PHILIPPINE ALLOTMENT GARDEN MANUAL

with an introduction to

ECOLOGICAL SANITATION

Periurban Vegetable Project (PUVeP)
Xavier University College of Agriculture, Cagayan de Oro City

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By

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Table of Contents

Foreword

"Population must increase rapidly, more rapidly than in former times, and ere long the most valuable of all arts will be the art of deriving subsistence from the smallest area of soil. No community whose every member possesses this art can ever be the victim of oppression in any of its forms. Such community will alike be independent of crowned kings, money kings, and land kings."

Abraham Lincoln, address before the Wisconsin State Agricultural Society, Milwaukee, Wisconsin, September 30, 1859

This Philippine Allotment Garden Manual is a product of research and extension activities of the Periurban Vegetable Project (PUVeP) of Xavier University College of Agriculture in cooperation with the city government of Cagayan de Oro, barangay administrations, local communities as well as universities and local government units from Germany and Belgium. What started in October 1997 as an international research project on urban and periurban vegetable production, has resulted in eight allotment gardens for almost 100 urban poor families of Cagayan de Oro. The success stories and failures experienced along the way are reflected in this booklet, which we decided to come up with to address the numerous requests for information on how to establish an allotment garden in the Philippines.

The standard operating procedures for the production of different vegetables are based on integrated crop management principles and are meant as an indicative guide only. The fertilization schemes, for example, are initial recommendations only, if soil analyses are lacking and difficult to obtain. The pest control strategies focus on preventive measures building on biodiversity. However, if all these measures fail, we recommend the responsible use of appropriate pesticides to save the crop and, thus, the investment of the gardener. This manual is far from being perfect and, hence, we appreciate the comments and suggestions of the reader to continuously improve this publication.

Heartfelt thanks to everybody who has contributed to make this possible.
Ad maiorem Dei gloriam.

Robert J. Holmer, Cagayan de Oro, February 2008

1. Background

1.1. What are Allotment Gardens?

Allotment gardens are a special type of community gardens and are characterized by a concentration in one place of a few or up to several hundreds of land parcels that are assigned to individual families. In allotment gardens, the parcels are cultivated individually, contrary to other community garden types where the entire area is tended collectively by a group of people. The individual size of a parcel usually ranges between 200 and 400 m^2, and often the plots include a shed for tools and shelter. The individual gardeners are organized in an allotment association which leases the land from the owner who may be a public, private or ecclesiastical entity, provided that it is only used for food production, but not for residential purposes. The gardeners have to pay a small membership fee to the association, and have to abide by the corresponding constitution and by-laws. On the other hand, the membership entitles them to certain democratic rights.

1.2. Allotment Gardens in Europe

Allotment gardens have been very popular in Europe for more than 150 years, although their functions have shifted over the years. The history of the allotment gardens is closely connected with the period of industrialization and urbanization during the 19th century when a large number of people migrated from the rural areas to the cities to find employment and a better life. Very often, these families were living under extremely poor conditions suffering from inappropriate housing, malnutrition and other forms of social neglect. To improve their overall situation and to allow them to grow their own food, the city administrations, the churches or their employers provided open spaces for garden purposes. These were initially called the “gardens of the poor” and were later termed as “allotment gardens”.

While during times of crisis and widespread poverty (from 1850 to 1950), the main importance of allotment gardening was to enhance food security and improve food supply, its present functions are to provide recreational areas and locations for social gatherings. As green oases within oceans of asphalt and cement, they are substantially contributing to the conservation of nature within cities.

1.3. Socio-cultural and Economic Functions

The *Office International du Coin de Terre et des Jardins Familiaux*, a Luxembourg-based organization representing 3 million European allotment gardeners since 1926, describes the socio-cultural and economic functions of allotment gardens as follows:

- for the *community* a better quality of urban life through the reduction of noise, the binding of dust, the establishment of open green spaces in densely populated areas;
- for the *environment* the conservation of biotopes and the creation of linked biotopes;
- for *families* a meaningful leisure activity and the personal experience of sowing, growing, cultivating and harvesting healthy vegetables amidst high-rise buildings and the concrete jungle;
- for *children and adolescents* a place to play, communicate and to discover nature and its wonders;
- for *working people* relaxation from the stress of work;
- for *the unemployed* the feeling of being useful and not excluded as well as a supply of fresh vegetables at minimum cost;
- for *immigrant families* a possibility of communication and better integration in their host country;
- for *disabled persons* a place enabling them to participate in social life, to establish contacts and overcome loneliness;
- for *senior citizens* a place of communication with persons having the same interests as well as an opportunity of self-fulfillment during the period of retirement.

1.4. Allotment Gardens of Cagayan de Oro

In 2003, the first allotment garden of the Philippines was established in Cagayan de Oro as part of a European Union funded project following a period of agronomic and socioeconomic research in cooperation with German, Belgian and Philippine universities, local government units and non-governmental organizations.

With the assistance of the German Embassy in Manila and several private donors from Germany, this number has grown to ten self-sustaining gardens located in different urban and periurban areas of the city, three of them within the premises of public schools, enabling more than 100 poor families the legal access to land for food production. Aside from different vegetables, some gardeners grow also herbs and fruits. In some gardens, small animals are kept to provide an additional income source.

Each allotment garden has a compost heap where biodegradable wastes from the garden as well as from the neighboring households are converted into organic fertilizer, thus contributing to the integrated solid waste management program of the city.

Further, all gardens are equipped with so-called urine-diverting dehydration toilets (see chapter 6).

1.5. Socioeconomic Impact of Allotment Gardens

Five years after the implementation of the first allotment garden in Cagayan de Oro, the gardening families are able to sustain their activities without external financial support, which was given to them for the first two croppings only.

Surveys which were conducted to assess the socioeconomic impact of allotment gardening, show that the perceived benefits are multiple. 25 % of the vegetables produced are consumed by the farming family, 7 % are given away to friends and relatives while 68 % are sold to walk-in clients, who come mostly from the immediate neighborhood. They appreciate the freshness of the produce, the convenience of proximity as well as the lower price compared to the public markets. The gardening activities, a secondary occupation for all the association members, have augmented the available income by about 20 % while the consumption of vegetables has doubled for 75 % of its members.

