's organic matter content up to 30 tons or more per hectare, thereby improving topsoil depth, water-holding capacity, nutrient content, friability and soil texture

d. shade the soil for as long as 11 months, , keeping the soil temperature as much as 10°C lower than uncovered soils. Therefore microorganisms remain active and organic matter is preserved.

e. Dense foliage of cover crops protects the soil from wind and water erosion.

f. Vigorous growing foliage competes well with weeds and suppresses their growth, thereby reducing or eliminating costly weeding operations.

g. provide high protein fodder for animals

h. provide human food and additional source of income

i. help sustain garden plots during dry months when other crops are hard to grow

Characteristics of cover crops ideal fur green manuring

a. rapid, prolific growth habit
b. ability to fix significant amount of nitrogen
c. tolerant to a wide range of soil conditions
d. good drought-tolerance
e. resistant to pests
f. ability of the plant to produce its own seed
g. fast decomposition of leaves
h. easy to control; some cover crops can be very aggressive and may be difficult to eliminate.

Some cover crops successfully used by farmers

Canavalia ensiformis (jackbean, habas)

drought-tolerant
180-300 days growth period
shade-tolerant
fairly tolerant of waterlogging and salinity
tolerant of a wide range of soil types provided the pH is between 5 and 6.

Voandzeia subterranea (Bambara groundout)

120-150 days growth period

tolerant of excessive rain

adapted to a wide range of soils, but light sandy, welldrained loams with a pH of 5.0-6.5 are preferred.

Cicer arietinum (chick pea, garbansos)

115-125 days growth period
can tolerate shade but for high yields bright sunshine is required
drought-tolerant
can be grown on a wide range of soil types provided the drainage is good.

Crotalaria sp. (sun hemp)

determinant growth habit
produces high herbage yield (1.4-2.42 tons dry matter/ha)
does not tolerate shading.

Cyamopsis tetragonoloha (cluster bean)

110-165 days growth period
sun-loving, intolerant of shade
drought-tolerant; cannot stand waterlogging
grows on a wide range of soils provided they are welldrained and not acidic
Sandy or sandy loams, pH 7.5 to 8.0, are generally preferred.

Dolichos lablab (hyacinth bean, batao)

75-300 days growth period
drought-tolerant; intolerant of waterlogging
grows on a wide variety of soil types provided they are well-drained
does particularly well on sandy loam, pH 6.5.

Lathyrus salivas (grass pea, chick pea)

150-180 days growth period
very tolerant of drought conditions
tolerates waterlogging
grows on a wide range of soil types, including very poor soils and heavy clays.

Macrotyloma uniflorum (horse gram)

120-180 days growth period
drought-tolerant; cannot stand waterlogging
grows on a wide range of soil types provided they are well-drained

and not highly alkaline
thrives on light, sandy soils, red loams and gravels.

Mucuna pruriens (velvet bean, kokua)

180-270 days growth period

tolerant of drought conditions; cannot stand waterlogging

grows on a wide range of soil types, including heavy clays tolerant of fairly acid soils, but for optimum yields light sandy loams with a pH of 5-6.5 are required.

Phaneolus aureus (mungbean, munggo)

80-120 days growth period
fairly tolerant to drought; cannot stand waterlogging
grows on a wide range of soil types tolerant of alkaline and saline conditions
well-adapted to clay soils, but for optimum results a deep loamy soil

is required.

Phaseolus calcaratus (rice bean, tapilan)

120-130 days growth period
fairly tolerant of drought conditions
grows on a wide range of soil types
cannot withstand waterlogged conditions.

Psophocarpus tetragonolobus (winged bean, sigarilyas)

economically productive from 5 years or more
does not survive prolonged drought
cannot tolerate waterlogging or salinity
Well-cultivated, rich, sandy loams are best for optimum yields.

Vigna unguiculata (cowpea, paayap)

60-240 days growth period
well adapted to semi-arid regions

grows over a wide range of soil types cannot tolerate waterlogging and salinity
Although reasonably tolerant of acidity, a pH of 5.5 to 6.5 is preferred.

Reference:

Bunch, R. 1986. What We Have Learned to Date About Green Manure Crops for Small Farmers. World Neighbors - Honduras 12 pp..Produced by the International

Cover crops as soil conditioners

In heavy clay, cover crops add humus and stimulate microorganisms to-loosen rock-hard compaction and create a crumbly, well-aerated and well-drained soil structure.

In heavy clay

In sandy soils, the extensive, deep-penetrating roots of cover crops bring up needed nutrients that have leached into the subsoil. As the nutrients decompose, the matted roots give the soil enough body to hold onto nutrients and water that otherwise would quickly drain below the reach of plants.

In sandy soils

In nitrogen-deficient soils, velvet bean, hyacinth bean, jackbean and winged bean treat nitrogen deficiency.

In nitrogen-deficient soils

In dry conditions, cover crops maintain lower soil temperatures and, thereby, conserve microorganisms and earthworms, and generally conserve the soil's organic matter and humus.

In dry conditions

Reference:

Quick Ways To Better Sail. 1990. Organic Gardening Magazine. 16 pp.

Nutrient requirement of vegetables

Vegetable	Nit.	Phos.	Pot.	PH Requirement
Asparagus	EH	H	EH	6.0-7.0
Beans,bush	L	M	M	6.0-7.5

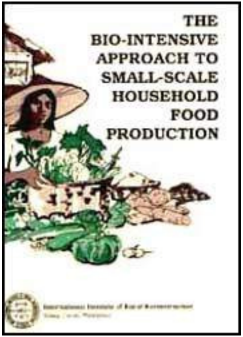
lima	L	M	M	5.5-6.5
Beets, early	EH	EH	EH	5.8-7.0
late	H	EH	H	same
Broccoli	H	H	H	6.0-7.0
Cabbage, early	EH	EH	EH	6.0-7.0
late	H	H	H	same
Carrots, early	H	H	H	5.5-6.5
late	M	M	M	same
Cauliflower, early	EH	EH	EH	6.0-7.0
late	H	H	EH	same
Corn, early	H	H	H	6.0-7.0
late	M	M	M	same
Cucumbers	H	H	H	6.0-8.0
Eggplant	H	H	H	6.0-7.0
Lettuce, head	EH	EH	EH	6.0-7.0

leaf	H	EH	EH	same
Muskmelons	H	H	H	6.0-7.0
Onions	H	H	H	6.0-7.0
Parsnips	M	M	M	6.0-8.0
Parsley	H	H	H	5.0-7.0
Peas	M	H	H	6.0-8.0
Potatoes, white sweet	EH	EH	EH	4.8-6.5
	L	M	H	5.0-6.0
				6.0-7.0
Radishes	H	EH	EH	6.0-8.0
Rutabaga	M	H	M	6.0-8.0
Soybeans	L	M	M	6.0-7.0
Spinach	EH	EH	EH	6.5-7.0
Squash, summer	H	H	H	6.0-8.0
winter	M	M	M	6.0-8.0

Strawberries	M	M	L	5.0-6.0
Tomatoes	M	H	H	6.0-7.0
Turnips	L	H	M	6.0-8.0

Nutrient Requirements
EH= Extra Heavy
M= Moderate
H= Heavy
L= Light

Home"" """"> ar.cn.de.en.es.fr.id.it.ph.po.ru.sw



Bio-intensive Approach to Small-scale Household Food Production (IIRR, 1993, 180 p.)

Seed and seedling management

Saving seeds through gardener curators

THE consciousness today about genetic resources and their importance to humankind is at an all-time high. Discussion has focused specially on the loss of traditional varieties, or "genetic erosion" and the control of germplasm by vested groups or companies. Varieties are being lost as they cease to be cultivated. There is a call to search out and retrieve these vanishing resources - if not for any other reason than for preservation, the same way a curator in the museum preserves heirloom cutlery. Finally, traditional varieties are sources of useful genes concerning special qualities such as resistance to diseases or drought. Such genes are invaluable in breeding new cultivars.

Tomorrow is Late

Unfortunately, conferences and workshops, do not save seeds. Despite the many meetings and papers on the topic of genetic erosion, action efforts to save seeds are sadly lacking in quality and impact. Historically, the best conservers of seeds have been small farmers and backyard gardeners, but programs to conserve seeds at their level are sadly lacking. Meanwhile, every day, the seed heritage slowly but steadily diminishes.

The Gardener or Small Farmer as Curator

Nongovernment organizations and others interested in saving seeds in situ (as opposed to storing them in laboratories) need to address this issue with a sense of urgency and through field-level and farmer-or gardener-involved interventions.

The concept of a farmer/gardener curator is valid because the seeds used by the majority of today's farmers in developing countries have been handed down by generation of farmers. When planted out every year, these varieties continue to evolve and adapt to the changing environment. These same seeds, stored in conventional low-temperature seed storage facilities, just remain dormant, and their characteristics remain unchanged - they do not evolve any further. In fact, varieties stored this way, if planted many years later in the field, may not be able to withstand the changed environment in the place they were originally collected.

Many traditional varieties do not meet the criteria and standards of today's consumers and so are not planted commercially even if they have superior nutritional, taste or storage qualities. One example is the bitter gourd. A favorite of Filipinos, improved varieties of this crop are superior in production and of larger individual size but are dependent on chemicals. Other varieties do not have synchronous harvests and so are getting lost. An example is the araw-araw ("daily") eggplant, so called because it provides a few eggplants every day compared with the improved varieties that come to harvest at a peak time and so are preferred for marketing.

Many traditional vegetable cultivars have multiple uses. A good example is the winged bean which produces a tasty and nutritious pod and has edible flowers and tubers. Unfortunately, many of the tuber-producing cultivars are rare and can only be found in remote areas such as Papua New Guinea.

The potato yam is another crop which is steadily getting lost. Even though it produces both aerial and ground tubers on the same plant, this is not enough to ensure its survival for the next generation of farmers.

The list of cultivars that have special qualities is long: cherry-sized tomatoes which can be grown in the rainy season with no fungal problems (as many as 1000 fruits can be harvested in the life of this cultivar), the mung bean with hairy leaf surfaces that keep most insects away and the deep-rooted leafy amaranths that can go for as long as six weeks i!, summer with no water and no wilt symptoms.

These qualities do not often make a difference to the consumers of marketed vegetables, who look for good size more than anything else. The bigger the better is the norm! In fact, most farm produce in exhibitions and competitions use size as a major criterion in crop judging. Is it not ironic when miniature vegetables in the West fetch the highest prices, but developing countries prefer the longest, heaviest, largest products? Why this obsession, when we know that eventually these are going to get cut down into small pieces to be eaten?

The emphasis on producing seedless products is another example of how preferences have changed over the years. The seedless grape and the papaya with just a few seeds in each fruit are examples.

But, finally, the most important factor is how our technicians and extension workers perceive the growers of such indigenous cultivars. If they treat farmers as primitive or outdated in their thinking and choice of varieties, then the farmers will have a poor self-perception and image. Unless an effort is made to give these traditional cultivars a new image, they will gradually be neglected by the farmers themselves. When that happens, all is lost for the cause of seed conservation.

The greatest opportunity for conserving such varieties is by reintroducing them for use in gardening programs'- in backyards of farm households, in urban gardens or in school areas. These gardens are raised primarily for family use and nutrition for school children. The special qualities of traditional cultivars, their hardy nature, prolific seed production, high nutritional value, well distributed fruiting periods (as opposed to peak production), shade tolerance, etc., all make them especially useful for these programs. What is also important to realize is that their yields do not have to be low because, if combined with improved crop husbandry techniques such as the big-intensive technologies, their output per unit area could compare favorably with the output, using conventional technologies and chemicals. Such gardens can consist of a great diversity of crops: a typical big-intensive garden area of 200 sq m can contain as many as 30 selections. Isn't that biodiversity also? While biodiversity often refers to natural forest ecosystem, we can create this in garden spaces and backyards as a conservation strategy. Of course, they will not have the looks of a neat garden with distinct rows and clean space between rows.

How Does One Get Started if There Are No Traditional Varieties in the Area?

Most developing countries still have a vast selection of materials to collect, if one knows where to look for them and what to look for. Where modern agriculture has been aggressively promoted, these genetic resources will still be around but often growing only in remote areas in backyards or in intercropping systems, or often as weeds. However, the way to ensure success is to focus the seed retrieval and collection missions in areas away from the beaten tracks and asphalt roads. It is less likely that seed merchants will have reached these places. Ethnic groups in most countries are especially important communities from whom to collect seeds. Often, these groups continue to grow old cultivars because they have not been exposed to extension agents or for cultural reasons (in defense of their cultures) have been resistant to change. The most diverse collection of planting materials can be found in the remotest areas.

One has to time one's visit to ensure that seeds are ready for collection. Usually, the three to four months immediately preceding the summer season are ideal times for legumes and other vegetables. The end of summer is the best time to select droughttolerant vegetables: just look for unirrigated areas where the crops have survived through the summer season. Market days are excellent opportunities for seed collection, especially in those parts of the world where small quantities of seeds are traditionally sold by fanners in the weekly market. If seeds are not available, these market days are good for acquiring produce from which seeds can be extracted. In the case of legumes, these can be bought from traders dealing with dried legumes - though germination is inevitably a problem with this method of acquiring seeds.

One of the most efficient ways to collect the greatest diversity of seeds is to get in touch with local schools in remote areas and through the authorities, launch an effort for seed retrieval through children. Finally, a consortia of NGOs in a country can be used for seed retrieval and subsequent exchange. NGOs working with farmer organizations can use their infrastructure to collect planting materials and seeds.

Common Problems Faced by Seed Collectors

The amateur seed conservationist will find the seed-saving idea a lot more complicated than when he or she anticipates. The problems of categorization, outplanting, characterization, storage and quality control are all essential to a systematic effort; yet, they are theeconsuming and, unfortunately, require financial resources.

The NGO or amateur conservationist will first have to limit the collection based on priorities, e.g., vegetables, cover crops, trees, fruits or rice. It is a common mistake to try to collect everything because it soon becomes overwhelming, difficult to manage and expensive. With cooperation, it is conceivable mat each NGO could focus on one crop and then exchange the collected and tested materials with other partner NGOs.

The planting-out of collected seeds is another important step -

probably the most expensive. Human labor is needed for this, as long as the crops are in the field. Seeds must be planted and observed for two to three seasons to ensure that the characteristics (e.g., planting season, flowering habits, pest susceptibility, etc.) can be recorded. Here we are not talking of sophisticated data but very simple but essential information without which the gardener or farmer receiving the seeds could get the wrong conclusion, i.e., indigenous varieties are not good. Many traditional varieties are season-bound and, if planted in the wrong season, give very poor results. Others do badly if fertilized and do well only under low fertility conditions.

The collection of seeds is labor-intensive and time-consuming. The next step, that of drying and then depodding or cleaning, is also labor-intensive. However, all activities mentioned so far can be easily learned and require systematic effort rather than expertise.

The storage of seeds and maintenance of viability is probably where the most problems will occur and where guidance from a seed technologist in the design of a technical strategy is important. Seeds can be dried too much or not enough. They can get infested with fungus while in storage, affecting their viability, or the seedlings can be damaged soon after germination. The seed moisture content in storage is the single most important factor. But the storage temperature and humidity often critical determinants of how successful the seed production effort has been.

The importance of labeling seed packets with information on the place of origin, local name and the date of collection cannot be over emphasized. Any observations from the gardener or farmer will be very helpful in future characterization of accessions, e.g., some cultivars store better than others, an important characteristic of old cultivars of beans and a trait lost in the new varieties. If this information is not recorded one might not know it by observing plants in the field. Another attribute of traditional legumes that farmers know well and use to describe their collections is the versatility, for instance, some legumes can be sold as green vegetables but are also equally good as dried legumes. This knowledge is best collected from the original growers themselves.

An institutional effort to conduct seed collection missions is justified (as opposed to farmers collecting the seeds from their own area for in sin' conservation) if seeds are rare and must be brought from other parts of the country and exchanged in order to reinstate the original diversity and variability. But such efforts are only useful and relevant if the seeds collected, tested and multiplied are returned to the communities for them to plant, try out and conserve. The sooner the materials are moved out, the better. The ideal approach is to give farmers a diversity from within each crop, e.g., six kinds of mungbeans, so they can choose from a range. Some retain what others will not. So somewhere in every village the materials will get preserved.

Unless the program is backed up with an elaborate conscientization strategy, one should not expect fanners to understand the philosophical or aesthetic dimensions of genetic resources conservation program. Their agenda may be different from that of the organization: they conserve the varieties for a host of reasons, the last of which may be conservation for conservation's sake. So, the idea of getting growers to continue to raise seeds only for purpose of saving them, as is being done in some Western countries, is a bit unrealistic. There is need to focus on seed accessions whose attributes will in themselves result in their being conserved. The genetic resources agenda then become a hidden one and need to be integrated with other activities, such as family food production though improved agricultural technologies for farms and gardens, or health and nutrition interventions.

It seems clear that conservation will not result from workshops on the topic of genetic erosion, even as we admit these are important at certain stages of the campaign. Nor will it result only from storing seeds in national or international germplasm banks, because of the need for these plants to continue their process of evolution and adaptation. Seed conservation is everybody's concern and not an activity limited to geneticists and breeders.

