



*Picture NR.6. A LEISA garden in full production. Sweet potato harvest.*

For more information: contact the Organic Farm Team of Water Harvest, Auroville 605101, Tamil Nadu, India, phone 622333, or by e-mail: [palmyra52@hotmail.com](mailto:palmyra52@hotmail.com)

## **RAISED BEDS**

*A form of permaculture for the dry and wet tropics*

*and*

## **LEISA**

*Low external input sustainable agriculture*

## **A MANUAL**

The idea of raised beds as described in this leaflet leads to high productivity, while requiring only very little labor and hardly any external input. The technique of building and maintaining raised beds for the cultivation of vegetables, is developed under climatological conditions of the South East Coast of India. Initial experiments with the system were started in Papua New Guinea.

*raised beds*



*a form of permaculture for the dry and wet tropics*



*Velvet Beans as living mulch.*

*Bed ready for planting.*

#### *Introduction*

Cultivation of crops in the tropics is often determined by extreme climatological circumstances: hot and intense sunshine during long hours of the day or prolonged periods through the year and very wet periods due to excessive rainfall during monsoon or local storms. These circumstances can cause stress to the crop, because of high temperatures near and in the soil and cause damage to the roots, because of water logging, especially in unprepared situations. Intensive cultivation of the soil is one of the activities that increases these effects. The natural vegetation is adjusted to the extreme changes e.g. availability of water, temperature, strong sunshine and other climatological circumstances. Also traditional agricultural systems are normally adjusted to these situations. This however means often that crops are grown in limited periods of the year.

#### *Cultivation of vegetable crops throughout the year*

Cultivation of vegetables throughout the year is limited by:

1. excessive rainfall (monsoon) which causes leaf damage and root problems (water logging)
2. excessive sunshine (sunburn) and high temperatures limiting growth and fruiting
3. shortage of water
4. irregularity of the seasons
5. soil condition (too dry, too hard, too wet)

Cultivation of vegetables throughout the year is stimulated by:

1. regular availability of water

2. protection of the soil against excessive sunshine and rain (mulching)
3. growing the right crop at the right time
4. providing (some) shade during hot spells
5. a living soil



*Picture NR 2. Basella Alba being watered with a mixture of cow urine and water.*

#### *Creation of a permanent soil-body (raised bed)*

One of the ways to create optimal circumstances, to regulate extreme soil-temperatures near or in the soil, to protect the soil and plants from the impact of heavy rains and to create an environment that is optimal for soil-life and for rooting of a crop, is to create a soil-body with its own (controlled) conditions. The creation of a 'skin' that protects the body from extreme changes in temperature and availability of water will produce this effect. This skin consists of (decomposing) plant material (green-covers, straw or other fibers and/or foliage). The soil-body is built by separating a certain amount of soil from the land by digging drains or trenches through it.

**Muscles!** A spade or local tool and two ropes of the length of your bed are used to build the beds.

**Cover!** Any organic material or living mulch can be used to create a 'skin'

**Water!** Hose-cans or hosepipe, drip irrigation or sprinklers (to keep the soil moist throughout the year)

**Nutrients!** Liquid manure, green manure and/or foliage of legumes.

**Crops!** Seeds, seedlings or parts of plants.

**The right spot!**

The decision whether a piece of land is suitable to start the building of raised beds depends on the following criteria:



**Drainage** - does the field flood during the wet season(s) and suffer from stagnant water? Can an excess of water easily be drained off?

**Water** - is water available throughout the year and easy accessible? For drip-irrigation and micro sprinklers a well, pump (and tank) is needed.

**Soil** - is the soil easily workable, not too heavy (clay) and preferable not too sandy? Loamy-sand will do best. Where groundwater table is low, a layer of clay underneath the topsoil is preferable. If the groundwater table is within reach of the roots sandy subsoil is preferable.

**Direction** - beds should where possible be situated North - South to get an even amount of sunshine (or shade in case of guiding hedges) during the day. On sloping land beds are preferably created along the contour lines. It is however important to avoid stagnant water in the drains.

#### *The building of a raised bed*

**1.** One drain or trench on each side of a new bed is needed to build the bed. The drain will be one spade wide and deep ( $\pm 25$  cm). Two ropes of the length of your bed are needed. The ropes limit the area where the bed including the two drains will be built. If we want to build a bed of 150 cm wide, the space in between the ropes will be 150 cm + 50 cm (for two drains) = 200 cm. Weeds are removed  $\pm 40$  cm inside the ropes (at least 15 cm wider than the width of the drain). Clearing the soil from weeds is done by scraping the topsoil a few centimeters deep. Weeds are placed on the strip where we actual want to create our bed. Only 120 cm (200 cm less 2 x 40 cm for clearing) will be left with weeds, covered by the weeds and soil, scraped from the clearance.