Aside from these economic benefits, the respondents particularly appreciate that the allotment gardens have strengthened their community values since they provide a place where they can meet, discuss issues and enjoy spending quality time with their families and friends in a clean and quiet natural environment, which they are deprived of in the densely populated areas where they live.

The gardens are also essential for the successful implementation of the city's integrated solid waste management program. In the city districts that have an allotment garden, the amount of residual wastes delivered to the landfill site was significantly reduced since the segregated biodegradable household wastes are converted into compost in the gardens. So-called urine-diversion dehydration toilets, which are established in all gardens, have further contributed to close the loop in the waste cycle.

2. Social Preparations

2.1. Criteria for Area Selection

- The Barangay[1] must be interested in allotment gardening and be willing to organize the community.
- The Barangay should appoint a Barangay Coordinator to overview the implementation and subsequent monitoring.
- It would also be helpful if the Barangay has already implemented the integrated solid waste program (*RA 9003; Ecological Solid Waste Management Act)* to have a source of biodegradable materials for composting. A possible location for the garden could be close to a Material Recovery Facility (MRF).
- The proposed allotment garden area should not be smaller than 3000 m^2 to accommodate a minimum of eight family parcels of 300 m^2 each, plus space for the tool room and nursery, composting area, a water well and the ecosan toilet.
- The area should suit basic agronomic standards (leveled, not water logged), should be free from any shade, and exposed to sunlight for the whole day.
- The area should have a water source that could sustain irrigation throughout the year.
- It should be accessible to transportation.
- The landowner should approve of the use of the area without rental fee or if otherwise, at a reasonable cost for a minimum of two years with an option to extend the contract thereafter.

2.2. Advocacy to Barangay Council

- The allotment garden concept should be presented to the Barangay Council and discussed thoroughly.
- Roles and responsibilities of all stakeholders (i.e. academe, NGO, LGU, community partners, etc.) should be clarified, specified and agreed upon.
- The Barangay Chairman will appoint a Barangay Coordinator for the allotment garden project.
- A strategy for an information and education campaign (IEC) to identify interested community members will be designed.

[1] The smallest local administration unit in the Philippines, corresponding to a city or municipal district.

2.3. Information and Education Campaign (IEC)

- The local government unit will organize the information and education campaign for the community.
- Those who are interested in becoming members of the new allotment garden will apply to the Barangay Coordinator.
- The Barangay will form a committee to screen the applicants according to the criteria mentioned in Section 2.4.
- The selected gardeners will receive an overview of the project, followed by lectures, exposure to other allotment gardens and hands-on training prior to the set-up of the garden.

2.4. Selection of Gardeners

Since allotment gardening is a family-based activity, at least two family members should appear for the interview. The gardeners should then be chosen according to the following criteria:

- Should be legal residents of the *sitio*/barangay with barangay clearance;
- Should be living near the allotment garden area;
- Should be physically fit to do gardening;
- Should have enough family members who are willing to help in all activities related to allotment gardening (at least 2);
- Applicant families should not be related to each other up to the third degree of affinity or consanguinity to avoid clan building;
- Should be willing to learn and share gardening experiences with others;
- Should be willing to do all necessary work for establishing and maintaining the allotment garden and its facilities;
- Should be willing to follow the good agricultural practices, the standard operating procedures as well as the ecological sanitation guidelines described in chapters 4 to 6;
- Should be willing to attend all trainings, seminars, workshops, field trips and other activities related to allotment gardening;
- Should be willing to form an allotment garden association and follow its constitution and by-laws.

The selected gardeners will then enter into a memorandum of agreement with the barangay and other stake holders (such as the land owner, etc.) which will stipulate the above mentioned provisions.

2.5. Memorandum of Agreement (MoA)

The MoA should contain the following information:

- General provisions of allotment gardening;
- Number of families;
- Size of each family parcel and overall garden size;
- List of facilities such as nursery, tool shed, ecosan toilet, compost and vermicomposting areas and water source;
- Roles and responsibilities of all stakeholders (e.g. land owner, community, local government unit, academe, private business partners, church organizations and the like);
- The specifics of the land use, particularly the duration, area dimension and limitations (for agricultural purpose only, not for residential use);
- Rental fees, if any;
- Conditions for cancellation or suspension of MoA.

The draft MoA is presented to all stakeholders, corrected and amended, if necessary, and eventually signed by all parties to the MoA, all of whom receive an original signed copy.

2.6. Community Organizing

Community organizing is a very crucial activity. It makes people realize and articulate the vision of the project through the process of evaluation and by reflection upon the situation. It is recommended that the community organizer should come from the local government unit (LGU), because:

- The LGU knows the people best.
- The community will respect the administrative authority of the LGU.
- The LGU has the capacity to control and, if necessary, to discipline individuals.
- Community organizing should be separated from technical aspects of allotment gardening (such as nursery management, fertilization, pest and disease management, etc.).

2.6.1 Community Organizer

A community organizer must possess good facilitation skills to enhance active participation of the people in a group, especially in a non-formal setting. A good facilitator:

- Ensures the effective flow of communication within a group.
- Poses problems and encourages group analysis.

- Provokes people to think critically and motivates them towards action.
- Does not change or ignore any decisions reached by the participants through consensus.
- Is sensitive, both to the verbal and non-verbal communications that occur in the group.
- Is sensitive to the feelings, attitudes, culture, interests, and any hidden agenda that may be present in a group.

During facilitation, the community organizer should observe the following:

- Keep the group focused on task and process.
- Do more listening than talking.
- Remain neutral.
- Encourage everyone to participate.
- Keep discussions going by asking questions or introducing new ideas.
- Acknowledge differing viewpoints.
- Be alert to sensitive issues.
- Speak clearly and slowly.
- Maintain eye contact when discussing.
- Summarize main points and decisions made or issues resolved at close of session and make sure that those are recorded properly.
- Maintain a friendly manner to the members.