We still have time to do something about this ... only if we start today.

Why producing your own vegetable seeds is important?

1. High-quality seeds can be easily produced and at a low cost, thus, reducing the costs of
gardening.

2. When the seeds you want are not available in the market, you can produce your own seeds.

3. When you produce your own seeds, you can sell them for income and/or share them with neighbors and friends.

4. By producing your own seeds, you can select seeds suited to your environment. If you want fruits that are big and are not attacked by pests in your garden, you can choose seeds of the plants that are grown in your garden with these specific traits.

5. Saving your own seeds is fun. It is also challenging to save seeds since you can experiment with different seed-saving techniques.

6. Seed self-reliance can be achieved by producing your own seeds.

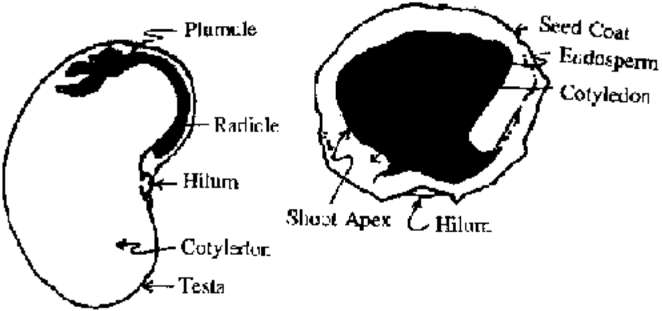
7. Valuable traditional or indigenous seed varieties of vegetables can be preserved for future generations.

Definition of a Seed

A seed is an undeveloped and dormant plant, usually with a reserve food supply and protected by a seedcoat. It is also defined as a miniature plant in an arrested state of development.

Botanically, the seed is a mature ovule enclosed within the ovary or fruit Seeds of different species vary greatly in appearance, shape, location and structure of the embryo and the presence of storage tissues.

A seed has three basic parts: (1) embryo; (2) food storage tissues or endosperm; and, (3) seed covering or seedcoat.



Definition of a Seed

Traditional or indigenous seeds

Traditional or indigenous seeds are those produced, growing or living naturally in a particular country or climate. They are seeds that have been selected and managed by local people in the local growing environment.

Traditional or Indigenous seeds

Characteristics of Traditional Seeds

1. Adapted to the conditions of the area where they are grown.

2. Multiple uses (examples: food, medicine, fuel, fiber, fertilizer, craft materials, feed for animals, religious articrafts).

3. Most are resistant to pests, diseases and environmental conditions, such as drought.

4. High nutritional value.

5. They do not have a peak season harvest. The fruits do not mature at the same time, so harvesting is staggered. Hence, they can provide a daily source of food for the family.

6. They provide plant breeders with valuable traits needed for crop improvement.

Choosing Good Plants for Seeds (Plant Selection)

The selection criteria for seeds depend on the selector's needs or use (example: food, fodder). Below is a list of characteristics which can help the selector find good plants for seeds:

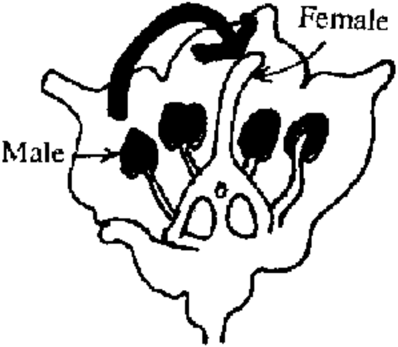
1. vigor and health of the plant
2. resistance to pests and diseases

3. resistance to adverse environmental conditions, like drought, heat, flood
4. time of fruit bearing
5. yield
6. characteristics of fruit and seed like color, size, shape, texture, etc.
7. cooking and eating quality (if the fruit or seed is meant for eating)
8. storage life of fruit and seed
9. other characteristics depending on the use (example: medicine, crafts, religious articrafts)

Based on the above criteria, select the plant to be used for seeds. Put a tag or mark the plant so that it is not harvested by accident and so that special care can be given to it.

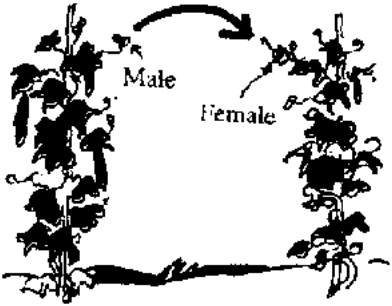
Seed production

Seeds come from flowers. Plants have to be pollinated in order to produce seeds. The pollen, the fertilizing powder which comes from the male part of the flower or anther, is brought to the female part of the flower - the stigma or pistil.



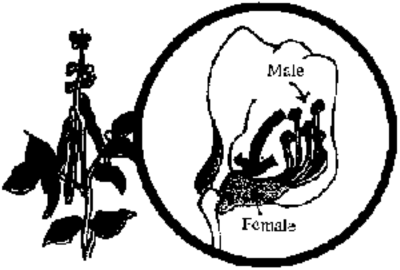
Seeds come from flowers

In cross-pollination, the pollen that will fertilize the plant will come from another plant. The plant cannot produce seeds if only one plant is planted because there will be no source of pollen. Examples of cross-pollinated plants are watermelon, melon, cucumber, squash, bottle gourd, sponge gourd, bitter gourd, pechay, mustard, radish, onion, carrot.



In cross-pollination

Plants may either be self-pollinated or cross-pollinated. In self-pollination, the plant can produce seeds without another plant. The pollen comes from the same flower or from another flower from the same plant. Examples of self-pollinated plants are tomato, hyacinth bean, soybean, lima bean, mungbean, Baguio bean, pea, winged bean, yardlong bean, cowpea, water hyacinth, lettuce.



Plants may either be self-pollinated or cross-pollinated

Sometimes mixed-pollination occurs. A single plant may either self-pollinate or cross-pollinate, depending on the environmental conditions. Examples of mixed-pollinated plants are eggplant, bell pepper, chili, pigeon pea, cauliflower, amaranth, ladyfinger.

Site selection and timing of seed production

Seed comes from the flower. The flowering and seeding are affected by the health of the plant and its surroundings or environment. Seed quality is also affected by the parent plant.

I. Environmental Factors that Affect Seed Production

A. Photoperiodism

Photoperiodism refers to the flowering response of a plant to the length of day, or more precisely, the length of the light and dark periods.

1. Short-day plants flower and bear fruit juring the months where the nights are long and the days are short. In the Philippines, short-day periods occur during the months of. September to February.

Example: most soybean varieties, winged bean, hyacinth bean, lima bean, pigeon pea

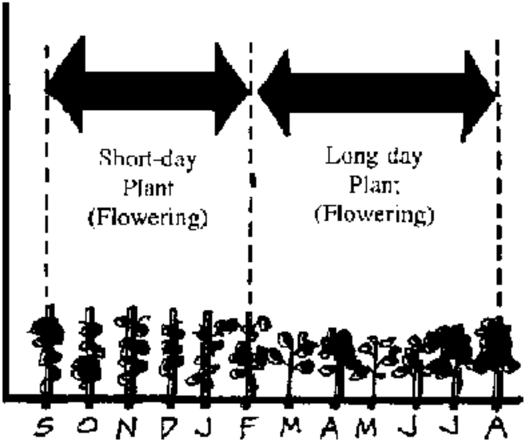
2. Long-day plants flower and bear fruit during the months wherein the nights are short and the days are long. In the Philippines, long-day periods occur during the months of March to August.

Example: onion, sunflower

3. Day-neutral plants flower and bear fruit all year round.

Example: yardlong bean, ladyfinger, cowpea

Depending on the variety, some plants, like soybean, can either be short-day, long-day or dayneutral.



Photoperiodism

B. Temperature

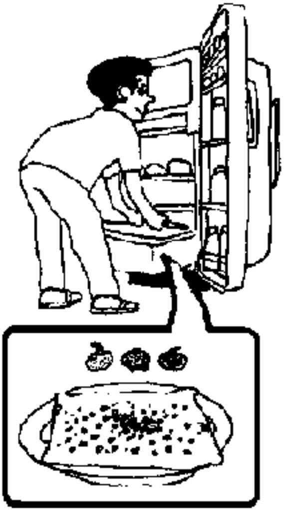
Temperature has a direct effect on flowering and seed production.

1. Tropical plants - These are plants that flower and produce seeds in hot or tropical areas. Most of these plants flower and produce seeds in the Philippines.

Example: tomato, pepper, cowpea, ladyfinger

2. Temperate plants - These are plants that flower and produce seeds in cold or temperate areas. Most of these plants flower and produce seeds in cold areas in the Philippines, like Baguio and Tagaytay.

Example: pea, cabbage, pechay, radish, onion, carrot, cauliflower



Temperature

In areas where the temperature is not cold, temperate plants can be induced to flower and produce seeds if they are placed in cool conditions before planting. This method is called vernalization. Vernalization is done by soaking the seeds in water and placing them (after the radicle or rudimentary root has protruded) or their plant parts (example: onion bulb, tuber of carrot) in a cold (but not freezing) place like a refrigerator.

Example:

	No. of days inside the refrigerator
onion bulb	30 - 90
onion seed	15
garlic bulb	40 - 50
tuber of carrot	14 - 56
radish seed	5- 7
pechay seed	4 - 8
cabbage seed	5 - 7
mustard seed	5 - 7

C. Water/Rain

The right amount of water is needed for the growth of the plant. Hard and continuous rain is not good for seed production since:

1. pollen is not transferred;
2. seeds do not develop from flowers;
3. the vegetative stage of the plant or the maturity of the fruit/seed is prolonged;
4. seeds germinate even if it is still not harvested from the plant;
5. harvesting becomes more laborious;
6. pests attack or infest the plants; and,
7. seed yield decreases.

To prevent seed production during the rainy periods, plants can be spaced at wider or longer distances so that all the plants can have enough sunlight.

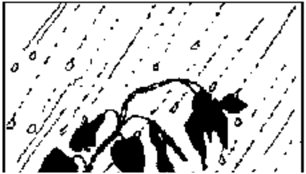
On the other hand, lack of rain or water is not good for the plant since it will prevent the normal growth of the plant and the plant may not produce flowers and seeds. Even if flowering occurs, the quality of the seeds is not good and the the seed yield is low.

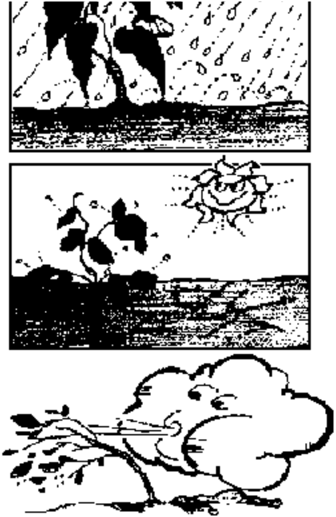
D. Wind

The strength and direction of the wind affect the pollination of flowers.

E. Soil

To produce good seeds, the soil must be healthy and fertile. The right pH (acidity of the soil) for a specific plant should also be obtained.





Water, rain, wind and soil

II. Cultural Practices

A. Timing of Planting

Plant seeds when the weather is good. Usually, seeds are planted during the rainy season in order to have continuous amount of water. It is good to transplant early in the morning or late in the afternoon.

B. Planting Distance and Rate of Planting

The distance between plants used for seed production is wider compared to that of plants used for other purposes (example: vegetable production, fodder production). More seeds need to be planted if the broadcast or sowing method is done. The distance of planting is also wider if the soil is not fertile and in the rainy season. Widening the distance will enable plants to receive enough sunlight.

C. Hastening Seed Germination

1. Seed Cleaning or Seed Washing - Soak the seeds in a container

of water and remove the seeds that float. Seeds which float have poor quality.

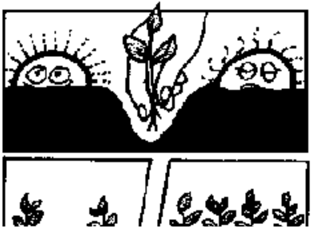
2. Use of Inoculants - Some microorganisms help in good growth of seeds. Rhizobium (a kind of bacteria) gets nitrogen from air and gives the nitrogen to the plant and soil. This is usually used for legumes. Mychorrhiza (a kind of fungus) helps the root absorb elements like phosphorus from parts of the soil that cannot be reached by the root. This has been found effective in corn and different vegetables. The two inoculants can be used to Minimize the use of fertilizer.

3. Seed Scarification - This method is appropriate to seeds (example: winged bean, bitter gourd, sponge gourd) that are hard and difficult for water and air to penetrate. This is done by (1) nicking off the seed coat with a knife or nailcutter, (2) puncturing the seed coat with a needle; and, (3) rubbing the seeds in sandpaper, file or any rough material. Care should be done so as not to injure the internal portion of the seeds, especially the

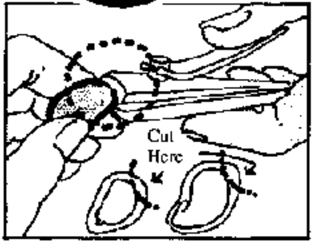
radicle.

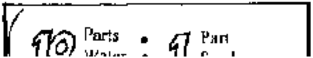
4. Hot Water Treatment - Pour hot water (boiled and then cooled for about 10 - 15 minutes) into a container with seed (10 parts water to 1 part seed). Let stand for 3 -10 minutes or until water cools off. Seeds may be left soaking overnight. Old seeds are soaked for a shorter time than new seeds.

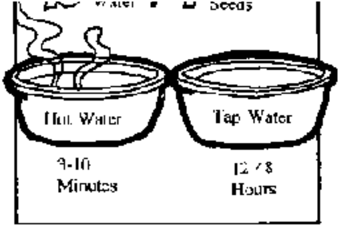
5. Soaking Seeds in Ordinary Water Overnight - Soak seeds in tap water for 1248 hours (depending on the species). This method is not recommended for all seeds, especially seeds that quickly absorb water like most legumes.




Poor
Quality
Seeds


Cut
Here


10 Parts
1 Part



Cultural Practices

D. Maintaining Seed Purity

The following methods are important to prevent contaminating other plant varieties from the variety that is being grown.

1. Planting distance - The plant being grown should be kept at a distance from other varieties and also from plants that are of the same family. Varieties of cross-pollinated plants should be planted at greater distances from each other than self-pollinated plants. For self-pollinated plants, the planting distance should not be less than 10 meters. For cross-pollinated plants, the planting distance should

not be less than 100 meters.

2. Planting timing - Avoid planting at the same time plants from the same family or of different varieties of the same species. This ensures that they will not flower at the same time.

3. Use of Windbreaks -Choose an area where there are tall plants in between plants of the same family or species.

4. Border Rows - Rows of plants of the same variety as the plants being used for seed production, planted on the edges of the plot. Seeds from the plants in the border rows are not used for planting.

5. Roguing - Roguing is done by pulling out plants that are: (1) off-types (plants with different color, shape, etc.); (2) diseased or insect-damaged; and, (3) of different varieties. Failure to remove off-types results in poor quality seeds since off-types might cross-pollinate with good plants.

6. Bagging and Caging - This prevents pollination of plants that are

of different species and variety.

E. Nutrition

Proper care and the right nutrition should be given to the plant to have good and high seed-yield. Organic fertilizers are recommended.

F. Irrigation/Watering

The amount and frequency of watering should be adjusted for good seed-yield. Plants need less water after flowering than during the vegetative stage.

G. Pest and Disease Management

Pests and diseases affect the quality and quantity of seed yield. To prevent infestation of pests and diseases, cultural practices like intercropping, mixed or multiple cropping and crop rotation are recommended.

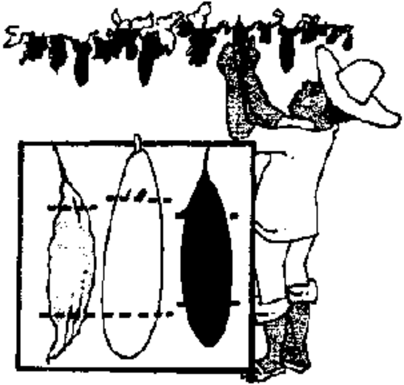
Botanical pesticides can also be used to prevent infestation of pests and diseases. If some plants already have disease, pull them out and burn or bury them underground to prevent contaminating other plants.

Use of good quality seeds (seeds with good germination percentage and without seedborne pests and diseases) can also prevent pest and disease infestation.

Another way of controlling pest and disease infestation is to use traditional seeds.

Seed harvesting and seed extraction

Seeds should be carefully harvested to ensure high quality. The seeds should possess the qualities of the variety that was planted. For example if a long purple eggplant was planted the harvested fruit should possess these qualities. Seeds from more plants should he harvested when the plant is cross -pollinated.



Seed harvesting and seed extraction

Seeds should also be harvested when they are already mature. Seeds that are overmature are not recommended since they might have already been infected with pests and diseases. Secondly they are already weak because they are old. Seeds that are undermature will not produce good seedlings and usually do not germinate. Usually for fruits that have lots of seeds (example: bottle gourd sponge gourd bitter gourd eggplant) the seeds that will be used for planting are collected or extracted from the middle portion of the fruit where the maturity of the seeds is just right and the seeds are the same age. If earliness or lateness of fruiting is not one of your selection criteria it is recommended to get fruits that ripen in the middle of the fruiting season.