**2.** Digging the drain is done with a spade or a local tool to a depth of about 20-25 cm. the soil will be equally spread over the full width (150-cm) of our bed. Cover the weeds on the middle of the beds properly! Initial plowing of the land is advised, but not necessary.

**3.** The newly made beds should be raked and covered with straw or whatever mulching material as soon as possible to avoid drying of the soil, which will create hard lumps and to avoid the impact of a heavy (nightly) rain (Picture NR 3).

**4.** If required the beds can be composted after clearing the weeds and before digging the drain. In this way the compost will be nicely covered by the soil. When soil condition or availability of compost is minimal, it is advisable to grow first a vigorous legume crop for several months (see **12.**).

**5.** Digging is best done after rain when the soil is soft, or after watering (flooding) the land. Give the newly dug beds some days to settle. (It is advised to dig one bed at the time and cover and plant the bed as soon as possible and to slowly enlarge the garden

in close relation to availability of labor, water etc. Unused beds will be covered by weeds in no time.)

**6.** Drip-irrigation should be laid out on the beds before covering with mulch. Preferable are drip-pipes with drips every 50-60 cm, to get a more or less equal distribution of the water in the beds. Two drip-lines/bed are advised.



*Picture NR 3. A newly made bed. Notice the cover with rice straw!*



*Picture NR 4. Three months later. The same beds covered with sweet potato plants*

**8.** The next bed is built by simply moving one of the two ropes, so that a new area of 200 cm wide is created, after which the same procedure as described in **1.**, is continued. In this way we get a trench of about 50-cm wide in between two beds.

**9.** Your bed is ready and seedlings, cuttings or (cover) crops with big seeds (pumpkin, velvet beans, corn etc.) can be planted directly into the mulch. This is done by moving aside the mulch a little bit where you want to plant your seedling etc. For many crops 30-50-cm space in between the plants and two to three rows per bed will do

**10.** Seedlings and cuttings will often do best if you cover them in the first two days or so with some mulch in case of strong sunshine. Make sure your seedlings or cuttings are planted in little holes so the mulch will not push on the plants. After planting always water to wash the soil around the roots or the cuttings. Seeds can also be provided with a little mulch on top to avoid heating and drying of the soil. Make sure that during germination the mulch is removed again. Crops with small seeds as Tandi Keerai and other Amaranths or radish etc. can be broadcasted on the mulch and need to be regularly watered during germination or to be covered with a shade cloth.

**11.** Several methods can be applied to control pests and diseases, so as different kinds of plant extract mixtures, Effective Micro-organisms, Bio-pesticides and fungicides. Also tunnels of mosquito wire are very effective to protect crops from pests and viruses transmitted by insects.



*Picture NR 5. Pumpkins and Elephant Food Yam growing on well mulched beds.*

**12.** Planting of seedlings direct in a freshly cut cover crop (used as living mulch) can be done and has been very successful with vigorous legumes like Velvet Bean (*Mucuna* sp., see first picture). In this case the plants are planted, as is described before, in two rows. After a few months this crop is cut close to the root with a knife or cutting scissors.\* The plants are left in place and given a few days to die. This might be the right time to clear your drain on both sides of the bed and cover the living (dying) mulch with some soil. After a few more days the bed, together with the dead plants, is thoroughly watered and a new crop can be planted as described before, by removing the mulch where you want to plant your crop and digging small holes in which to plant your seedlings. The Velvet Beans will do your weeding, the mulching and will compost your bed! Weeds cannot survive underneath the lush legume cover of the live mulch, and plenty of nitrogen is fixed to feed your new crop.\*\*

**13.** Additional nutrients might be given by applying liquid manure directly to the plants or to the middle of the bed where it will mix with the water from the drips. Liquid manure can be made of any green material or with fresh cow dung and/or urine diluted with water. For distribution a simple (kerosene) hand pump, plastic barrel and hosepipe can be used (the liquid should be filtered before use).

**14.** If the water supply is regular, soil-life will develop and together with the decomposing mulch and penetration of roots the soil-structure will improve. No further cultivation of the soil is practiced.\*\*\*

**15.** Drip-irrigation has several advantages besides being less labor intensive and uses a minimum of water. Beneath the drip-pipe a kind of water-dome develops. The outside of the bed remains dry and forms more or less a crust, which prevents water from evaporating and weeds from germinating. In this sense it might be worth mentioning that micro-sprinklers have the effect of a rainshower and will activate germination of dormant weed-seeds. Moreover evaporation and run off of water is also more likely to occur, and some leaf-diseases could be stimulated in the case of wet crops.

\*Make sure that the Velvet Beans have formed abundant litter and fresh material before cutting. The growing period might take up to about five months.

\*\*This whole system has proved to require a minimum of labor to be productive. When cultivation of food crops is alternated with a crop of Velvet Beans the need for weeding and composting the soil is reduced to a minimum.

\*\*\*Before building a bed the soil underneath can be loosened with a fork or can be turned one spade deep. This depends a little bit on the structure of the soil and requires much more labor.