2.6.2. Asset-Based Community Development (ABCD)

The allotment gardens of Cagayan de Oro were established following the so-called *Asset-Based Community Development (ABCD)* approach. This methodology seeks to uncover and highlight the strengths within communities as a means for sustainable development. The basic tenet is that, although there are both capacities and deficiencies in every community, a capacities-focused approach is more likely to empower the community and therefore mobilize citizens to create positive and meaningful change from within. In short, the ABCD approach does not focus primarily on the problems, but on the assets of the community.

Asset-based community development begins with the assumption that successful community building involves rediscovering and mobilizing resources already present in any community such as:

- The skills and resources of its individuals;
- The power of voluntary associations, achieved through building relationships;
- The assets present in the array of local institutions, the physical infrastructure of the community and the local economy.

Although some resources from outside the community are often needed, the key to lasting solutions comes from within. The gifts and skills of residents and the assets of the physical community are always the starting place. Although there is no blue-print for ABCD, the following steps are proposed to facilitate the process:

- Collecting stories about community successes and identifying the capacities of communities that contributed to success.
- Organizing a core group to carry the process forward.
- Mapping completely the capacities and assets of individuals, associations, and local institutions.
- Building relationships among local community members for mutually beneficial problem-solving within the community.
- Mobilizing the community's assets fully for economic development and information sharing purposes.
- Convening a group that is as broadly representative as possible for the purposes of building a community vision and plan.
- Leveraging activities, investments and resources from outside the community to support asset-based, locally defined development.

The following table shows the characteristics of the ABCD approach as a capacity focused paradigm versus the traditional needs-based development approach:

Table 1: Characteristics of ABCD versus Traditional Development Approaches

Traditional Development (Needs-Based Paradigm)	ABCD (Capacity-Focused Paradigm)
• top-down approach and outside-in (solutions come from outside, dependent on agencies)	• bottom-up approach and inside-out (solutions come from inside, community fabric is built)
• focuses on needs, deficiencies, problems	• focuses on capacities, assets, dreams, strengths
• projects a negative mental map	• projects an optimistic mental map
• creates client mentality	• fosters citizen participation
• undermines local leadership	• builds local leadership and confidence
• creates dependency	• enhances empowerment
• divides community	• builds connections

2.6.3. Constitution and By-Laws

Part of community organizing is the formation of an allotment garden association with corresponding constitution and by-laws.

A Constitution:
- o Is concise;
- o Clarifies the group's purpose;
- o Explains the fundamental purposes of the group;
- o Provides the basic framework for the group's processes;
- o Provides historical perspective;
- o Is rarely revised.

By-laws:
- o Outline specific procedures for the group's functioning;
- o Help the group conduct business in an orderly manner;
- o Provide further definition to the constitution;
- o Easily revised, and revised regularly as procedures change.

What should be covered in a constitution?
Constitutions should be concise, yet contain the important framework of an organization. They should be between two and four pages in length, leaving the detailed procedures of a group's daily functions to the by-laws. Below is an outline of the kinds of information that should be included in a constitution.

- o Article I: Name of institution
  - Include any affiliations with state or national groups.
- o Article II: Purpose of institution
- o Article III: Membership
  - Include any requirements for membership. Neither membership in, nor services provided by the organization will be denied to anyone on the basis of race, color, religion, national origin, physical or mental handicap, age, sex, sexual preference, ancestry, or medical condition.
- o Article IV: Officers
  - Include titles, terms of office, how and when elected.
- o Article V: Advisor(s)
  - Include term and how and when selected.
- o Article VI: Meetings
  - Frequency, special meetings, how called.

- Article VII: Quorum
  - The number of members required to conduct business, usually stated as a fraction of the number of members, such as 3/4 or 2/3.
- Article VIII: Governing Principles
  - Procedures.
- Articles IX: Amendments
  - Procedure for amendment, notice required, voting procedures.

What should be covered in by-laws?

By-laws are the daily working procedures of an organization. They contain the detailed processes of a group. They are usually easier to change, requiring only a simple majority, compared with a constitutional amendment which normally requires a 2/3 vote.

Below is an outline of the kinds of information normally covered in the by-laws:

- Membership Selection
  - Requirements, resignations, expulsion, rights and responsibilities.
- Dues
  - Amount, how collected, special fees, when payable, and to whom.
- Executive Board
  - Structure, membership, powers, responsibilities.
- Responsibilities of Officers
  - Powers, responsibilities, specific job descriptions.
- Committees
  - Standing, special, how formed, chairpersons, meetings, powers, responsibilities, how dissolved.
- Responsibilities of Advisor(s)
- Elections
  - Include when, voter eligibility, winning vote margin, procedures for filling expired or unfilled terms of office, removal from office, and the appeal process.
- Amendments
  - How to propose, notice required, voting procedures.
- Other specific policies and procedures

3. Physical Preparations

3.1. Equipment and Tools

To start the physical set-up of the allotment garden project, prepare a list of all equipment and tools needed by the project. A sample list of equipment and tools is provided in chapter 8.

3.1.1. Purchasing Guidelines

In purchasing tools, these guidelines should be followed:

- Buy the best quality tools you can afford.
- Stainless steel, cast aluminum and some other materials do not rust, hold better and last longer.

3.1.2. Turnover to Community Members

There may be instances where some allotment gardeners will back out a few days or weeks after the start of the project. To avoid the possibility that they will take away with them the garden tools and equipment, the following process is recommended:

- All the equipment and tools will be turned over to the Barangay custodian. The acknowledgement receipt has to be co-signed by the Barangay chairman.
- A small ceremony should be organized where these equipment and tools will be turned over to the allotment gardeners.
- The community partners will sign an acknowledgement receipt as soon as they receive the equipment and tools.
- They will commit themselves in written form to safeguard and maintain the equipment and tools and to only use them for allotment gardening purposes.
- Equipment and tools should always be kept in the tool room and supervised by the tool keeper of the community.

3.1.3. Care of Gardening Tools

General:

- Maintain and care for tools regularly throughout the year.
- Hang tools up rather than resting them on their points.
- Do not leave tools outside in the elements but always bring them in and wipe them off after use.

Maintenance:

- Remove all dirt from the tools.
- Rub with oil and wipe with a dry rag to prevent rusting.