To allow for losses during storage germination and early growth' about 50% more seeds than needed for planting should be harvested. It is very important that the seeds are labelled after harvesting to avoid mixing up the seeds.

How To Determine if the Seeds are Already Mature

1. The fruit has a hollow sound.
Example: squash watermelon melon

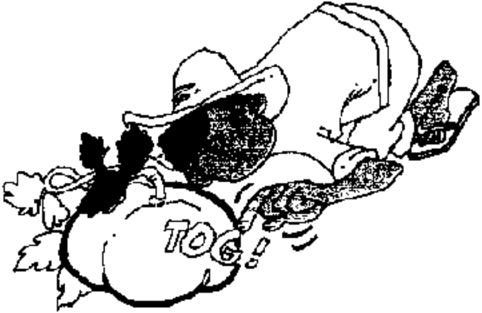
2. Color size and shape of the fruit.
Example: tomato and chili (red); cowpea and other legumes (yellow

to brown); eggplant (yellow)

3. Shattering of pods.
Example: legumes

4. Fruit is disconnected from the branch.
Example: squash watermelon melon

5. Number of days - This depends on the familiarity of the farmer for the type of plant.



How To Determine if the Seeds are Already Mature

After-ripening

Some seeds improve their germination if they are allowed to stay inside the fruit for several weeks.
Example: squash bottle gourd sponge gourd

Seed Extraction/Cleaning

The extraction of seeds from the fruit depends on the condition of the fruit and seeds that will be harvested:

1. Wet seeds from fleshy fruits -The fruit and the seeds are both wet. Usually, the flesh is attached firmly to the seeds. Seeds are extracted using the hands or a knife. The fermentation process is sometimes done to remove the seeds. Soak the fruit in water for one to two days. After soaking, separate the seeds from the flesh, and throw away the flesh together with the seeds that float (except when the seeds naturally float). Sunken seeds are then washed and dried.

Example; eggplant, cucumber, tomato, bitter gourd, squash, sponge gourd, bottle gourd

2. Dry seeds - These are obtained or extracted from a dried fruit or pod. These are extracted by hand or pounded collectively while inside a sack or net bag. Pounding the seeds inside the bag is necessary to prevent them from scattering.

Example: cabbage, cauliflower, mustard, pechay. lettuce, pea, lima bean, cowpea, hyacinth bean, yardlong bean, pigeon pea, munghean, onion

If possible, do not harvest these seeds when it is raining or in early morning when there is still dew. Also, do not harvest at midday since the pods will break or shatter, allowing the seeds to come in contact with the soil and with microorganisms that lower seed quality.

3. Dry seeds from fleshy fruits -The ripe fruit is dried before extracting the seeds.

Example: chili, ladyfinger

For all kinds of seeds, winnowing or removal of contaminants after drying and before storage is recommended to maintain good quality. Contaminants include weed seeds, seeds of other crops or of different variety of the crop, chaff, dust and other inert materials like rocks, dirt, twigs and leaves.

Seed Extraction/Cleaning

Seed drying

It is necessary to dry moist seeds before processing and storing. Seeds with high moisture content are more susceptible to physical damage during processing. This reduces viability and encourages the formation of molds.

In addition, the germination of moist seeds that are stored can be severely reduced. In this condition, the respiration of the seeds and of the microorganisms present in and on the seeds may produce enough heat to kill the seed. Excess moisture favors infestation of insect pests. It also increases the respiration of the seeds, consuming the stored food of the seeds and resulting in weak seedlings. Seeds which are not welldried have high respiration rates, causing them to rot. Usually, the moisture content of seeds after harvesting is high, especially when they are cleaned by washing.

If the air is humid, dry seeds absorb the water from air. If the air is dry, it absorbs water from wet seeds. This is why air-drying can dry wet seeds. This is also the reason seeds are stored in air-tight containers after they have been properly dried.

Things to Remember in Drying Seeds

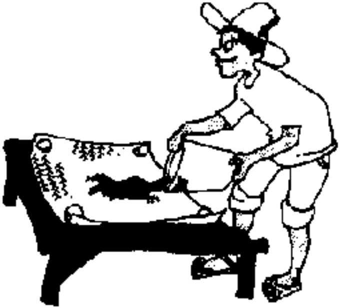
1. Do not allow the seeds to come in contact with the soil or ground. This will prevent the seeds from getting in contact with soil microorganisms that will lower the quality of the seeds. Use a wedge so that the seeds can be dried above the ground.

2. Use a drying material with holes (example: sack, winnowing basket, mat) to allow air to pass through, giving fast, even drying.

Do not allow the seeds to come in contact with the soil or ground

3. Do not dry the seeds rapidly because it will lower seed germination. Rapid drying can also harden the seed coat, making the seed impermeable to water when planted. If the initial moisture content of the seeds is high, air-dry the seeds in a shady area for

one to two days before sun-drying. Do not dry seeds under the sun from 11:00 a.m. to 2 p.m. when the heat of the sun is intense because it will kill the seeds.



Do not dry the seeds rapidly

4. Spread the seeds thinly and stir and turn them occasionally (at least 4 to 5 times a day) to make drying fast and even.

5. Before it rains or gets dark, cover the seeds and take them

indoors to prevent their moisture content from increasing.

How to Determine if Seeds are Well-dried

1. Seeds that were harvested dry have enough moisture content when they are dried under the sun for 2-3 days. If seeds were harvested wet or were washed before drying, 3-5 days sun-drying is enough after they have been air-dried for 1-2 days.

2. Seeds have distinct sounds when their moisture content is already low enough for storage.

a. Large, thin seeds will break with a "snapping" sound when twisted between the fingers.

Example: squash, bottle gourd

Will break with a "snapping" sound

b. Large, thick seeds will break with a "cracking" sound when bitten between the front teeth. Do not do this for very hard seeds because it might damage your teeth. Also, avoid this if the source of the seeds is unknown since they might have been applied with chemicals.

Example: ladyfinger, cowpea

c. Small seeds will break with a "cracking" sound when squeezed between the fingernails.

Example: mustard, pechay, amaranth

3. Seeds 'have a distinct tinkle when they are well-dried.

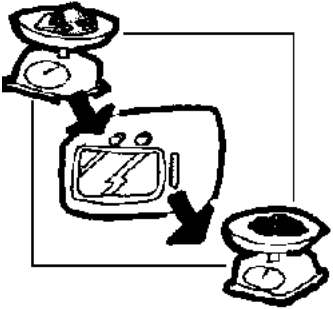
4. If possible, use an oven which can reach a temperature of 100°C or higher. Weigh the seed sample before placing it inside the oven. Weigh the seeds again after drying for 17-20 hours inside the oven. The lost weight indicates how much water was lost after the seeds have been dried. From these, the percent moisture content of the seeds can be computed. The seeds are dried enough for storage when they reach a moisture content of or less than 10%.

Example: Before oven drying - weight of seeds is 10 grams After oven drying - weight of seeds is 9 grams

Lost water 1 gram

% Moisture Content of the Seeds = 1 / 10 × 100= 10%

However, it is not easy to obtain an oven to determine the moisture content of the seeds so the practical methods above are recommended.



How to Determine if Seeds are Well-dried

Seed storage

The length of time that seeds can be stored depends on: (1) the seed type; (2) its quality; and, (3) the storage conditions.

Factors that Affect the Longevity of Seeds During Storage:

1. Moisture Content of the Seed - Even if seeds are thoroughly dried, improper storage can still enable them to absorb water. To avoid damage caused by excessive moisture content, (1) store seeds in air-tight containers (bottle with tightly closed metal cover, tin can, sealed thick plastic); (2) keep seeds dry by including desiccants or materials that absorb moisture (example: dry charcoal, dry ash, toasted white rice, lime, silica gel) inside the storage container, and, (3) replace desiccants, such as dry charcoal, dry ash and toasted white rice, each time the container is opened. The moisture content of the seeds can also be kept low if the seeds are sun-dried from time to time.

2. Temperature - The life of vegetable seeds during storage is prolonged when the storage temperature is low or cold (but not

freezing). If a refrigerator or airconditioner is not available, choose a cold place (example: near the river, under trees, underground, inside a clay jar). Ensure that the seeds will not get wet.

As a general rule:

The life of seeds doubles when the moisture content is lowered by 1% or when the storage temperature is lowered by 5°C.

Example:

> If the storage life of a seed with 14% moisture content is two years, its storage life can be prolonged to four years if the moisture content of the seed is lowered to 13%.
>
> If the expected life of a seed is three years in a storage room with a temperature of 15°C, its life can be prolonged to six years if the storage temperature is lowered to 10°C.
>
> If both the moisture content of the seed and storage

temperature are lowered, the increase in the life of the seed is greater.

Example

Condition Result

Moisture Content	Temperature	Storage Life	% Germination
13%	30°C	½ year	50%
12%	30°C	1 year	50%
13%	25°C	1 year	50%
12%	25°C	2 years	50%
11%	25°C	4 years	50%
10%	30°C	4 years	50%

3. Pests - Storage weevils, fungi and bacteria shorten the life of seeds during storage. Storage weevils begin to multiply when the moisture content is 10%. Fungi infestation becomes a problem

when the moisture content is 13%. Bacteria become a problem when the moisture content is above 20%. To prevent pest infestation, choose only pest-free seeds during storage. Pest problems can also be prevented if the seeds are maintained dry. Materials that prevent or stop the growth and multiplication of pests can also be used. These are:

a. Dry ash and charcoal - They absorb water inside the storage container. Ash prevents the growth and increase of weevils. Use one-half kilo of ash for every one kilo of seed. Use ash which has been cooled for at least 12 hours to prevent the seeds from burning.

b. Sand - Mix the sand with the seeds and make sure that the storage container is full so that the weevils cannot move around.

c. Cooking Oil - Some seeds can be mixed with cooking oil to prevent increase of weevil. The recommended rate is one teaspoon oil for every one kilo of seeds.

d. Lime - In addition to absorbing moisture, lime can also prevent an increase in the number of weevils. Mix 15 teaspoons (about 50 grams) of lime for every kilo of seeds.

e. Dried and powdered leaves or seeds of different aromatic plants - Weevils are sensitive to odorous plants which prevent their multiplication and cause their death The effect of the plants depends on their preparation, the amount applied and the type of seed and weevils. Some of these plants can affect the seed so it is important to test what is appropriate for a certain kind of seed. Also, make sure that the right amount is applied.

Examples of Aromatic Plants

Neem - Dry the leaves or seeds under the sun and grind them to a powder. Mix 3-4 teaspoons (15-20 grams) of powdered seeds (double the amount if powdered leaves are used) for every one kilo of seeds.

Hot pepper or chili - Dried and powdered fruits are better than dried whole fruits. Mix 46 teaspoons (20-30 grams) of dried and powdered chili for every one kilo of seeds.

Black pepper - Mix 6 teaspoons (30 grams) of powdered black pepper (double the amount if powdered leaves are used) for every kilo of seeds.

Other plants which can be tried:

Powdered rhizome of turmeric - Mix 4 teaspoons (20 grams) for every kilo of seeds.

Powdered leaves of mint - Mix 14 teaspoons (5-20 grams) for every kilo of seeds.

Powdered seeds of yambean -Mix 1-2 teaspoons (5-10 grams) for every kilo of seeds.

Powdered leaves of lagundi, mango and tobacco - Mix 14 teaspoons (5-20 grams) for every kilo of seeds.

4. Other factors - The storage life of seeds can become shorter if the seeds are overmature, if they came from plants that have been attacked by pests and diseases or if the seeds were damaged during seed processing.

Labeling

Place labels inside and outside the storage container, especially when lots of different types of seeds will be stored. The following should be included in the label: (1) name of seed; (2) date harvested; (3) date stored; (4) date germination test was conducted; and, (5) percentage germination. If necessary, the characteristics of the plant and the seed should also be included.

Testing seed quality

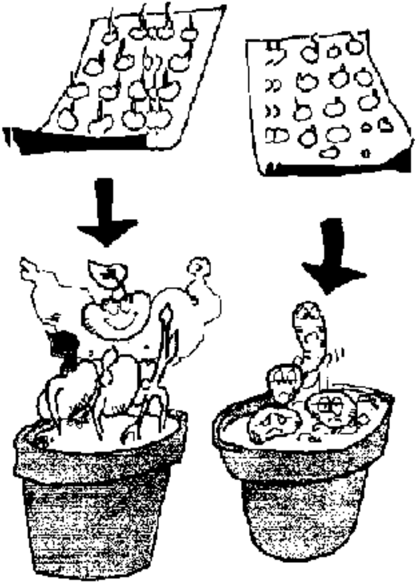
Seed quality should be determined when buying seeds, selling seeds, giving or sharing seeds, storing seeds and sowing or planting seeds.

A. Seed Vigor

The strength or vigor of seeds, especially after exposing these to conditions of the storage room and planting area, needs to be determined. Weak seeds planted in poor field conditions will die, or the resulting plants will be susceptible to pests and diseases. Yields will, therefore, be low. Weak seeds will also not survive long during storage. In addition, even if a number of seeds have germinated, their rate or timing of germination and growth will be slow and not uniform. Determine seed vigor at the same time as measuring the percentage germination, in which seed vigor is the speed and uniformity of germination of the seeds. Compare the number, speed and uniformity of germination of the seeds being tested to those of good quality seeds.

Seed vigor can also be determined by soaking the seeds in water.

Usually, the seeds which float are weak.



Seed Vigor

B. Seed Health

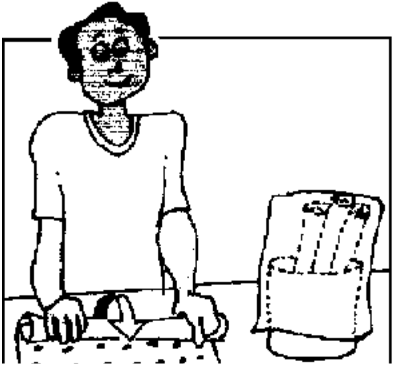
Healthy seeds are free of pests and diseases which can kill or damage. They will not infect other plants and spread a disease. If a microscope is not available, examine the seeds carefully. Look for blemishes or stains in the seedcoat, molds, holes caused by insects or eggs of insects. These seeds might cause an epidemic or will introduce a new pest or disease and are, therefore, unfit for planting. Clean the seeds and remove diseased or infected seeds.

Sometimes, a disease can be seen only after the seeds have been planted. Check if germinating seeds have fungi or bacteria (symptoms of infection: seeds are watery, shiny and have bad smell). It will also be helpful to know the place and the plant where the seeds were collected, especially for purposes of determining seed-borne diseases.

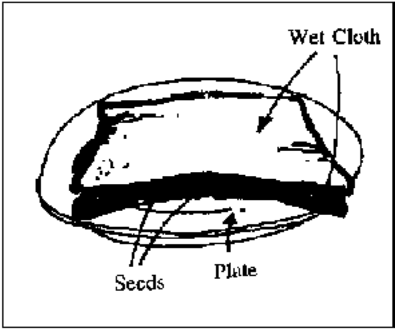
Many fungi and bacteria which can be killed by soaking the seeds in hot water (50°C) for 30 minutes. However, some pests and diseases cannot be killed by this method. Some tests on seed health are better conducted in the laboratory. If you think that your seeds have pests and diseases, have them tested in appropriate offices or agencies (example: Bureau of Plant Industry).

C. Seed Purity

Make sure the seeds you procure are the right ones or the ones as stated in the label. This can only be determined by knowing the characteristics of the seeds well. Also, determine whether there are contaminants in the seeds, such as dirt, stones, leaves or seeds of other plants, broken seeds and pests and diseases. The contaminants lower seed quality. If possible clean the seeds before storing or giving to others.



OR



Seed Purity

D Moisture Content of the Seeds

The standard moisture content is 14% for seeds that are not oily (like ladyfinger and pechay) and 12% for seeds that are oily (like soybean, peanut, yardlong bean and mungbean). High moisture content decreases the viability of seeds.

E. Percentage Germination

Obtaining percentage germination gives an idea on whether the seeds should still be stored, planted or thrown away. This will also indicate the number of seeds to be planted to get the desired number of plants. You need a material which can absorb water. For large seeds, use river sand or clean soil (usually boiling water is poured on the soil before using to kill germs) as a germination medium. For small seeds, paper (example: filter paper, tissue paper) or cloth (example: cheese cloth) can be used as a germination medium. Arrange the seeds (not dose together) in the germination medium and roll the medium like a mat, or cover with another layer of the medium. Water the seeds, but do not flood them. Place the medium with the seeds in a box or plastic bag which allows air to penetrate, or stand it in a container with enough water to be absorbed upwards. Do not place the medium in the sun or where it can be reached by rats or ants.

After several days, count the number of normal seedlings (the ones which have the ability to continue growing normally and those which have normal leaves and roots).