- To clean a rusty saw or tool, take some sandpaper and scrub the rust off. Then place the saw or tool into the bucket of sand (see below "tool cleanser" for details).
- Sharpen cutting edges with a metal file.

Wood handles:
- Use sandpaper to smooth the surface to avoid splinters.
- Rub handles with a rag soaked in oil to prevent drying and cracking.
- Check and tighten any screws or bolts along the handle.

Pruners and loppers:
- Lubricate the screws and bolts.
- Sharpen the blades regularly.
- Remove any sap with soapy water or turpentine.

Tool Cleanser:
- Materials needed are motor oil, sand and large plastic container.
- Pour some sand and motor oil into the plastic container.
- Stir the oil and sand well until all the oil is absorbed.
- Take any tool and put it into the oily sand to clean and prevent rusting.

3.2. Layout of the Allotment Garden

- As a first step, there should be an ocular inspection of the future allotment garden site to lay out the different components and facilities.
- One family parcel has an area of 300 m^2 (15 m width x 20 m length) to accommodate 8 beds (1.30 m width x 20 m length plus 0.50 m walking space between beds; see chapter 3.7 for details).
- Allocate all family parcels in such a way to fit the shape of the garden.
- Allow sufficient area for the tool shed, conference room and nursery (size depending on the number of member families).
- Identify areas for the ecosan toilet, compost heap, vermicomposting area and water source.
- Compute the fencing material needed to protect the area from stray animals, thieves and trespassers.
- Suggested border crops for excess areas are banana, papaya, pineapple, horseradish tree, taro, etc.
- If desired and possible, identify areas for animal keeping. However, keep in mind that they should not become a nuisance and source of irritation for the neighbors.

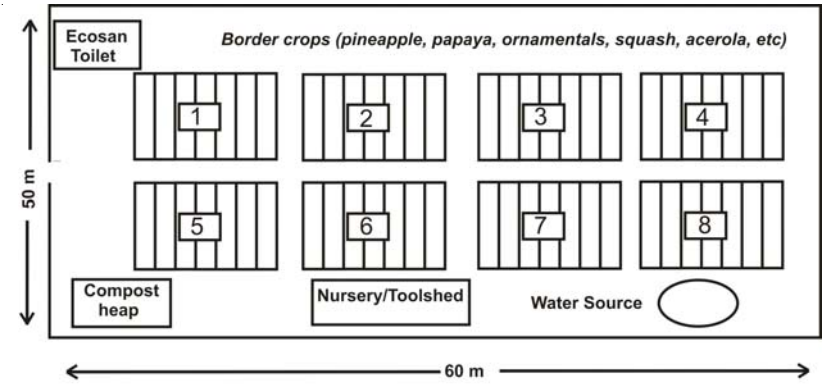

Figure 1: Layout of an allotment garden with 8 family parcels and its other components

3.3. Water Source

Water is one of the most important resources in gardening. In vegetable production, watering has to be done at least twice a day, once in the morning, preferably before 8:00 am, and once in the afternoon, preferably after 4:00 pm. Important factors to be considered are:

- The garden must have a permanent water source to sustain watering even during prolonged drought periods.
- Tap water is not recommended since it is very costly.
- If there are surface waters such as a river or a creek, use pumps to drive water. Since fuel or electrically driven pumps are costly to operate, try to use ram pumps or hydro powered pumps if these are available and feasible.
- If the water table is shallow (less than 7 m) the water can be pumped using a hand driven jetmatic pump or a pedal driven treadle pump.
- If the water table is very deep, drilling has to be done by a professional company.
- If the area is swampy, a drainage canal with corresponding water catchment has to be constructed.
- Rainwater catchments can provide additional irrigation sources to conserve water.

3.4. Tool Shed, Conference Room and Nursery

- Each garden must have a small building to accommodate the tool shed, conference room and nursery. The roof should be equipped with a gutter to enable rainwater harvesting.

- The tool shed is the place where the tools are properly kept. The gardeners will assign a custodian who is in charge of proper tool keeping.
- The conference room is a place where the gardeners gather for meetings and to accommodate visitors. It also serves as a venue for lectures and trainings as well as a place for rest.
- The nursery is a place to raise quality seedlings as a precondition for a healthy crop. It should have space for soil media and seed trays.
- The roof of the nursery should be translucent to allow entry of light. The sides should be permanently screened with nets to prevent insects and other animals from entering. The nursery should have elevated tables for the seed trays.

3.5 Soil Acidity & Liming

The vegetable crops described in this booklet grow best in a soil with a pH between 6.0 and 7.0. Since most Philippine soils are acidic, a representative soil sample should be taken to determine the pH (and, if possible, the nutrient status) of the allotment garden site.

3.5.1 Acid Soil Infertility

- If the pH is below 6.0, the availability of nutrients such as phosphorus, potassium, calcium, and magnesium decreases. The availability of aluminum, zinc, manganese, copper, and iron, however, increases as the pH decreases.
- If the pH is allowed to drop much below 5.5, the availability of manganese and aluminum is increased to the point that they could become toxic to plants. Aluminum toxicity to plants is the main concern of acid soils in the Philippines.
- The problems of very acid (pH < 5.5) and alkaline soils (pH > 7.5) are summarized below:

Problems in very acid soils:	**Problems in alkaline soils:**
o Aluminum toxicity to plant roots	o Iron deficiency
o Manganese toxicity to plant roots	o Manganese deficiency
o Calcium & magnesium deficiency	o Zinc deficiency
o Molybdenum deficiency in legumes	o Excess salts (in some soils)
o Phosphorous deficiency (P tied up by Fe and Al)	o Phosphorous deficiency (P tied up by Ca and Mg)

3.5.2. Amount of Lime to Apply

Unless otherwise recommended by the laboratory that has conducted the pH analysis, the following general guidelines are given by the Philippine Bureau of Soils and Water Management (BSWM) to bring a soil to a pH of 6.0:

Soil pH (actual)	Average amount of ground limestone ($CaCO_3$) in tons per hectare for different soil types of average organic matter content to bring to pH 6.0				
	sandy	sandy loam	loam	silt	clay
4.0	2.0	3.5	4.5	6.0	7.5
4.5	1.5	2.5	3.2	4.2	5.2
5.0	1.0	1.5	2.0	2.5	3.0

The amount of lime to apply to increase the soil pH to a desired level is affected by a number of factors, such as the soil type, crops to be grown, kind and fineness of lime used as well as the economic returns in relation to cost of lime.