Calculate the percentage germination.

$$\%\ \text{germination} = \frac{\text{number of normal seedlings}}{\text{total number of seed germinated}} \times 100$$

Example:

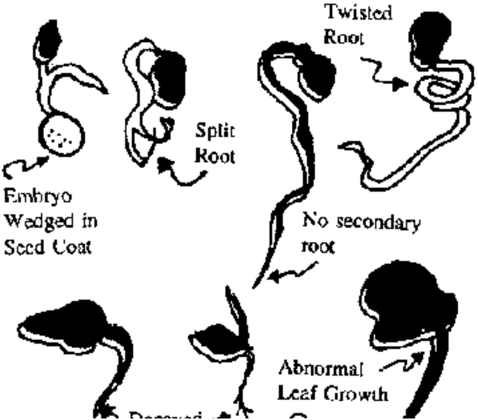
$$\%\ \text{germination} = = \frac{80\ \text{(number of normal seedlings)}}{100\ \text{(total number of seeds germinated)}} \times 100 = 80$$

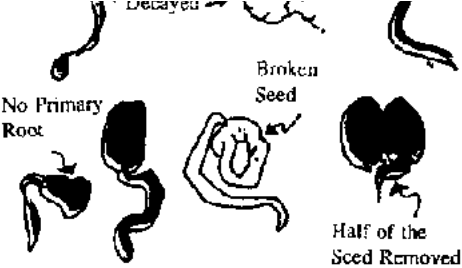
The more seeds tested for percentage germination, the more accurate the percentage germination will be. If possible, replicate testing and use 50 or more seeds. You can then find the number of seeds to plant:

$$\text{number seeds to be planted} = \frac{\text{desired number of plants}}{\text{\% germination}}$$

Example:

$$\text{number of seeds to be planted} = \frac{\text{160 (desired number of plants)}}{\text{80\% (percentage germination)}} = 200$$





Abnormal Seeds

Do not store or plant seeds if their percentage germination is lower than 50%. These seeds will usually produce weak seedlings and will deteriorate rapidly, if stored.

There are instances when seeds do not germinate at once, not because they are dead, but because they are dormant or fail to absorb water (example: mungbean, winged bean). In addition, some temperate seeds (example: pechay, carrot, cabbage) absorb water but do not readily germinate, especially when they are new or fresh. Hard-coated seeds need methods that will open the seedcoat (example: rubbing in sandpaper, use of nailcutter or chipping with a knife). Take extra care in preventing embryo damage. You can also soak the seeds in hot water for 3-10 minutes (l part seed for every 10 parts water) or in boiling water for 1-10 seconds. The duration of soaking depends on the type of seed and the age of the seed. Seeds which are old, hard and easily absorb water should be soaked for a shorter length of time compared to seeds which are young, soft and do not easily absorb water. Seeds usually grown in cold areas can be placed in the cold for several days while In the germination medium before transferring them to a planting area.

References:

Chapman, S. and L. Carter. 1976. Crop Production - Principles and Practices. W.H. Freeman and Co., USA: 566 p.

Cleveland, D. and D. Soleri. 1991. Food from Dryland Gardens: An

Ecological, Nutritional and Social Approach to Small-scale Household Food Production. USA: pp. 285 - 306.

Fernandez, P., E. Masilungan, E. Corcolon, B. Garcia, M. Petalcorin, C. Ramirez and M. Tolentino. 1992. Pagpaparami at Pangangalaga ng Binhi. Philippines. 33 p.

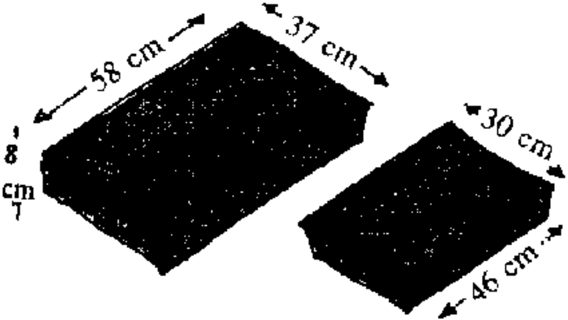
Janick, J. 1963. Horticultural Science. 2nd Edition. W.H. Freeman and Co., USA. 586 p.

McCollum, W. 1968. Producing Vegetable Crops. The Interstate Printers and Publishers, Inc., USA: 588 p.

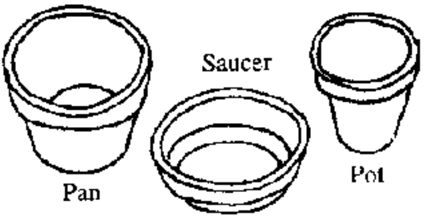
Nursery techniques for seedlings

Direct seeding is the most common method of sowing vegetable seeds. However, some vegetable seeds perform better if they are sown in containers or seedbeds initially and are later transplanted. Here are some basic steps in starting plants by this method:

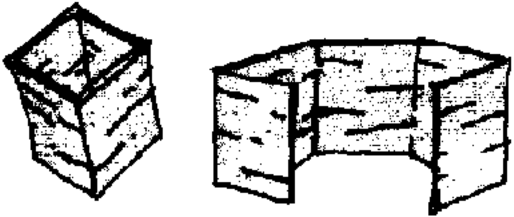
1. Select suitable container. Planting in a seedbed is cheaper than using a container. However, using a container allows the gardener to choose the right medium for growing the seedlings. Any container deep enough to allow seedlings to root and wide enough to prevent their becoming cramped will do. Containers may be:



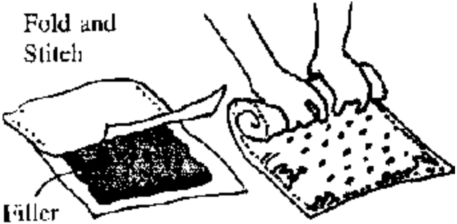
Seed flats



Clay seed-pans

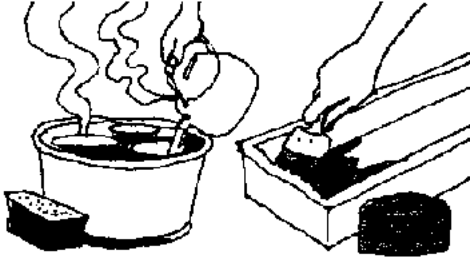


Plant bands/paper box

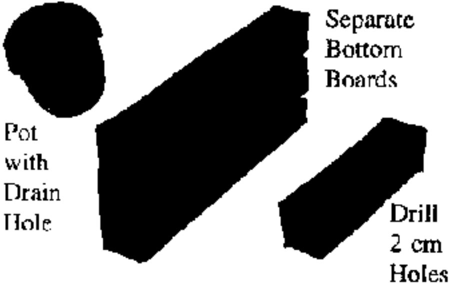


Rag doll

2. Prepare container for planting. Containers should be cleaned properly to ensure they harbor no fungus spores or insect pests. Adequate drainage should also be provided to avoid damping-off (soil-borne disease that destroys seedlings).

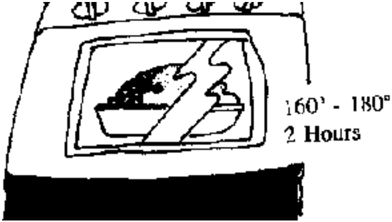


Cleaning containers



Providing drainage

3. Prepare the soil medium. The soil medium should be free of weed seeds, fungus spores and garden pests. It should be sufficiently porous to allow the delicate rootless to penetrate and to admit air and moisture. Usually, a mixture of equal parts of sand, soil and compost is recommended, though a modified mixture can be made to produce a soil mixture that is more favorable for the growth of seedlings.

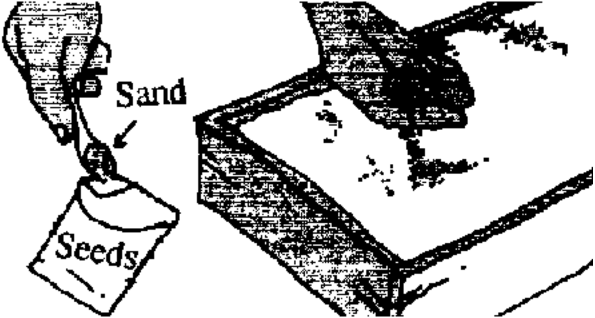


Sterilizing soil

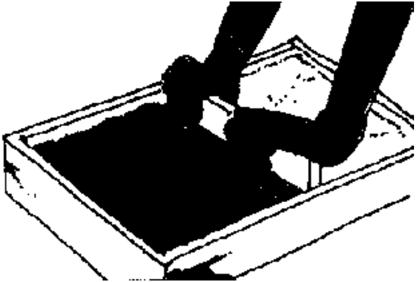
Filling flat or pan

Watering

4. Sow the seeds. The manner in which seeds are placed in the soil depends largely on their size.



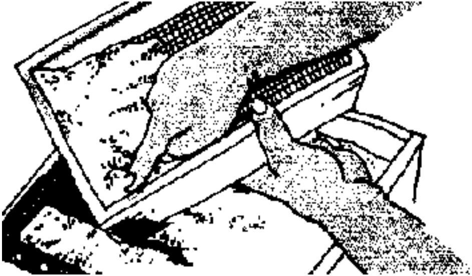
Fine seeds are usually broadcast together with sand.



Medium-sized seeds are often sown in drills.

Large seeds can be poked in slightly with a finger.

5. Cover the seeds. Cover the seeds by sifting soil medium through a fine sieve held above the seed bed. Large seeds are covered to a depth equal to twice their width.



Cover the seeds

Fine seeds are not covered but are merely pressed gently into the soil with a flat, level piece of wood.

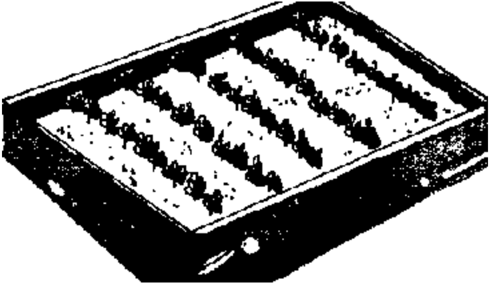
Fine seeds are not covered

6. Care for Germinating Seeds. Seedlings should be protected from temperature fluctuations. Enough moisture and air circulation must be provided.

Dry soil can stop germination, but overwatering can encourage damping off. When watering is necessary, soak by immersion if possible.

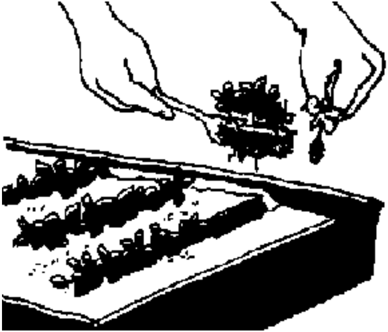
It is advisable to set the seedbox in the open. If it is covered or is indoors, the seedlings may suffer from lack of moving air.

The seedlings should continue to get some protection until the first true leaves emerge. When one or two sets of true leaves become visible, the seedlings are ready for transplanting.



The seedlings should continue to get some protection

7. Pricking/thinning is the process of transplanting seedlings from the seedbox to another seedbox. This step gives the seedlings a chance to start development of root and leaf systems before the plants are left to fend for themselves in the garden. Seedlings should be pricked out as soon as they have two sets of leaves



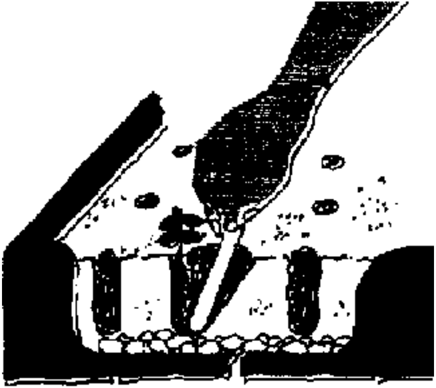
Pricking/thinning is the process of transplanting seedlings

Use a sharp tool to help remove the plants so as not to injure them.

If seedlings come up with their roots entangled, they can be separated by soaking the root ball in water.

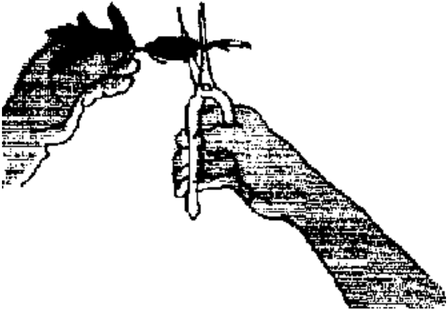
If seedlings come up with their roots entangled

Transplant the Seedlings. Punch holes in the seedbed with a dibble at two inches apart. Working quickly, insert the roots of the individual seedlings in the holes and firm them in with either the dibble or with forefinger and middle finger.



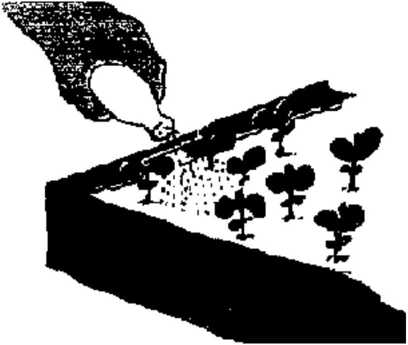
Transplant the Seedlings

If roots of a seedling are lengthy, they should be cut with shears or sharp knife.



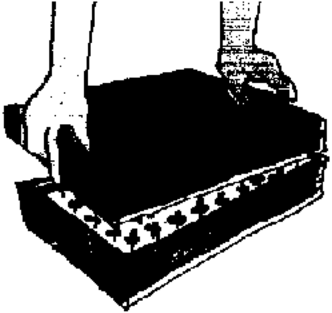
They should be cut

When the seedbox is filled, it should be watered with a fine spray from a hand syringe to settle the soil around the roots and to freshen wilted stems and leaves.



Should be watered with a fine spray

If plants are particularly soft and subject to wilting, cover the box with a sheet of newspaper or another box fumed upside down.



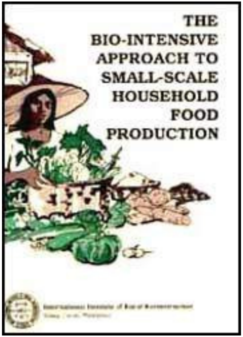
Cover the box with a sheet of newspaper

In about four or five weeks, the young plants will be ready to go out into the open ground. A week before transplanting, the plants should be hardened by gradually increasing exposure to sun and air. Before finally setting in the garden, the plants should be given several days of full sunlight; and if they are going into a sunny position, watering is also held back gradually before transplanting..

Reference:

Sunset Western Garden Book. 1959. Lane Publishing Co., Menlo Park, California, USA. 384 pp.

Home"" """"> ar.cn.de.en.es.fr.id.it.ph.po.ru.sw



Bio-intensive Approach to Small-scale Household Food Production (IIRR, 1993, 180 p.)

Crop management

Crop planning

Crop planning considers what, when, where and which plants to grow in relation to their requirements for space, sunshine, water, maturation, season of planting and tolerance for each other.

For a garden to give the maximum yield for the family, it should be kept planted all the time. Good planning is necessary.

Important Considerations in Crop Planning

1. Diversification

Grow different kinds of vegetables, trees and other plants in one area. Each plot must contain at least one of each of the following crop categories: leafy, legume, tuberous and fruitbearing vegetables. In this way, the nutritional needs of the family are being met. By growing a diversity of vegetables of different durations, the family is assured of the availability of vegetables throughout the year. This practice is also one way of checking pest outbreaks and certain intercrops serve the additional purpose of being insect repellents.

Rotation of Each Crop Within Each Bed

Bed	Planting season			
Subdivision	First	Second	Third	Fourth
1	Leaf	Fruit	Root	Legume
2	Fruit	Leaf	Legume	Root
3	Root	Legume	Leaf	Fruit
4	Legume	Root	Fruit	Leaf

2. Crop Rotation

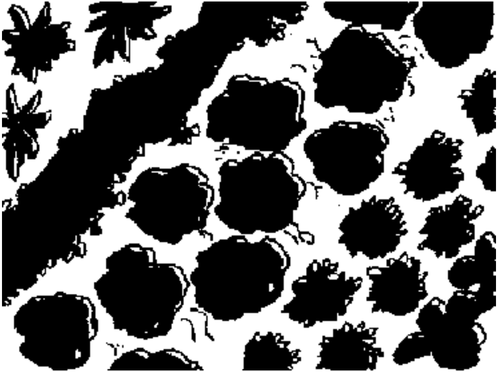
Different plants have varying' rooting depths and so extract nutrients and moisture from different points of the soil profile. The cultivation of different plants in the same part of the bed from season to season does not overburden the soil. Also, each kind of plant takes away something from the soil, but also gives something back. By rotating the plants from one part of the bed to another, the land is allowed to rest from one kind of plant and the soil gets richer from the other plant that was put in its place. Crop rotation enables the land to "rest" without keeping it idle. Follow heavy feeders with heavy givers and then light feeders.