If agricultural lime is not available, ground shells and wood ash can also be used to increase the pH of a soil, however, their relative neutralizing value is much lower than of lime.

3.6. Land Preparation and Fencing

- Prior to the land preparation, the area should be cleared from big stones, shrubs and trees.
- If the area is water logged or swampy, especially during wet season, there is a need to construct a drainage canal with a corresponding water catchment. The latter can be used as a water source for irrigation.
- Thereafter, the area should be disc plowed and harrowed by a tractor. If a tractor is not available, an animal drawn cultivator should be used.
- After the operation of all heavy equipment is completed, the fencing of the area will be done.
- The most convenient and effective material for fencing is hog wire. However, barb wire, cyclone wire, and low cost materials such as bamboo and other wood sources can also be used.

3.7. Construction of Permanent Raised Beds

In the tropics, where several crops per year can be grown in the same area, constant soil cultivation leads to rapid depletion of organic matter resulting in increased soil infertility. During rainy season, leveled fields are often flooded causing moisture stress to vegetables, most of which are very sensitive to water-logged conditions.

The production of vegetables on permanent raised beds has the following advantages:

- Permanent raised beds reduce the risk of water logging during and after heavy rains.
- Soil compaction is limited since people will walk in the pathways only and do not step on the beds.
- The beds allow high density planting of crops and a more efficient use of agricultural inputs, as they are applied to the bed area only.
- The bed width of 1.30 m allows convenient cultivation of the crops since it is easy to reach the bed's center from either side.
- By alternating deep rooted with shallow rooted crops, the need for tillage is reduced. As a consequence, organic matter will break down much more slowly than under frequent tillage.
- Permanent raised beds allow mulching, which further prevents surface compaction caused by rain drops, aside from preserving soil moisture and moderating soil temperature (see chapter 4.6 for details).

Construction of permanent raised beds:

- Each family parcel accommodates eight beds.
- Each bed is 20 m long, 1.30 m wide and at least 0.30 m high.
- In between beds is a walking space of 0.50 m width to allow easy and convenient crop maintenance, monitoring and harvest.
- The initial construction of beds is very labor intensive, time consuming and tiring. It requires extra effort, perseverance and patience from the gardeners. This activity demands the full and continuous support of the community organizer. However, all the efforts exerted will pay off in the end with a bountiful harvest.
- From time to time, beds have to be repaired and fixed.
- It is advised to use marigold as a rotational crop once a year on each of the beds. The roots of marigold will exude phytochemicals that will repel nematodes and contribute to loosen the soil and make it friable for the following crop (see chapter 4.4.7 for details).

4. Good Agricultural Practices (GAP)

4.1. Nursery Management

A healthy seedling is the precondition for a successful crop and a high quality yield. It should be disease and insect free, with great vigor and without symptoms of nutrient deficiencies.

A vegetable nursery is a place to grow and develop healthy seedlings. It must be established in a place where there is enough sunlight that can penetrate inside the area. Preferably, translucent roofing should be used. In summary, a vegetable nursery seeks to provide the following growing conditions:

- Protection from diseases, pests, and higher animals like birds and dogs.
- Protection from rain and flooding.
- Protection from excessive sunlight and temperature.

4.1.1. Seedling Establishment

Crops can either be directly seeded or transplanted depending on their seed size and nature of plant roots. There are three categories according to planting practices:

- Crops that are usually transplanted are brassicas and solanaceous crops, bulb onion, lettuce and sweet corn.
- Crops that are usually directly seeded are cucurbits, legumes, kangkong, and okra.
- Crops that are planted by using plant or tuber cuttings are sweet potato, bunching onion, Malabar spinach (*alugbati*) and purple yam *(ube*).

Soil is the universally available medium for germinating seeds and growing seedlings but not necessarily the best medium. Characteristics of an ideal nursery medium are:

- It should have a good water-holding capacity and be well aerated (medium should not dry out too fast but should also not tend to water log; it should not be very compact to allow good root development).
- It should have the capacity to supply plant nutrients.
- It should be free from soil-borne plant pathogens.
- It should not contain any harmful substances such as salts and herbicide residues.

The following mixture is recommended:
- o 1 part compost : 1 part vermicast
- o If these materials are not available, mix 4 parts of rich top soil with 1 part of washed river sand.
- o Plain compost or plain vermicast can also be used.
- o Do not mix sawdust in your soil media. It tends to fix the available nitrogen in the media making your seedlings nitrogen-deficient (i.e. stunted, yellowish growth).

4.1.2. Sowing Methods

a) Use of multi-cellular plastic trays
- o Multi-cellular plastic trays are available in different sizes (50 to 104 cells per tray).
- o The soil media is filled into the plastic trays.
- o Depending on crop, one to three seeds are placed into each cell (see Chapter 5 for details).
- o Depth of sowing depends on size of the seed. As a rule of thumb, it should be only twice the size of the seed.

b) Use of banana leaves *(lokong)*
- o Banana leaves are rolled into a dimension of 2 cm in diameter by 15 cm long.
- o The soil media is placed into the rolled banana leaves and placed in rows on a leveled area.
- o Seeds are placed into each *lokong*. All other practices follow those described under multi-cellular trays.

Covering the trays or *lokong* with empty sacks after sowing prevents erosion and conserves moisture. It also maintains a uniform temperature that hastens germination. Covers should be removed at seedling emergence to prevent deformation and abnormalities.

4.1.3 Nursery Water Management

Watering of the seedlings should be done carefully:
- o Water source in the nursery should be preferably tap water or rain water since surface water may carry plant pathogenic microorganisms.
- o Large water droplets tend to erode the thin soil covering the small seeds, thus watering with a mist sprayer or knap sack is recommended. Hence, a sprayer should always be present in the nursery.

- The soil media must be always kept moist but not wet.

4.1.4 Fertilization of Seedlings

- In the rare case that seedlings show nutrient deficiencies such as stunted growth with yellowish and purplish color, DAP (18-46-0) or Complete (14-14-14) fertilizers should be applied at the rate of 5 to 10 grams per liter of water.

4.1.5. Hardening of Seedlings

- Seedlings should be prepared for the shock and stress of transplanting into the field ("transplanting shock") by slowly removing the optimum growing conditions of the nursery.
- This is accomplished by a process known as "hardening" which is the gradual reduction of water application and gradual exposure of the seedlings to full sunlight. This is usually done starting 5 to 10 days before transplanting.
- Care must be taken not to over-harden the seedlings.

4.1.6. Common Problems in the Nursery

Damping-Off:

- A disease commonly caused by fungi of the genera *rhizoctonia* and *pythium*.
- Symptoms are water-soaked lesions which soften the stem causing the seedlings to lodge, dry up and die.
- The disease is favored by warm conditions and wet soil medium.

If damping-off occurs in the nursery, the following counter-measures are recommended:

- Keep seedlings in the nursery moist but not overly wet.
- To minimize harmful microorganisms in the soil medium, it has to be sterilized by either of the following (or a combination thereof):
  - burning with rice straw;
  - sterilization with steam;
  - solarization (soil is wetted and sterilized by covering it with plastic sheets and exposure to sunlight for several days);
  - chemical treatments such as fungicide application;
  - addition of beneficial microorganisms such as *trichoderma harzianum* and EM (effective microorganisms) to the soil medium.

Oversized seedlings:
- Are caused by lack of sunlight, over-fertilization, or due to delayed field preparation and unfavorable weather conditions prior to transplanting;
- Have smaller chances of surviving field conditions;
- Have less ability to generate roots than younger seedlings.

4.2. Direct Seeding and Transplanting

4.2.1. Direct Seeding

- It is important that prior to direct seeding, beds should be well prepared, free from weeds and stones.
- Beds should be well leveled.
- Seeds should be directly sown into the beds according to the standard operating procedure of the certain crop.
- In the event of mortalities, seed should be replanted as early as possible to attain uniformity in germination sizes.

4.2.2. Transplanting

The term "transplanting shock" refers to the temporary growth retardation or mortality of seedlings after transplanting. This can be prevented by adequately preparing the seedlings. Ideal transplanting conditions are as follows:
- Prior to transplanting, the beds should be well prepared and thoroughly irrigated.
- It is important to use only transplants (e.g. seedlings, plant and tuber cuttings) that are healthy (free from pathogens and insects) and are in good condition.
- Transplants should not be oversized.
- Avoid damaging roots when removing seedlings from the seedling tray or *lokong*.
- Severely wilted plants should be soaked in water for a short time to recondition them prior to transplanting.
- Transplanting is best done early in the morning or late in the afternoon to minimize transplanting shock.

4.3. Plant Nutrition

4.3.1. Fertilization

Plants require 16 nutrient elements to grow, 13 of which come directly from the soil, namely nitrogen (N), phosphorous (P), potassium (K), sulfur (S), calcium (Ca), magnesium (Mg), boron (B), copper (Cu),

chlorine (Cl), manganese (Mn), molybdenum (Mb), iron (Fe) and zinc (Zn), while 3 come from air and water, namely carbon (C), hydrogen (H) and oxygen (O). *Macronutrients* (nitrogen, phosphorus, potassium, sulfur, calcium) are essential elements required in large quantities while *microelements* (boron, chlorine, copper, manganese, molybdenum, iron, and zinc) are essential elements required in small quantities (ranging from a few grams to a few hundred grams per hectare).

Fertilization is a way to provide plants with nutrients that are missing in the soil. One can use either organic or inorganic (synthetic) fertilizers. Inorganic fertilizers provide the bulk of plant nutrients needed while organic fertilizers improve the physical, chemical and biological properties of the soil (e.g. its organic matter content, pH-value, texture, nutrient and water-retention capacity), but supply only a small amount of nutrients.

Best results are obtained if a combination of inorganic and organic fertilizers is used. The following table lists some common fertilizers available in the Philippines and the nutrients they typically contain. The actual nutrient level of organic fertilizers can vary depending on the source:

Table 2: Nutrient content of different inorganic and organic fertilizers

	(%)				
Inorganic fertilizers	**N**	**P_2O_5**	**K_2O**	**Mg**	**S**
Urea	46	0	0	0	0
Ammonium Nitrate	35	0	0	0	0
Ammonium Sulfate	21	0	0	0	24
Diammonium Phosphate	18	46	0	0	0
Monoammonium Phosphate	16	20	0	0	0
Complete	14	14	14	0	0
Potassium Nitrate	13	0	44	0	0
Solophos	0	18	0	0	0
Muriate of Potash	0	0	60	0	0
Kieserite	0	0	0	17	23
Epsom Salt	0	0	0	10	14
Organic fertilizers	**N**	**P_2O_5**	**K_2O**	**Mg**	**S**
Chicken dung*	4.0	4.5	2.8	n/a	n/a
Pig manure*	2.9	3.7	1.8	n/a	n/a
Duck manure*	2.2	2.6	1.4	n/a	n/a
Sheep manure*	2.0	4.0	2.6	n/a	n/a
Horse manure*	1.6	3.8	0.8	n/a	n/a
Cattle manure*	1.5	2.3	1.1	n/a	n/a
Human faeces	1.0	1.4	0.6	n/a	n/a
Compost	1.0	0.5	0.6	n/a	n/a

**Source: Cosico, Wilfredo C., 1985. Organic Fertilizers: their nature, properties and use. UPLB Los Baños, Laguna. 136p*

4.3.2. Composting

What is composting?

- Composting is the controlled aerobic decomposition of biodegradable materials by insects, earthworms, fungi and bacteria.
- Compost is the end product of composting and is utilized as a soil amendment and organic fertilizer for crops.

What materials can be composted?

- Compostable materials generally fall under one of the two categories: "browns" (rich in C) and "greens" (rich in N):
  - Brown (dry) ingredients include: dried leaves, dry grass, rice straw and hulls, sawdust, corncobs, peanut shells, and the like.
  - Green (wet) ingredients include: fruit peels, vegetable peels, garden waste, fresh grass cuttings, but also coffee grinds, tea bags, egg shells, and similar wastes.