3. Intensive Planting

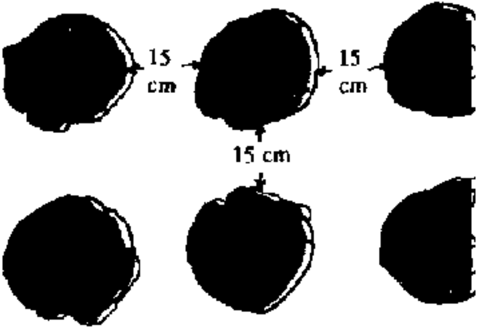
Use every bit of the area as many months of the year as possible. Close spacing is recommended to prevent the growth of weeds and reduce the direct exposure of the soil to sunlight, thereby reducing moisture evaporation as the plant canopy serves as "living mulch." Space plants closely, seeing to it that each plant has enough sunshine and space to grow. Plants are correctly spaced when the leaves of the fully grown plants barely overlap with the adjacent ones. This achieves maximum use of space and higher yields per unit area, when compared with conventional gardening. Plant in a triangular fashion. The seeds or seedlings are planted at each end of an imaginary triangle, with the sides of the triangle being equal to the recommended spacing. This portion allows more plants to be grown within a small area than the usual method of square or row planting.

Two Methods of Planting

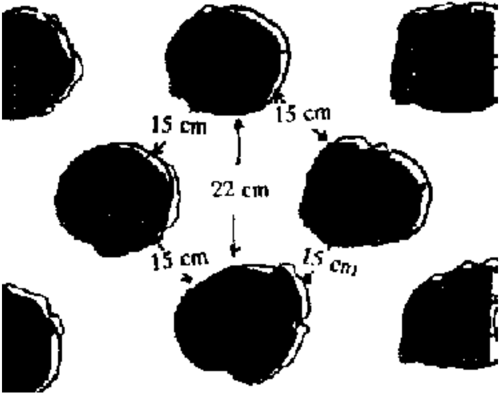
Row planting has more soil space exposed to sunlight which leads to rapid evaporation of soil moisture.



Thick canopy of plants reduces moisture evaporation and prevents weed growth.



Square planting

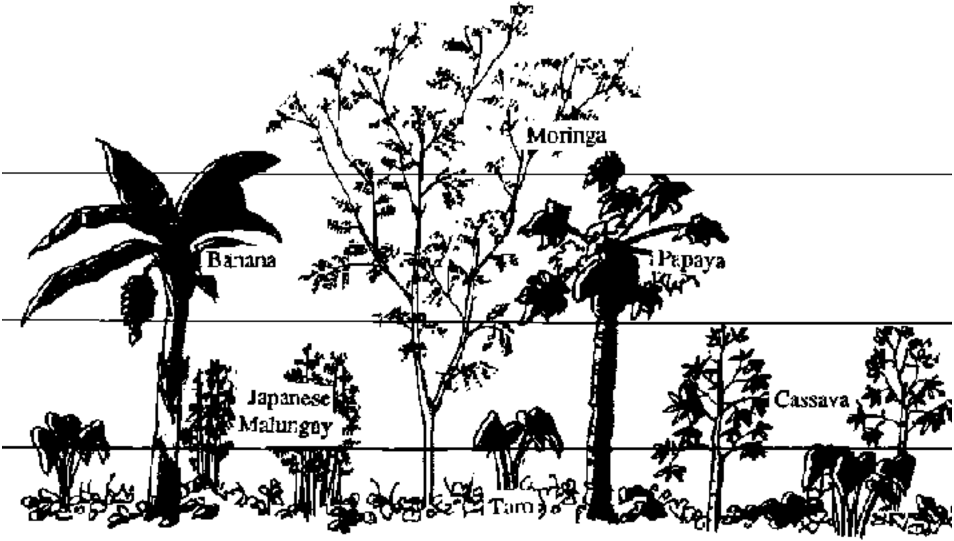


Triangular planting

Triangular method of planting gives more plants per unit area.

Using the fenceline for planting annual and perennial crops

Trees, shrubs and other crops must be planted in such a way that a multistoried cropping pattern is achieved. This way, various crops can-be grown in a limited space without competing with each other. Weed growth is also controlled through shading by the upper canopy level and by crawling vines.



Using the fenceline for planting annual and perennial crops

Upper canopy species (A) - form a protective canopy against tropical sun and torrential rains.

Middle canopy species (B) - feature staple and fruit production including trailing plants which can be allowed to climb the trees.

Lower canopy species (C) - bush-level growth which can be grown to form a double layer of protection against stray animals.

Understory crops and - shade-tolerant crops and crawling vines can be planted to further
creepers (D) cover the soil.

Purpose of Live Fence

1. protection against stray animals
2. windbreak
3. green manure
4. food
5. fuelwood
6. fodder

How to Make a Fenceline

1. Dig a trench 1 ½ ft. wide and 1 ½ ft. deep along the fence.
2. Mix the dug out soil with wood ash and compost and return the mixture into the trench.
3. Plant the seeds or cuttings.

Examples of Plants that Can Be Used in a Fence:

A. Upper Canopy Species
Moringa oleifera (horseradish tree)
Sesbania grandiflora (katuray)
Gliricidia septum (kakawate)
Averrhoa bilimbi (kamyas)
Psidium guajava (guava)
Persia americana (avocado)
Artocarpus altilis (breadfruit)
Artocarpus heterophyllus (jackfruit)
Annona muricata (soursop)

Annona squamosa (sugar apple)
Calliandra calothyrsus (calliandra)

B. Middle Canopy Species
Carica papaya (papaya)
Musa spp. (banana)
Citrus mitts (calamansi)
Flemingia macrophylla (flemingia)
Desmodium rensonii (rensonii)

Climbers
Psophocarpus tetragonolobus (winged bean)
Dioscorea alata (greater yam)
Dioscorea esculenta (lesser yam)
Pachyrrhizus erosus (yam bean)

C. Lower Canopy Species
Sauropus androgynus (Japanese malungay)
Corchorus olitorius (jute)

Capsicum frutescens (chili)
Manihot esculenta (cassava)
Cajanus cajan (pigeon pea)
Zea mays (corn)
Pandanus odoratissimus (pandan)
Maranta arundinacea (arrowroot)

D. Understory Crops and Creepers
Ananas comosus (pineapple)
Zingiber officinale (ginger)
Colocasia esculenta (taro)
Adropogon citratus (lemon grass)
Sesamum orientale (sesame)
Foeniculum vulgare (fennel)
Ipomoea batatas (sweet potato)
Ipomoea aquatica (swamp cabbage)
Basella alba (basella)

Reference:

Niez, V. 1984. Household Gardens and Small-scale Food Production. Food and Nutrition Bulletin 7(3): 1-5

Companion plant guide chart

"Companion" plants have complementary physical and chemical demands. They will grow well together. "Antagonistic" plants have a negative effect on one another. Avoid planting them close to each other.

Vegetable	Companion	Antagonist
Abelmoschus esculentus (ladyfinger)	sweet potato, swamp cabbage, squash, radish, pechay (Brassica chinensis)	
Allium cepa (onion)	lettuce, beets, tomato	peas, beans
Allium sativum (garlic)	carrot, lettuce, beets, tomato	peas, beans

Apium graveolens (celery)	cabbage family, tomato, bush bean	
Asparagus officinale (asparagus)	tomato	
Beta vulgaris (beets)	onion, garlic	pole beans
Brassicas (cabbage family)	potato, celery, beet, onion, garlic	pole beans
Colocasia esculenta (taro)	sweet potato, swamp cabbage	
Cucumis sativus (cucumber)	corn, pole beans, ladyfinger, cowpea, radish, eggplant	potatoes
Cucurbita	bottle gourd, sponge gourd, bitter	

Cucurbita maxima (squash)	bottle gourd, sponge gourd, bitter gourd, cucumber	
Ipomoea aquatica (swamp cabbage)	taro, sweet potato, cassava (Manihot esculenta), tomato, ladyfinger, corn, eggplant, amaranth (Amaranthus gracilis)	
Ipomoea batatas (sweet potato) ladyfinger,	corn, cassava, eggplant, pigeon pea (Cajanus cajan)	
Lactuca sativa (lettuce)	carrots, radish, cucumber	
Lagenaria siceraria (bottle gourd)	sponge gourd, bitter gourd, cucumber	
Luffa cylindrica (sponge gourd)	bottle gourd,	

bitter gourd, cucumber		
Lycopersicon Iycopersicum	onion, lettuce, sweet potato,	potato, cabbage
(tomato)	radish, swamp cabbage,	
	squash, pechay, garlic, asparagus, carrots	
Momordica charantia	lima bean (Phaseolus lunatus),	
(bitter gourd)	hyacinth bean (Dolichos lablab),	
	winged bean (Psophocarpus tetragonolobus),	
	pole bean	
Phaseolus aureus (mungbean)	corn, sorghum (Andropogon sorghum)	
Phaseolus	corn, carrot, cucumber, potato,	onion,

vulgaris (snap bean)		garlic
	cabbage family	
Raphanus sativus (radish)	beans, cucumber, lettuce	
Solanum melongena (eggplant)	beans, lettuce,	
sweet potato,		
	swamp cabbage, squash, pechay,	
	radish, pepper (Capsicum annuum)	
Solanum tuberosum (potato)	garlic, beans, corn, cabbage	cucumber, tomato
Vigna sesquipedalis	corn	onion, beet

(pole bean)		
Vigna sinensis (bush bean)	potato, cucumber, corn, celery	onion

Vegetables that can be harvested in less than a month

Scientific Name	Common Names	No. of Days from Planting to
Harvesting		
Brassica juncea	mustard	25
Brassica chinensis	pechay	25
Raphanus sativus	radish	20-25
Basella alba	basella	25
Amaranthus gracilis	amaranth	25-30
Ipomoea batatas	sweet potato	20

Ipomoea aquatica	swamp cabbage	20
Coriandrum sativum	coriander	15
Cucumis sativus	cucumber	30
Lactuca sativa	leaf lettuce	25
Portulaca oleracea	purslane	25
Talinum triangulare	Philippine spinach	25

Shade-tolerant vegetables

As plants are fitted together according to their various above-ground growth patterns, one should be aware of the plants' light and shade requirements so that they can benefit from the shade-light patterns and grow with minimum competition for light. Vegetables that grow best in the shade should be planted underneath larger ones.

Scientific Name	Common Name	Light Requirements
Zingiber officinale	ginger	requires about 50% shade
Colocasia esculenta	taro	tolerates up to 50% shade
Basella alba	basella	requires partial shade
Apium graveolens	celery	requires partial shade
Cucumis sativus	cucumber	requires partial shade
Lactuca sativa	lettuce	requires light shade
Brassica oleracea var. capitata	cabbage	requires light shade
Talinurn triangulare	Philippine spinach	tolerates light shade
Daucus carota	carrot	tolerates light shade
Solanum tuberosum	Irish potato	tolerates light shade

Drought-resistant vegetables

Scientific Name	Common Name	Degree of Resistance
Voandzeia subterranea	Bambara groundnut	highly drought-resistant
Tylosema esculentum	Marama bean	highly drought-resistant
Arachis hypogaea	peanut	highly drought-resistant
Vigna sesquipedalis	yardlong bean	highly drought-resistant
Cajanus cajan	pigeon pea	highly drought- and heat resistant once established
Abelmoschus esculentus	ladyfinger	fairly drought-resistant
Vigna	moth bean	most drought- tolerant crop grown

Vigna aconitifolia	moth bean	most drought- tolerant crop grown in India
Sorghum bicolor	sorghum	highly drought-resistant
Vigna sinensis	cowpea	drought- and heat-toleran
Solanun melongena	eggplant	drought-tolerant
Manihot esculenta	cassava	drought-tolerant once established
Dolichos lablab	lablab bean	drought-tolerant once established
Phaseolus lunatus	lima bean	drought-tolerant once established
Ipomoea batatas	sweet potato	fairly drought-tolerant
Amaranthus gracilis	amaranth	fairly drought-tolerant
Phaseolus aureus	mungbean	fairly drought-tolerant

Solarization: A weed control technique using sunlight

Solarization is a technique for killing weeds in a garden plot using the sun's heat. A clear plastic sheet is used to cover the garden plots and is then exposed to the heating rays of the sun for 10 - 15 days. This technique is used before the crops are planted and only when weeds are a serious problem and in the first year of starting a garden. Subsequently, garden practices such as yearround cultivation, crop rotation and intercropping should control weeds.

How to solarize:

1. Dig the garden bed to a depth of 20 - 30 cm, pulverize and level.

2. Water the surface to a depth of 15 - 20 cm.

3. Cover the entire surface of the garden with clear plastic (polyethylene).

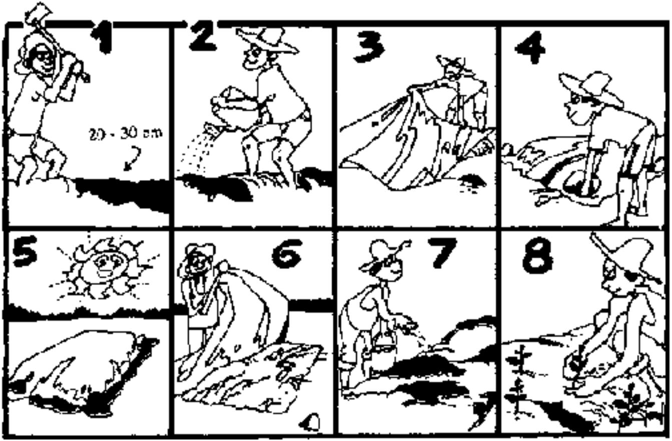
4. Seal all sides by covering the edges of the plastic with soil or pieces of lumber/wood.

5. Keep the plastic in place for 10-15 days. During this period, the weed seeds will germinate and, through the intense heat of the sun, will gradually be killed.

6. Remove the plastic cover.

7. Apply compost and other soil supplements and incorporate into the soil to a depth of 10 15 cm.

8. Level the garden bed and plant.



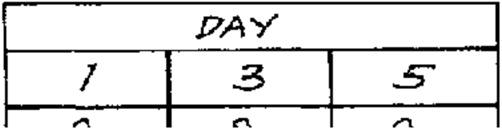
How to solarize

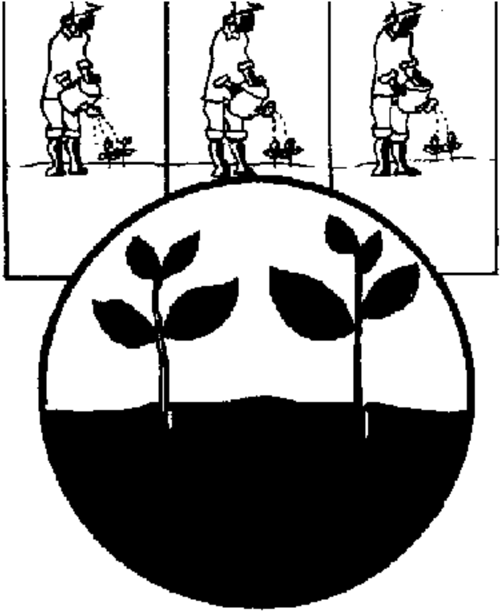
* Water buffalo, cow and horse manures, if applied directly (even in dried form). can result in increased weed growth due to the presence of weed seeds in the excreta. If such uncomposted manure is used, it should be incorporated into

the soil before the plastic cover is placed onto the bed. Weed seeds are not generally found in pig and Poultry manures.

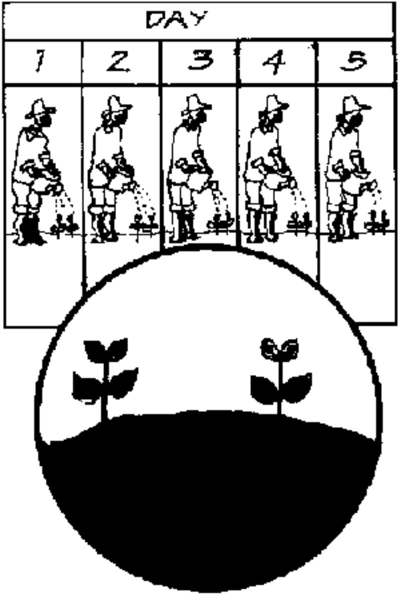
Watering

One of the most critical factors for successful gardening is water. Poor watering practices can stunt plant growth and can even be fatal to plants. As a rule, plants should be watered thoroughly but infrequently. Thorough watering dampens the soil. This allows the water to move down through the soil by progressively satisfying the waterholding capacity of every soil particle. Likewise, well-sequenced watering allows the water to sink slowly and the soil surface to dry up. These conditions encourage the development of a deep root system.





Well Sequenced Watering



Too Frequent Watering

Plants are deep-rooted and can withstand drought periods because they rely on subsoil water.

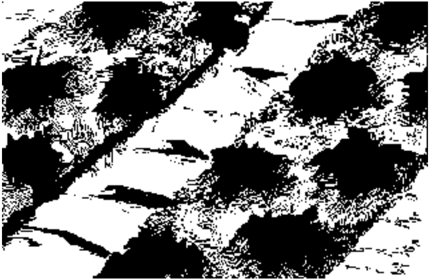
Plants are shallow-rooted and suffer with even a slight reduction in moisture availability; plants become dependent on applied water.

> Note: This does not apply to young plants (i.e., less than 40 days old), which need daily watering in dry weather.