The following materials should not be placed in the compost heap:

- bones, meat, fish, since they may attract rats and dogs;
- inorganic materials such as plastics, batteries and diapers.

What are the factors for successful composting?

- Ratio of brown to green materials should be 50:50 (C/N ratio of about 30:1).
- Compost heap should be moist but not wet.
- Compost heap should have sufficient aeration to allow oxygen to enter and carbon dioxide to leave (do not cover with plastic, but add twigs and other bulking material > 15 vol. %). A well aerated compost heap will not emit foul odor.

How long does it take?

- Depending on the methods and materials used, it can take as little as one month, or as long as a year to produce compost.
- Addition of microorganisms such as BIMO or *trichoderma* can enhance the decomposition process.
- IMO (*Indigenous Microorganism*s) are produced by mixing three-day old cooked rice with muscovado sugar at a 1:1 ratio. The mixture is placed in a bamboo pole or clay pot, covered and placed in a shaded area for 1 week. A mud-like appearance indicates that it is ready for use.
- *Trichoderma* can be purchased at the Department of Agriculture Regional Office.
- Urine can also be used as a compost activator. It should be applied at a rate of 0.5 liter per 10 kg of fresh substrate.

4.3.3. Vermicomposting & Vermiculture

- Vermicomposting
  - is the process by which earthworms are used to convert organic materials into a humus-like material known as vermicompost.
- Vermiculture
  - is the artificial rearing or cultivation of earthworms. The worms are either used to expand a vermicomposting operation or sold to customers.
- Worm casting
  - also known as "vermicast", is a biologically active mound containing an abundance of beneficial bacteria, enzymes, and nutrients as well remnants of plant materials that were not digested by the earthworm.
- Type of worm used
  - The African night crawler (*Eudrilus eugeniae*) is the most preferred earthworm species for vermiculture and vermicomposting. They are warm weather animals and thrive best at temperatures between 18-27 °C, grow very large with an average size of 15-20 cm and produce an excellent vermicast.

Advantages of vermicomposting and vermicompost:

- Vermicomposting
  - Reduces household garbage amounts by converting waste into a valuable resource.
  - Produces less odor and attracts fewer pests than putting food wastes into a garbage container.
- Vermicompost
  - An eco-friendly natural fertilizer, which improves soil aeration, texture and tilth, thereby reducing soil compaction.
  - Improves water retention capacity of soil.
  - Promotes better root growth and nutrient absorption.
  - Improves the macro and micro nutrient status of the soil.
  - Is basically pathogen free and, thus, an ideal substrate for the nursery to grow healthy seedlings

Choosing the right container (or "vermi-bin')

- The container should have a large surface area to provide enough oxygen for the earthworms to carry out their work.
- The material of the container should be impermeable to light since the earthworms are very light sensitive.
- Always place the vermi-bin in a cool and shady area and cover it.

- Drainage of the worm beds is critical to prevent the substrate from becoming anaerobic and suffocating the worms. There should be an outlet to drain excess water, which may be used as liquid fertilizer (also called “vermi-tea”).
- However, a moisture content in the bedding of less than 50% is dangerous. If a worm’s skin dries out, it dies.With the exception of extreme heat or cold, nothing will kill worms faster than a lack of adequate moisture.

Bedding:

- Bedding is the material that provides the worms with a relatively stable habitat. It is both a comfortable home and a source of food.
- It must have the ability to retain moisture while being light enough to allow good aeration throughout its depth.
- Good bedding material is shredded newspaper but also corrugated cardboard, rice straw, dried leaves or sawdust may be used.
- A 20-25 cm layer of bedding must be placed in the bottom of the vermicomposting bin.The bedding must be moist, but not wet.
- As the composting process goes on, organic matter added to the bin usually provides the necessary moisture

Worm food:

- Compost worms are able to eat one half of their body weight per day.
- They derive their nutrition from many forms of organic matter such as decaying plant matter, shredded paper, protozoans, nematodes, bacteria, fungi and decomposing remains of other animals.
- Since vegetable and fruit wastes added to the bin are fresh and mostly high in N, the decomposition process must be balanced with carbon-rich compostable materials (see chapter 4.3.2. for details).

Vermiculture:

- In order to mass produce worms pre-composted cow manure is an ideal substrate.
- If there is no available manure for worms, pre-composted plant material rich in nitrogen can be used (e.g. leguminous plants).
- Indicators that the pre-composted substrate is ready for use:
  - Temperature of the substrate is at ambient level.
  - Manure worms are present.

Important factors to consider:

- If the material is too dense, or packs too tightly, then the flow of air is reduced or eliminated. Worms require oxygen to live, just as humans do.
- The ideal pH for most worm species is between 6 to 7.

- Appropriate worm density conditions: the density (the number of worms per unit volume of soil) at which different worm species can survive (or increase) varies enormously. Manure worms and African night crawlers thrive at densities of 30-65 cm^3/worm.
- Knowledge of the worms' life cycle (varies with different species).

4.3.4. Green Manuring

What is "Green Manure"?

- "Green manure" are crops that are allowed to grow, either until the land is needed again or until the plants have reached a certain growth stage.
- At this point, they are cut down, dug into the top 15-20 cm of soil and are left to decompose, thus releasing vital plant nutrients which are then used by the next crop.
- The crop residues may also be left on the soil surface as an organic mulch.

What are the benefits of green manure?

- Leguminous green manures contain nitrogen-fixing symbiotic bacteria in root nodules that fix atmospheric nitrogen in a form that plants can use.
- Green manures increase the percentage of organic matter in the soil, thereby improving water retention, aeration, and other soil characteristics.
- The root systems of some varieties of green manure grow deep in the soil and bring up nutrient resources unavailable to shallower-rooted crops.
- Common cover crop functions of weed suppression and prevention of soil erosion and compaction are further benefits.

4.3.5. Nutrient Deficiencies

Intensive cultivation of vegetable crops makes them prone to nutrient deficiencies, not only of macroelements but also of microelements. Zinc and boron are those microelements frequently deficient in Philippine soils.