Mulching

Mulch is loose organic materials, such as straw, cut grass, leaves and the like used to cover the soil around the plants or between the rows for protection or improvement of the area covered. A mulch aids in maintaining a favorable condition of the soil underneath. The increased plant growth is due primarily to conditions resulting from the use of a given material rather than any growth promoting substances present in the mulch itself.

Since organic mulches are derived from plant materials, decomposition will occur and this has several positive effects on both the soil and the plants.



Mulching

Physical Effects

1. If mixed in the upper soil layer, the material dilutes the soil and usually increases root growth. Aeration and water-holding capacity are increased on clay and sandy soils, respectively.

2. During the decomposition of the organic material, soil microorganisms secrete a sticky material which promotes the granulation or clinging together of the soil.

3. Mulch improves and stabilizes soil structure or the arrangement of soil particles. It serves as a cushion, reducing soil compaction caused by pelting rain, coarse streams or drops of water from irrigation devices.

Chemical Effects

1. Most organic materials will raise the soil pH slighty, making it more alkaline. This can be remedied by mixing acid-forming or organic matter like sawdust and moss peat with the soil.

2. In two or three months, mulch rots and small amounts of fertilizer become available to the plants.

3. Nitrogen deficiency may become apparent with mulched plants because an appreciable amount of nitrogen is taken from the soil by

the microorganisms decomposing the organic mulch. To avoid this, liquid fertilizer must be applied to the plant as nitrogen-supplement .

Biological Effects

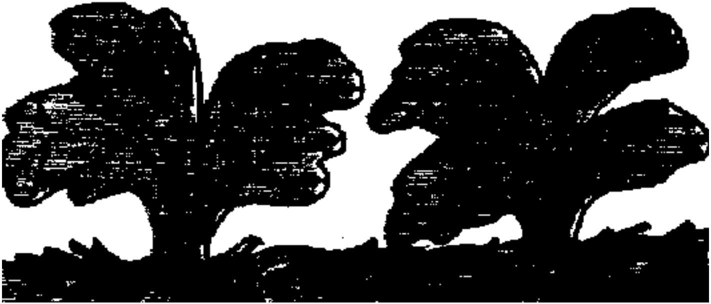
1. Organic mulch serves as food for many microorganisms found in the soil. It also helps keep the temperature more constant so microorganisms activity can proceed at a uniform rate.

2. Sometimes undesirable organisms like disease-causing fungi, bacteria and nematodes may be added to the soil with the application of organic plant materials. Stirring the mulch occasionally eliminates the mold. During rainy season, mulch should be applied only when the plants are at least a month old to deter pest attack.

3. Weed seeds may be introduced into the garden with hay or straw. This can be avoided by using only the middle portion of the plant as mulching material. The flowers and the roots must first be

composted.

Without mulch, weeds are growing in between plants.



Mulch prevents the growth of weed.

Mulching prevents soil compaction.

The role of organic mulches

Mulches have many beneficial effects upon the soil, plants and area surrounding the plants.

1. They conserve soil moisture by reducing evaporation of water from the soil.

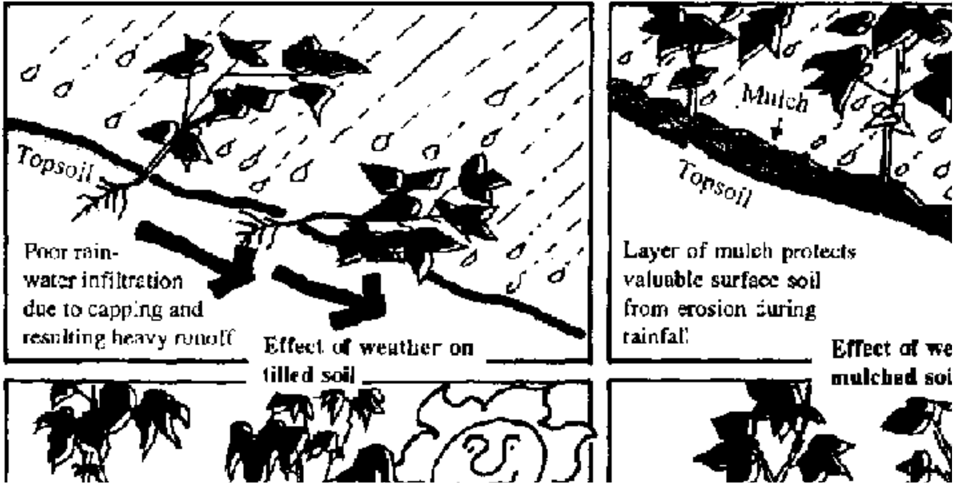
2. They prevent crusting of the soil surface, thus improving absorption and percolation of water to the soil areas where the roots are growing.

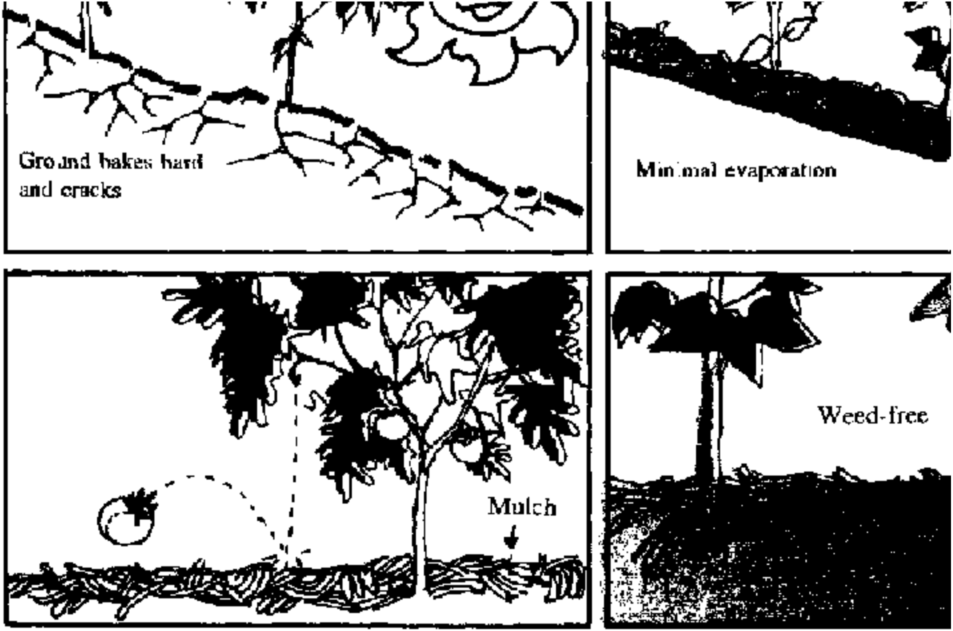
3. They maintain a more uniform soil temperature by acting as an insulator that keeps the soil warm during cool spells and cooler during the warm months of the year.

4. They prevent fruits and plants from becoming mud splashed and reduce losses from soil-borne diseases.

5. They reduce weed problems when the mulch material itself is

weed-free and is applied deep enough (at least 2.5-cm thick) to prevent weed seed germination or smother existing smaller weeds. Time and labor of weeding is reduced considerably when mulches are used properly.




Ground bakes hard
and cracks
Minimal evaporation
Mulch
Weed-free

Some tropical materials for use as mulch

	Nitrogen	Phosporus	Potash
Corn cobs	x	x	xxx
Corn silage	x	x	x
Corn stalks	x	x	x
Rice straw	xx	x	x
Rice bran	xx	x	x
Wheat straw	xx	x	x
Wheat bran	xx	x	x
Peanut shells	x	x	x
Egg shells	x	x	x
Feathers	xxx	x	x
Sugar by-products	x	xxx	x

Coffee grounds	x	x	x
Tea grounds	xx	x	x
Seaweed	xx	x	x
Fish bones	xx	xx	xx
Banana stalk	x	xx	xxx
Banana skins	x	xx	xxx
Banana leaves	x	xx	xxx
Tobacco leaves	xx	x	xx
Tobacco stalk	xx	x	xx

xxx - Good source
xx - Fair source
x - Poor source

References:

Brooks, W. M., J.D. Utzinger and H. R. Tayama. (Undated). Mulches

for the Home Grounds. Ohio State University.

Gardening in dry environments

Some of the problems associated with dry-land gardening are light saturation and excessive evaporation, which can lead to more serious problems like nutrient deficiency and soil alkalinity. These problems can greatly affect the growth and development of plants. But, gardening is still possible under such conditions if a special environment is created.

1. Deep digging. This improves soil structure, making it more porous. With more spaces in the soil, greater amounts of water can be stored for the use of the plants.

2. Addition of large amounts of organic matter into the soil. While nutrients can be present in dryland soils, they are usually chemically unavailable due to high soil pH. Organic matter is essential to create humus, which can make the elements become available to the plants. It also acts like a sponge, absorbing water

so that less evaporates.

3. Close spacing of plants. With all available spaces filled up with plants, there is less exposure of soil to direct sunlight; hence, less evaporation. Shading of the soil also keeps down weeds, another competitor for water.

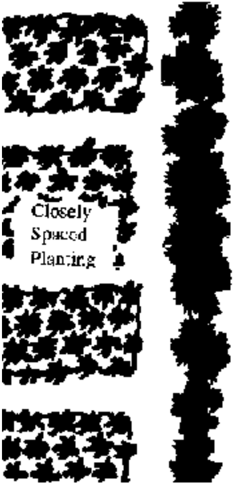
4. Provision of windbreaks. Growing trees around the garden helps to lower the temperature in the immediate vicinity of the garden and deflects dry winds. It, therefore, decreases water loss from the plant surfaces.

5. Clay pot technique. Water in a clay pot buried in the soil will diffuse slowly from the pot to the plants:

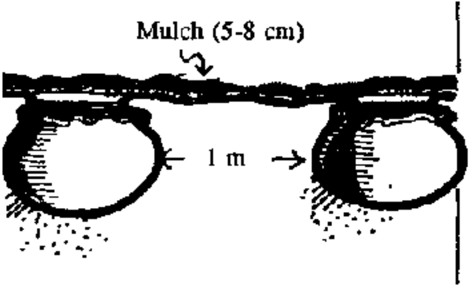
a. Sink unglazed, porous clay pots into the beds (with the opening just above the bed surface) one meter apart. Fill with water and cover to reduce direct evaporation.

b. Add a thin layer (0.5 cm) of straw or grass clippings as mulch.

c. When the plants are about three weeks old, add more mulch (5 - 8 cm).



Close spacing of plants



Clay pot technique

Water-saving ideas for gardens during dry season

Conserving water is especially important during dry months when water is limited. However, water conservation does not necessarily mean cutting down on water, rather, it means making the most of available water.

1. Water early in the morning. Watering in the morning allows greater absorption of water by the soil. Later in the day, the air is hot and dry and water evaporates from the soil surface faster.

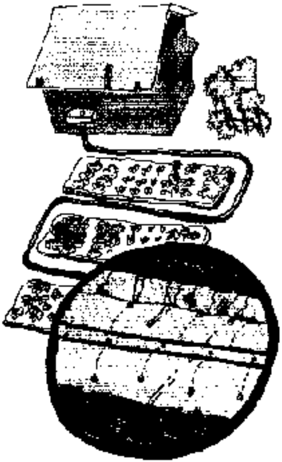
2. Water placement. The best method of watering is by trickle or drip irrigation with a perforated plastic hose placed adjacent to each crop row. This puts the water exactly where it is needed.

3. Mulch. Mulch helps retain moisture by reducing surface evaporation. It also prevents weed growth and builds up humus, improving the water-holding capacity of the soil.

4. Weed regularly. Undesirable plants should not be allowed to have a share of any available water.

5. Select adapted plants. Use plants with a low water need, a deep root system and which tolerate heat and drought. Cucurbits, beans and some grains are good examples of plants that can be grown with little water.

6. Recycle water. Any water from household uses (must be low in detergents and grease) can be saved and used in the garden.



Water-saving ideas for gardens during dry season

References:

Ameroso, L. (Undated). Plan Now to Conserve Water In Your Garden. Cornell Cooperative Extension, New York City Gardening Program.

Mollison, B. and R. M. Slay. 1991. Introduction to Permaculture. Tagari Publications, Australia. 198 pp.

Growing vegetables in saline areas

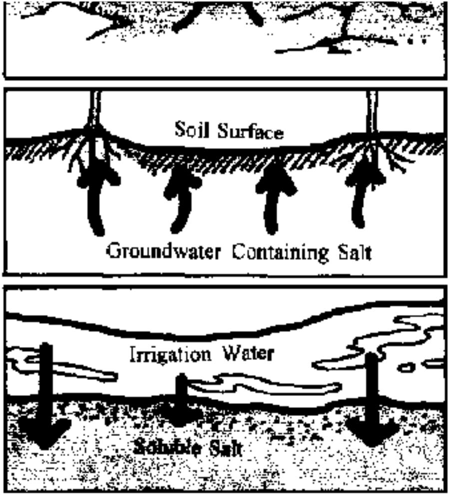
Saline soils are soils that have been harmed by excessive amounts of soluble salts - mainly sodium, calcium, magnesium, chloride and sulfate, as well as potassium, bicarbonate, carbonate, nitrate and boron. The abnormally high salt concentration of saline soils reduces the rate at which plants absorb water, consequently growth is retarded. Aside from growth retardation of plants, certain salt constituents, like boron, are specifically toxic to some crops.

What Causes Soil Salinity?

1. Lack of water. Salt-affected soils are common in arid or semiarid regions because there is less rainfall available to leach and transport the salts and because the high evaporation and plant transpiration rates in arid climates tend to further concentrate the salts in soils and surface waters.

2. Poor drainage. When water table rises to within 1.5 or 2 m of the surface, groundwater containing dissolved salt moves upward into the root zone and to the soil surface. Groundwater then causes the soil to become saline.

3. Excessive irrigation. Irrigation waters may contain large amount of salt. Considerable quantities of soluble salts may be added to irrigated soils in a short time.



What Causes Soil Salinity

How to Tell if your Soil is Affected by Salinity

The salinity status of soils is appraised by measuring electrical conductivity of the solution extracted from saturated soil paste. The yields of very salt-sensitive crops may be restricted at readings as low as 2, moderately salt-tolerant crops grow satisfactorily below readings of 8; only salt-tolerant crops grow satisfactorily when readings range between 8 and 16.

Management Practices for the Control of Salinity

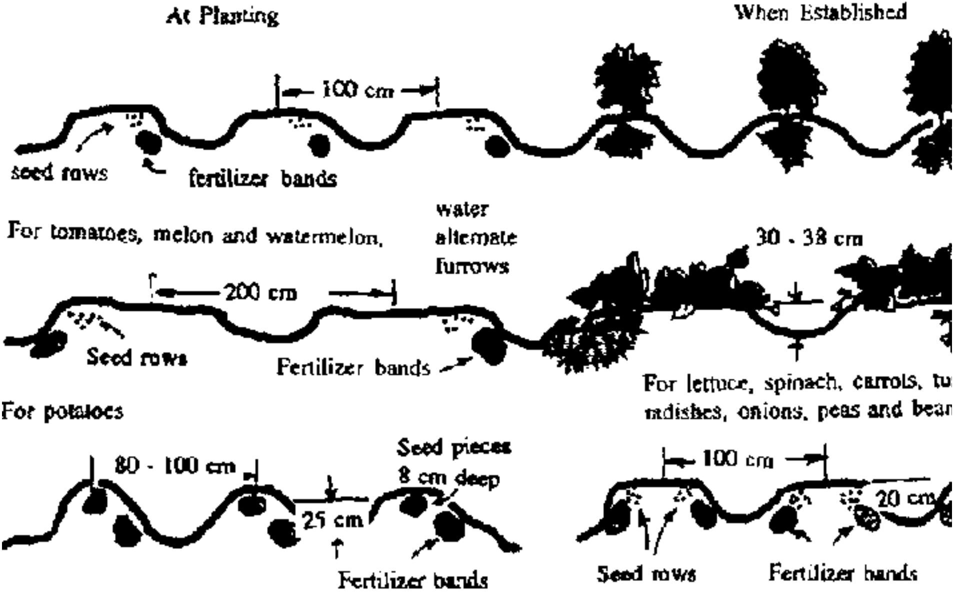
1. Select crops or crop cultivars that can grow successfully under saline conditions. Among the highly tolerant vegetables are beets, kale, asparagus, spinach and tomato.

2. Use land preparation and tillage methods that aid in the control of salinity. Careful leveling of land makes possible a more uniform application of water and better salinity control.

3. Modify watering practices and bed shape to alter the of salts to accumulate near the seed. Pre-emergence watering in special furrows placed close to the seed often is done to reduce the soluble

salt concentration around the seeds and thus permit germination. After the seedlings are established, the special furrows may be abandoned and new furrows made between the rows.

4. Use special planting procedures that minimize salt accumulation around the seed. The tendency of salts to accumulate near the seed during irrigation is greatest in single-row, flattopped beds. With double-row beds, most of the salt is carried into the center of the bed, leaving the shoulders relatively free of salt and satisfactory for planting.



Standard vegetable bed' for saline soils

For peppers chile, ladyfinger, sweet potatoes, cowpeas and sweet corn

5. Water properly, so as to maintain a relatively high soil moisture level and, at the same time, allow for periodic leaching of the soil and reduce salinity problems. The method and frequency of watering and the amount of water applied are of prime importance in the control of salinity. The amount of water applied should be sufficient to supply the crop and satisfy the leaching requirement but not enough to overload the system.

6. "Pond" water over the entire soil surface to make leaching efficient. Soils can be leached by applying water to the surface and allowing it to pass downward through the root zone.

7. Apply special treatments, such as, adding organic matters and growing sod crops to improve soil structure. Low permeability of the soil causes poor drainage by impeding the downward movement of water. The impedance may be the result of an unfavorable increase

in groundwater level, which then causes the soil to become saline.

Reference:

Bower, C. A. and M. Fireman. 1957. Saline and Alkali Sails. In Yearbook of Agriculture by USDA, Washington, D. C.

Lead in urban gardens

URBAN gardens are often affected by the presence of metal pollutants in the air and on the soil. Air pollution can cause health problems for humans and can retard plant growth.

Of the metal pollutants, lead is a major concern. At least two sources of lead affect city grown produce: gasoline emissions and lead-based paint. Lead can be deposited directly on the plant leaves or on the soil. Lead in the soil is usually not taken up by plant roots unless it is present in large quantities. Soil-borne lead is rarely found in the fruiting parts of the plants. It is found mostly in the roots and leaves.

A number of factors affect the amount of soil-borne lead found in plants. Plants growing in soils with high organic matter content take up small amounts of lead. Decomposed organic matter and well-rotted manure tend to bind the lead and makes it insoluble to plant roots. If the soil pH is kept between 6.5 and 7.0, lead uptake can be reduced. Soil pH levels above 6.5 also reduce the absorption of metallic cadmium, another dangerous pollutant. Applying 8 - 10 cm of well-decomposed compost to each bed and incorporate it in the soil helps reduce lead uptake.

A bigger concern in lead-contaminated gardens comes from the exposure of children to the soil. Young children playing in the garden may put soil in their mouths, ingesting the lead. This method of lead poisoning is more common than through "consuming lead-polluted vegetables. Avoid taking young children into urban gardens to reduce their direct exposure to surface soil lead.

Fortunately, lead deposits on leaves can easily be washed off.

Water alone is not sufficient. Wash with diluted vinegar (1% or one spoonful of vinegar in 100 spoons of water) or diluted dish washing liquid (0.5% or half a spoonful for every 100 spoons of water) is preferred. Root crops should be peeled to ensure that lead adhering to the skin is removed. Since green leafy vegetables are most affected by lead deposits, they should be planted as far away as possible from roads with heavy traffic.

Vegetables such as tomatoes, eggplants, beans, squash and peppers should be planted closer to the roads since they show lower concentrations of the metals. However, at least 10 meters should separate any garden from the street. Barrier crops such as a hedge planted at the side of the garden facing the road can effectively reduce the deposit of lead and other metals on garden produce and on the soil itself.

The problem of lead pollution in urban gardens can be addressed by the following measures:

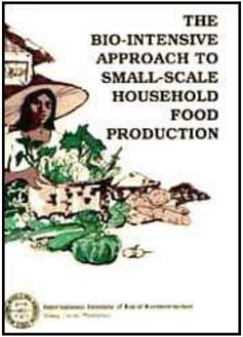
- Apply high quantities of organic matter to the soil.
- Cultivate root and fruiting vegetables.
- If you grow leafy vegetables, plant them away from the source of lead emissions.
- Wash vegetables with diluted soap or vinegar.
- Keep very young children away from lead-polluted gardens.

Reference:

Bassuk, N. L. 1983. Lead in Urban (frown Vegetables. Cornell University.

Home"" """"> ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Bio-intensive Approach to Small-scale Household Food Production (IIRR, 1993, 180 p.)



Bio-intensive Approach to Small-scale Household Food Production (IIRR, 1993, 180 p.)

Pest management

Some common garden pests

1. APHIDS

Sucking insects attacking the leaves and stems. When attacked, the leaves and stems of the plants begin to look pale and spindly. Aphids can change color to match plant parts and metamorphose from nymphs to adult, both with and without wings. When the aphids in one plant get overcrowded, they develop wings and fly to another plant host of the same plant family. Aphids mature in 12 days.

APHIDS

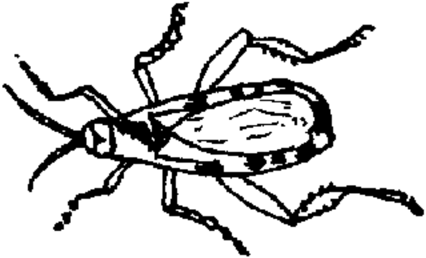
2. BORERS

Boring insects attacking the flowers, pods, stems and roots. Borers hatch, eat and grow inside plant part as caterpillars. The presence of borers is indicated by the sudden wilting of plant tops.

Borers

3. BUGS

Sucking insects that attach to plant parts and drain plant juices. In case of mealybug, eggs are laid in white, cottony masses. Young are crawlers like scale insects. Bugs excrete large amounts of honeydew that attract ants and encourage black mold fungus.



Bugs

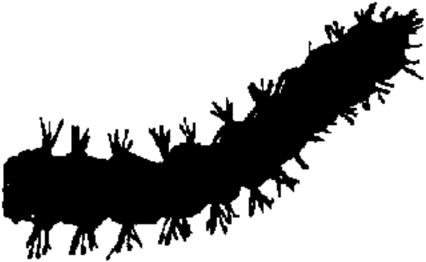
4. BEETLES

Chewing insects which feed on leaves, flowers, stems and even roots. They feed on most vegetables. Severe infestation can defoliate plant.

Beetles

5. CATERPILLARS/WORMS

Chewing insects usually developing from patches of eggs on the underside of leaves. The larval stage of moths and butterflies, caterpillars feed on foliage and tender stems.



Caterpillars/worms

6. FLIES

Some are tiny sucking insects that hatch and live mostly on underside of leaves. In case of whiteflies, stationary scale-like nymphs do most of damage, sucking juices and excreting honeydew, thereby attracting ants and encouraging fungus growth.

Flies

7. HOPPERS/KATYDID

Feed on foliage of many plants. Grasshoppers are most often found in late summer when fields next to gardens become dry. In severe infestations, large plants may be defoliated. The tender bark may be stripped from trees and shrubs.

Hoppers/katydid

8. SCALE INSECTS

Small insects, covered by protective shells, that attach themselves to stems and undersurfaces of leaves and suck out plant juice. Generally, they are able to move about in younger stages, but become stationary or nearly so in adulthood.

Scale insects

9. SLUGS AND SNAILS

Slimy trails and tattered foliage indicate snail and slug invasion. In daytime, they can be found under rocks, leaves, densely foliaged plants, boards or any object that rests on the ground. At night, they can be found busily feeding on plant parts.

Slugs and snails

10. ROOT-KNOT NEMATODES

Microscopic worms that either stick their heads on a plant to suck the sap or actually spend their lives inside the plant. They attack roots of various plants and form galls or root knots. Infested plants wilt or die due to the inability of the damaged root systems to supply enough water to their tops.

Root-knot nematodes

Name of Pest	Target Vegetables
Suana concolor (Tussock moth caterpillar)	ladyfinger
Hippotion celerio (Sphinx moth)	peanuts, taro
Lamprosema indicata (Bean leaf roller)	beans, peanut
Stornopteryx subsecivella (Leafminer)	peanut
Eumeta fuscescens (Pepper bagworm)	solanaceous crops
Lymantria lunata (Tussock moth caterpillar)	solanaceous crops
Acherontia lachesis (Hornworm)	sweet potato

Euchnomia horsfieldi (Tussock moth caterpillar)	sweet potato
Aciptilia viveodactyla (Sweet potato plume moth)	sweet potato
Rhyncolaba acteus (Green sphinx moth)	taro
Agrius convolvuli (Sweet potato hornworm)	sweet potato, taro

Flies

Ophiomyia phaseoli (Bean fly)	beans
Bemisia tabaci (White fly)	cassava, garlic and onion, sweet potato
Pieris canidia (Cabbage butterfly)	crucurbits
Dacus cucurbitae (Fruit flies)	cucurbits

Hopper/Katydid

Hopper/Katydid

Phaneroptera furcifera (Long-horned grasshopper)	corn, cucurbits, peanut, sweet potato
Mecopoda elongata (Katydid)	cucurbits
Empoasca biguttula (Cotton leafhopper)	peanut, solanaceous crops
Atractomorpha psittacina (Slant-fac grasshopper)	peanut, sweet potato
Empoasca fabae (Potato leafhopper)	potato
Leptocentrus manilensis (Tree hopper)	solanaceous crops
Locusta migratoria manilensis (Oriental migratory locust)	sweet potato

Mites

Tetranychus telarius (Spider mite)	cassava, potato, winged bean
Tetranychus truncalus (Common mite)	cucurbits, sweet potato
Aceria tulipae	garlic and onion
Dolichotetranychus floridanus (Tenuipalpid mite)	pineapple

SCALE INSECTS

Chrysomphalus ficus (Florida red scale)	cassava
Saissaetia nigra (Soft scale)	cassava, ladyfinger

(Soft scale)

Saissaetia coffeae (Hemispherical scale)	cucurbits
Aspidiella hartii (Ubi scale)	ginger, yam
Aspidiella zingiberi (Luya scale)	ginger
Aspidiotus destructor (Coconut scale)	ladyfinger, pineapple, taro, yam
Pinnaspis aspidistrae (Fern scale)	ladyfinger, pineapple
Lepidosaphes rubrovittatus (Tampoi scale)	ladyfinger
Abnidiella aurantii (California red scale)	pineapple

Other Insect Pests

Macrotermus gilvus (Mound building termite)	cassava
Thrips tabaci (Tobacco thrips)	cucurbits, garlic and onion, potato
Leucopholis irrorata (Root grubs)	pineapple, corn
Anomala sp. (Root grubs)	corn, sweet potato
Gryllus bimaculatus (Black cricket)	corn
Gryllotalpa africana (Male cricket)	potato
Dysdercus cingulatus (Cotton stainer)	ladyfinger
Catochrysops cnejus (Bean lycaenid)	peanuts

Cylas formicarius	sweet potato
(Sweet potato weevil)	
Tagiades japetus titus	taro
(Gabi skipper)	

Aphids

Myzus persicae	celery, crucifers, cucurbits,
(Green peach aphid)	potato
Aphis gossypii	cucurbits, sweet potato,
(Melon aphid)	taro
Aphis craccivora	beans, cucurbits, peanuts
(Bean aphid)	
Toxoptera auratii	cucurbits, citrus
(Citrus aphid)	

Borers

Maruca festulalis	beans

(Bean pyralid)	
Estiella zinckenella	beans
(Bean pod borer)	
Apomecyna historion	cucurbits
(Vine borer)	
Manilaboris cucurbitae	cucurbits
(Cucurbit boring boric)	
Mimegralla coeruleifrons	ginger
(Ginger root borer)	
Zeuzera coffeae	ladyfinger, coffee
(Coffee carpenter moth)	
Phthorimaea operculella	potato
(Potato tuber moth)	

Bugs

Ferrisia virgata	cassava, sweet potato
(Gray mealybug)	

(Gray mealybug)	
Phenacoccus hirsutus (Hibiscus mealybug)	cassava
Dysmicoccus brevipes (Pineapple mealybug)	pineapple, corn, taro
Physomerus grossipes (Sweet potato bug)	cucurbits, sweet potato
Cyclopelta obscura (Dapdap bug)	cucurbits
Nezara viridula (Green soldier bug)	cucurbits
Acanthocoris scabrator (Coreid bug)	solanaceous crops, sweet potato
Malcus flavidipes (Lygaeid bug)	sweet potato
Planococcus lilacinus (Cottony cushion mealybug)	ladyfinger taro

Beetles	
Leucopholis irrorala (June beetles)	corn, peanut
Monolepta bifasciata (Corn silk beetle)	corn, ladyfinger, taro, yam
Sylepta derogata (Leaf-eating caterpillar)	ladyfinger
Hyposidra talaca (Measuring caterpillar)	ladyfinger
Epilachna philippinensis (Tomato lady beetle)	tomato cucurbits
Aulacophora cottigarencis (Squash beetle)	cucurbits
Lasioderma serricorne (Cigarette beetle)	garlic and onion
Nisotra gemella	ladyfinger

(Flea beetle)	
Phytorus spp.	sweet potato
(Chrysomelid beetles)	
Asphidomorpha fusconotata	sweet potato
(Tortoise shell beetle)	
Caterpillars/worms	
Homona coffearia	beans, garlic and onion,
(Leaf folder)	jute, peanut
Spodoptera litura	celery crucifers, garlic and
(Common cutworms)	onion peanut, potato, sweet
	potato, taro
Pseudalatia separata	corn, cucurbits, sweet
(True armywomms)	potato
Agrotis ipsilon	corn, cucurbitus garlic and
(potted cutworm)	onion, potato
Helicoverpa armigera	corn, crucifers, cucurbitus,

(Corn earwomm)	garlic and onion, peanuts, solanaceous crops
Chrysodeixis chalcites (Corn semi-looper)	corn, jute peanut
Crocidolonia binotalis (Cabbage worm)	crucifers, cucurbits
Plutella xylostella (diamond-back moth)	crucifers
Pieris canidia (Cabbage butterfly)	crucifers
Anadenida peporis (Squash semi-looper)	cucurbits
Diaphania indica (Leaf folder)	cucurbits
Dasychira mendosa	cucurbits, peanut

(Tiger moth caterpillar)	
Sitotroga cerealella (Angoumois grain moth)	garlic and onion
Ephestia elutella (Cacao moth or Tobacco moth)	garlic and onion
Anomis sabulifera (Cutworm)	jute, ladyfinger
Xanthodes transversa (Cutworm)	ladyfinger
Oxya chinensis (Short-homed grasshopper)	sweet potato
Terophagus proserpina (gabi planthopper)	taro

Alternative pest management

This is an approach that utilizes different techniques other than the use of chemical pesticides to control pests. It involves natural pest population-control methods, including cultural and biological controls the use of botanical pesticides as needed.

Cultural method of pest control

These methods are aimed either at reducing the sources of inoculum or at reducing the exposure of plants to infection. Its primary objective is the prevention of pest damage and not the destruction of an existing and damaging pest population.

1. Good soil preparation

This is the first important element in pest control strategy. A healthy soil means healthy plants which are relatively more resistant to pests. A soil rich in humus hosts a wide variety of beneficial microflora that trap nematodes and destroy or keep in dormancy disease organisms, thereby encouraging beneficial insects.

Good soil preparation

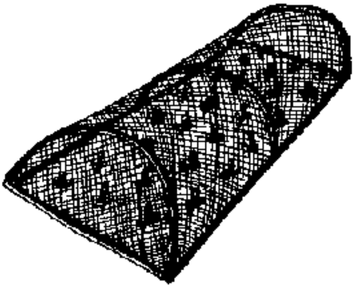
2. Use of indigenous varieties

Traditional varieties are hardier and relatively more resistant to pests. They can withstand harsh environmental conditions better than modem hybrids.

Use of indigenous varieties

3. Pest control through the use of mesh screen (nylon nets)

Younger plants are usually preferred by insects and they suffer significantly from such attacks when compared to older plants. Therefore, a single netting over the plants during the first 3045 days of their growth can reduce pest damage. Also, the net helps diffuse sunlight thereby improving the quality of some vegetables. Finally, the net breaks the impact of raindrops thus (i) reducing physical damage to the plant and (ii) reducing soil erosion from the beds.



Pest control through the use of mesh screen

4. Roguing or Pruning

Removal of diseased plants or plant parts prevents the spread of microorganisms to uninfected areas.

Roguing or Pruning

5. Intercropping with aromatic herbs

Several types of odorous plants can be grown together with the main crop to repel insects. The following are some examples:

Allium cepa (onion)	Hyptis suaveolens (bush-tea bush)
Allium odorum (leek)	Mentha cordifolia (mint)
Allium sativum (garlic)	Ocimum basilicum (sweet

basil)

Artemisia vulgaris (mugwort, worm wood)	Ocimum sanctum (sacred basil)
Coleus amboinicus (oregano)	Tagetes spp. (marigold)

6. Encouraging insect predators

Pests can be controlled by their natural enemies. By growing a variety of flowering plants, specifically those belonging to Umbelliferae family, such as, fennel (Foeniculurn vulgare) and celery (Apium graveolens), insect predators will be attracted to stay in the garden. These beneficial insects feed on pests, keeping the pest population below economic injury level.

Encouraging insect predators

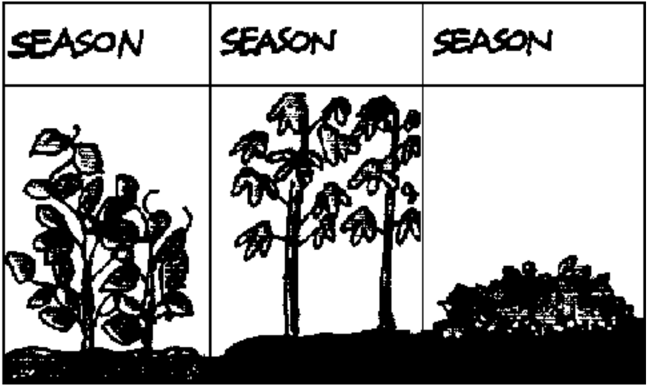
7. Multiple cropping

This provides genetic diversity to minimize pest increase. Variation in susceptibility among species or varieties to a particular disease is great. Given abundant hosts of a single species or variety, a pest could easily be spread from host to host. When the number of hosts declines, the pest incidence will also decrease for lack of necessary food for the organism.

Multiple cropping

8. Crop rotation

This is a practice of following a crop susceptible to a pest by a resistant crop. There is no build-up of the organism to a high level since the growth cycle of the organism has been broken.



Crop rotation

Biological pest control

Biological pest control is the suppression of pest populations by living organisms such as predators, parasites and pathogens. These agents are responsible for keeping pests under control most of the time.

Predators are usually other insects and spiders. Both, but particularly spiders, feed on a wide range of insects. Adults and immatures are often predatory.

Praying mantis, Dragonfly, Damselfly, Assassin bugs
Feed on all types of insects.

Praying mantis

Lacewings, White-banded clerid Robber files Feed on aphids and soft-bodied insects.

Lacewings

Ground beetles, Whirligig beetles, Rave beetles, Tiger beetles, Green carabid beetles
Feed on other insects.

Ground beetles

Ladybird beetles feed on scales and aphids only. They eat 40-50 insects per day. Their larva eat even more.

Ladybird beetles

Toads, snakes and spiders eat insects and other garden pests. Toads eat as many as 10,000 insects and other pests in three months, including cutworms, slugs, crickets, ants, caterpillars and squash bugs.

Toads, snakes and spiders

Birds

Some birds are omnivorous. Some examples from the temperate zone provide a good illustration of what birds eat. A house wren feeds 500 spiders and caterpillars to her young in one afternoon; a brown trasher consumes 6,000 insects a day; a chickadee eats 138,000 canker worm eggs in 25 days; and, a pair of flickers eats 5,000 ants as snack.

Birds

Parasitic insects are usually small flies or wasps which attack one or a few closely related pest species. They are parasitic in their larval stages but free-living as adults.

Tachinid flies, Braconid wasps

Complete their life cycle on insect pests. They usually attack the egg of the host pest or the caterpillar by laying an egg into its body.

The wasp larva hatches inside the caterpillar body and feeds on it.

Tachinid flies, Braconid wasps

Trichogramma spp.

Attacks eggs of butterflies and moth. This wasp produces very few side effects on beneficial insects.

Trichogramma spp.

Epidinocarsis lopezi

Feeds and reproduces on mealybugs of cassava. It has the ability to establish itself in cassava fields.

Epidinocarsis lopezi

Encouraging predators

In nature, pests are usually controlled by the presence of insect predators and parasites which keep the populations of the harmful insects in control Most of the insects in nature are either beneficial or at least harmless. There are many ways to encourage insect predators in one's garden.

1. Create a Suitable Habitat for Insect Predators - Flowering shrubs and trees throughout the garden will attract many beneficial insects, including parasitic wasps which require pollen and nectar for their growth and maturity. Plants belonging to Umbelliferae family are particularly effective in attracting natural enemies of pests.

2. Provide Alternate Hosts for Pests - To ensure availability of food for the beneficial organisms, grow alternate host plants along fence lines and in between cultivated crops. The natural enemy populations on these alternate host plants will control pests attacking the cultivated crop.

Encouraging predators

3. Create Nesting Sites for Frogs, Reptiles and Birds - Logs of dead trees, irregularly shaped rocks with crevices and cavities and plenty of mulch can be a good nesting sites for snakes, lizards, frogs, rove beetles and carabid beetles, which feed on insects.

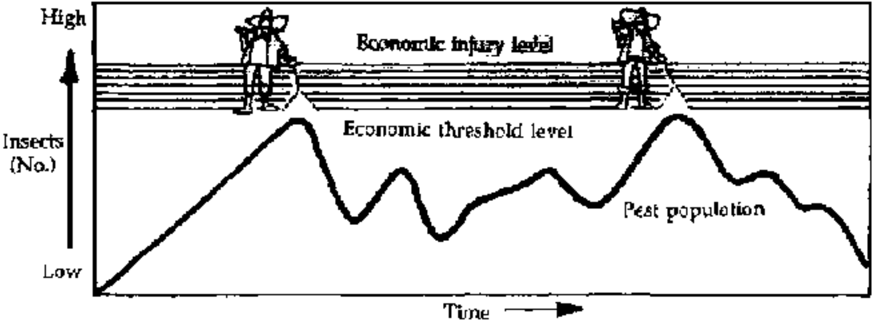
4. Increase Humidity by Providing Water Holes - Humidity is much needed for the survival of natural enemies. It serves as a source of drinking water for reptiles, birds and frogs. Many predatory insects live in, on and near water. Well-vegetated small dams, little water pools and swales scattered throughout the garden will create conditions for the build-up of natural enemies.

5. Practice Mixed Cultivation - Growing mixed crops and harvesting them in strips help maintain natural enemies and confuses pests. For fungal pathogens, the practice of mixed cropping is desirable as the root exudates of another crop can be toxic to the pathogen. Mixed cropping also encourages soil microbes which, in turn, act as barriers to the fungal pathogen.

6. Reduce Dust Build up in Crop Plants - Dust inhibits the functioning of natural enemies. Growing well-designed windbreaks and ground cover crops like centrosema and lablab bean will reduce dust. Use of overhead sprinklers will also help periodically in washing off the dust.

7. Avoid Spraying Chemical Pesticides - Chemical pesticides eliminate beneficial insects. If pest infestation reaches economic threshold levels and spraying cannot be avoided, use selective chemicals, such as:

> a soil incorporated granular systemic insecticides for sucking insects;
> b. stomach poisons; avoid broad-spectrum contact poisons; and,
> c. insecticides with short-term residual action rather than persistent action.



Improved application method should be developed and minimum doses should be applied.

Botanical pest control

Fungicidal Plants[1]

Plant Name[2]	Part(s) Used	Mode of preparation	Target Pest(s)

		and application³		
Allium sativum	cloves	Chop finely, soak in 2 teaspoons of oil for one day,	Altenaria	fr ea pu bl sp
(Garlic)		then mix with half a liter of soapy water and filter.	Cercospora	le le ea fr
		Mix 1 part solution with 20 parts water, then spray.	Colletotrichum	le ar fr sn
			Curvularia	le le

			Diplodia	fr st
			Fusarium	da st ro ea
			Helminthosporium	wi to
			Pestalotia	le
				le
Cassia alata	leaves	Extract juice and spray at a rate of 1 cup juice/liter water.	Altenaria	fr ea pu bl sp
(Acapulco)			Cercospora	le le

				ea fr
			Colletotrichum	le ar fr sn
			Diplodia	fr st
			Fusarium	da st ro ea
			Helminthosporium	wi to
			Pestalotia	le le
Amaranthus gracilis	leaves	Extract juice	Altenaria	fr

		of 1 kg leaves, then mix juice with 3		ea pu bl sp
(Amaranth)		liters of water, and spray.	Cercospora	le le ea fr
			Colletotrichum	le ar fr sn
			Curvularia	le le
			Helminthosporium	le
			Pestalotia	le
Leucaena leucocephala leaves	Pound, soak in	Altenaria	fruit rot, early blight, purple	

	small amount of water, and use		blotch, leaf spot	
(Ipil-ipil)		infusion as spray.	Cercospora	le le ea fr
			Colletotrichum	le ar fr sn
			Curvularia	le le
			Helminthosporium	le
			Pestalotia	le

Allium cepa	bulb	Chop finely, soak in two teaspoons of oil for 1 day,	Cercospora	le le ea fr
(Red onion)		then mix with half a liter of soapy water and filter.	Colletotrichum	le ar fr sn
		Mix 1 part solution with 20 parts water, then spray.	Curvularia	le le
			Fusarium	da st ro ea
			Helminthosporium	wi

				to
			Pestalotia	le
				le
Moringa oleifera	leaves	Extract juice of 1 kg leaves, then mix juice with 3	Altenaria	fr ea pu bl sp
(Drumstick/Horseradish)	liters of water, and use as spray.	Colletotrichum	leaf spot, anthracnose, fruit rot, smudge	
			Diplodia	fr st
			Pestalotia	le
Impatiens balsamina	leaves	Extract juice	Altenaria	fr

		of 1 kg leaves, then mix juice with 3		ea pu bl sp
(Kamantigi)		liters of water, and use as spray.	Cercospora	le le ea fr
			Helminthosporium	le
Centella asiatica leaves	Extract juice of 1 kg leaves, then mix juice with 3	Fusarium	damping-off, stem and root rot, early blight,	
(Takip-kuhol)		liters of water,	Helminthosporium	wi

(Tukip-kahoi)		liters of water, and use as spray.	Helminthosporium	w to
				le
Jatropha multifida	leaves	Extract juice of 1 kg leaves, then mix juice with 3	Diplodia	fr st
(Mana)		liters of water, and use as spray.	Fusarium	da st ro ea
				wi to
Gendarussa vulgaris	leaves	Extract juice of 1 kg leaves, then mix juice with 3	Altenaria	fr ea pu bl

				sp
(Bunlao)		liters of water, and use as spray.	Colletorrichum	le ar fr sn
Carica papaya	leaves	Pound, soak in water, and use infusion as spray.	Cercospora	le le ea fr
(Papaya)			Diplodia	fr st
Mimosa pudica	whole plant Pound, soak in water and use	Diplodia	fruit and stem rot	

	infusion as spray.			
Sensitive plant			Pestalotia	le
Artemisia vulgaris	leaves	Extract juice and use as spray at the rate of 2-5	Altenaria	fr ea pu bl sp
(Damong Maria)		tablespoons juice/liter of water.		
Zingiber officinale	rhizome	Extract juice and use as spray.	Cercospora	le le ea fr
(Ginger)				

Gliricidia septum	leaves	Extract juice of l kg leaves, then mix juice with 3	Cercospora	le le ea fr
(Kakawate)		liters of water, and use as spray.		
Coleus scutellarioides	leaves	Extract juice of 1 kg leaves, then mix juice with 3	Cercospora	le le ea fr
(Mayana)		liters of water, and use as spray.		
Vitex negundo	leaves	Extract juice of 1 kg leaves, then mix juice with 3	Cercospora	le le ea fr

(Lagundi)		liters of water, and use as spray.		
Blumea balsamifera	leaves	Extract juice and spray at a proportion of 1 part juice	Cercospora	le le ea fr
(Sambong)		and 1 part water		
1 Plant species showing; activity against different fungal pathogens at two days incubation after seeding, based on zone of inhibition. (Data from Quebral, 1981)				
2 Plant names in italics				

2 Plant names in italics are scientific names; those in parenthesis are common/local names.				
3 Based on indigenous practice of farmers.				

Insecticidal, Plants

Name of Plant²	Part(s)	Mode of Preparation and Application³	Pest(s)[4]	Source [5]
	Used			
Aegeratum conizoides	leaves		diamond backmoth Alcantara, 1981	
(goat weed)			cotton	

			stainer	
Artemisia vulgaris	leaves	Pound, extract juice and spray at a rate of 24	corn borer	Calumpang, 1983
(damong maria)		tablespoons/16 liters water		
Lantana camara flowers	Pound and spread around stored grains	corn weevil	Fuentebella & Morallo	
(lantana)				Rejesus, 1980

Derris philippinensis	roots	Extract juice and spray at a rate of 5 cups juice/5 gallons of water; or Powder,	diamond backmoth	Maghanoy & Morallo
(tubli)		mix with detergent and spray at a rate of 120 grams powder + 250-300 grams		Rejesus, 1975
		detergent/4 gallons of water		
Tithonia diversifolia	leaves	Pound, extract juice and use as spray at a rate of 1-2 kg fruits/liter	cotton stainer	Cario & Morallo

		of water		
(wild sunflower)			black army worm	Rejesus, 1982
			diamond backmoth	
Tagetes erecta	roots	Extract juice and spray at a rate of 24 tablespoons juice/liter of water	rice green leafhopper	Morallo-Rejesus &
(marigold)			brown planthopper	Eroles, 1978
			diamond backmoth	Morallo-Rejesus &
			black bean aphid	Decena, 1982

Tagetes patula	roots	Pound, extract juice of 1 kg roots and mix with 1 liter water, then spray the	green aphid	Morallo-Rejesus &
(French marigold)		solution directly into the soil	less grain borer	Silva, 1979
Tinospora rumphii	vines	Extract juice and spray at a rate of 15-20 tablespoons juice/5 gallons water	diamond backmoth	del Fierro & Morallo
(makabuhay)			rice green leafhopper	Rejesus, 1976
				Morallo-Rejesus &

				Silva, 1979
Piper nigrum	fruits	Pulverize seeds, mix with water and spray; powder and spread around stored	cotton stainer	stainer & Morallo
(black pepper)		grains	diamond backmoth	Rejesus, 1982
			common cutworms	Ponce de Leon, 1983
			corn weevil	
Capsicum frutescens	fruits	Pound, extract juice and spray at a rate of 2-3 cups	rice moth	Ponce de Leon, 1983

		fruit/liter of water		
(hot pepper)				
Annona squamosa	seeds	Powder and disperse in water, then strain and use as spray	rice pests	Saxena & co-workers
(custard apple)				(IRRI), 1984
Azadirachta indica	seeds	Remove husks of 2-3 handfuls of mature seeds. Winnow or put in water to float	rice pests	Saxena & co-workers
(neem)		away the husks.	diamond	(IRRI),

		Grind seeds into fine particles. Soak ground seeds in 3-5 liters	backmoth	1984
		water for at least 12 hours. Filter the solution, then use as spray.		

1 Found effective, based or crude assay but further studies are needed to determine safety and residual action.

2 Names in italic are scientific names; names in parenthesis are common/local names.

3 Based on indigenous practice of farmers.

4 Mortality is 30% or more with crude extracts.

5 Researchers who conducted laboratory teas on particular

plant.

References:

Alcantara, J. A. 1981. Insecticidal activity, screening and identification of two major crystalline fractions in Aegeratum conyzoides L. MS Thesis, University of the Philippines at Los Baos, College, Laguna. 56 pp.

Calumpang, S. F. 1983. Insecticidal activity, screening and identification of the major crystalline fractions of Artemesia vulgaris (Compositae). MS Thesis, University of the Philippines at Los Baos, College, Laguna. 109 pp.

Cario, F. A. and B. Morallo-Rejesus. 1982. Isolation and characterization of the insecticidal fraction from Tithonia diversifolia (A. Gray) leaves. Ann. Trop. Agric. 4:1-11.

Del Fierro, R. and B. Morallo-Rejesus. 1976. Preliminary study on the insecticidal activity of makabuhay, Tinospora rumphii Boer.

Youth Res. Apprenticeship Action Prog. Rep. Society for the Advancement of Research. 9 pp. Unpublished.

Fuentebella, F. and B. Morallo-Rejesus. 1980. The insecticidal activity of fancy buttons (Lantana camara L.) flower extracts to several insect species. Youth Res. Apprenticeship Action Prog. Rep., Society for the Advancement of Research. 19 pp. Unpublished:

Javier, P. A. and B. Morallo-Rejesus. 1982. Isolation and bioassay of insecticidal principles from black pepper (Piper nigrum L.) against three stored grain insects. In Progress In Grain Protection. Proc. 5th Ann. Workshop on Grain Post-Harvest Protection. SEA Coop. Post-Harvest Res. and Dev. pp. 49-59.

Maghanoy, O. and B. Morallo-Rejesus. 1975. Insecticidal activity of extracts from Derris philippinensis. Youth Res. Apprenticeship Action Rep. Society for the Advancement of Research. 6 pp.

Morallo-Rejesus B. and L. Eroles. 1978. Two insecticidal principles from marigold (Tagetes spp.) roots. Philipp. Ent. 4: (1 & 2) 87-98.

Morallo-Rejesus Bland D. Silva. 1979. Insecticidal activity of selected plants with emphasis on marigold (Tagetes spp.) and makabuhay (Tinospora rumphii). NRCP Ann. Rept. 19 April 1978-March 1979. Mimeo 25 pp. Unpublished Rep.

Morallo-Rejesus B. and A. Decena. 1982. The activity, isolation, purification and identification of the insecticidal principles from Tagetes. Phil. J. Crop Sci. 7:31-36.

Ponce de Leon, E. L. 1983. Further investigation of the insecticidal activity of black pepper (Piper nigrum L.) and red pepper (Capsicum anuum) on major storage pests of corn and legumes. MS Thesis, University of the Philippines at Los Baos, College, Laguna. 44 pp.

Quebral, F. C. 1981. Assay on the fungicidal properties of some medicinal plants. Nat. Crop Prot. Center Ann. Rep. 1981. p. 21-25.

Saxena, R. C. 1984. Evaluation of neem seed derivatives against insect pests of rice. Paper read at the "Research Planning Workshop on Indigenous Plant Materials for Pest Control". International Rice

Research Institute, Los Baos, Laguna. August 6-10 1984.