While nutrient deficiencies usually are caused by lack of the specific nutrient in the soil, they may also occur due to over-fertilization of certain nutrients (e.g. potassium), which may result in the inhibited uptake of magnesium and calcium. Root infection by nematodes may also cause nutrient deficiencies due to inhibited uptake.

Table 3: Nutrient deficiencies and their symptoms

Nutrient	Symptom
Nitrogen	N-deficiency causes pale, yellowish-green plants with spindly growth. Symptoms begin on the older leaves and progress up the plant if the deficiency persists.
Phosphorus	P-deficient plants are dark green with reddish purplish leaf tips and margins on older leaves. P-deficient plants are smaller and grow more slowly.
Potassium	K-deficiency is first seen as a yellowing and necrosis at the leaf margins of the lower leaves.
Magnesium	The veins of the leaves will remain green in color, while the remaining leaf blade is yellowish ("interveinal yellowing"). Older leaves become reddish-purple, and the tips and edges may become necrotic. Mg-deficiency can be induced by high soil potassium levels or high rates of applied potassium.
Calcium	Ca-deficiency occurs in soils with pH values below 5.0 or those with very high magnesium and potassium levels. Plants may be severely stunted, fruits deformed (e.g. blossom end rot in tomato or tip burn in cabbage)
Zinc	Zn-deficiency results from low organic matter soils with high soil pH as well as excessive applications of P-fertilizers. Plant indicators are dwarfish plant size with small leaves, chlorosis of the interveinal areas with small-reddish mottles on the leaf surface.

4.4. Pest and Disease Management

What are pests?

- Organisms such as insects, weeds, fungi, rodents, nematodes, viruses, terrestrial or aquatic plants, which cause damage to crops or foodstuffs.

What are diseases?

- Organisms such as fungi, bacteria and viruses, which destroy living plants and those harvested crops in storage or transport.

The major pests and diseases occurring in allotment gardens are listed in chapter 5 under the standard operating procedures described for different vegetable crops.

4.4.1. How to Prevent and Manage Pest and Disease Problems

- Weak plants suffer more from attacks by insects or pathogens than healthy plants. Good crop management will help reduce damage from insects and disease.
- Select cultivars that will grow well in the local climate. Get advice from seed companies or your local extension agent.
- Do not grow the same vegetable crop in exactly the same place where it was planted before. Rotate the crop with a representative of a different botanical family. This will help prevent a build-up of disease infection in the soil.
- Practice field sanitation and always remove diseased plant parts and burn or bury them.
- Grow plants, such as lemon grass, basil, marigolds, etc., which are known to repel certain insects (see chapter 4.9).
- If you use pesticides, strictly follow the instructions on the label and the measures described in chapter 4.4.5.
- "Natural" pesticides such as extracts from tobacco, chili, tubli (*Derris ellipitica*) and others can also be very toxic to humans, animals and beneficial insects if not applied appropriately.

4.4.2. Protection from Animal Damage

- Protect root crops by placing coconut shells around the plants.
- Plant cassava or place bamboo sticks around the plant base so that chickens cannot dig up the roots or peck at the plant.
- Establish a living fence (i.e. pineapple) to prevent animals from entering your garden.

4.4.3. Safe and Effective Use of Crop Protection Products

What are crop protection products?

- Any biological, chemical or physical substance or product or mixture thereof, intended to control, prevent, destroy, repel, mitigate directly or indirectly, and manage population of any pest.

Basic steps of crop protection:

- Know the pest.
- Select the right product against the target organism.
- Apply the product as directed.
- Wear protective equipment.

Before mixing and application of crop protection products:

- Read and understand the product label carefully.

- Check the spray equipment for defects. Never blow into a clogged nozzle but use any pointed thing to remove the dirt.
- Calibrate the sprayer to calculate the desired dilution rates to meet the recommended dosage.
- Do not use defective spray equipment.
- Use proper personal protective equipment such as mask, boots, gloves, during application.

During mixing of crop protection products:

- Keep animals and children away from the mixing site.
- Use suitable equipment for measuring and mixing.
- Use personal protective equipment.
- Never use bare hands in scooping and stirring the solution.
- Always handle dusts and wettable powder formulations carefully.

During field application:

- Do not eat or smoke during pesticide application.
- Do not spray against the wind.
- Do not apply crop protection products when it is likely to rain.

After the application:

- Thoroughly wash the spray equipment after use.
- Wash contaminated clothing separately from other clothes.
- Observe proper hygiene and do not eat or drink unless you wash thoroughly your hands and face after application.
- It is advisable to take a bath with soap after application.

Safe handling during storage:

- Always make sure that crop protection products are stored separately from food and foodstuffs.
- Store them in a secured place away from animals and children.

Safe handling during transportation:

- Load crop protection products carefully in transport vehicles.
- Keep them away from animals and passengers and load them separately from food and foodstuffs.

If spillage occurs:

- Contain spill with sawdust or sand to prevent further spreading.
- Rinsing should be absorbed by sawdust or sand, and buried.
- Keep people and animals away from the spill area.

Disposal of empty crop protection product containers:

- Never use empty container for storage of water and food.
- Burn the cartons away from people and animals.
- Dispose of them properly.

4.4.4. Biological Pest Control

What is biological pest control?

- Natural control strategies that employ biological agents for pest suppression. It refers to the practice of rearing and releasing natural enemies.

Advantages of biological pest control:

- Economically sustainable: Does not require a large investment of money or time to use or maintain. Other tools require a greater investment of resources.
- Ecologically sustainable: Once established, biocontrol agents are self-sustaining – they will always be there, working in the background to control pests.
- Biocontrol agents are not known to cause any adverse ecological consequences.

Disadvantages:

- Not always available. Availability varies depending on local sources.
- Biocontrol agents usually have one target pest and often only attack a certain stage of the pest (e.g. egg, larvae, adult). Hence, biological control requires a good understanding of the life cycles of the pest and the predator to be able to release the control agent at the time when the pest is most vulnerable.
- Biocontrol agents will take some time to successfully establish a population. It is not a "quick fix".
- No biocontrol agent works in every situation. More than one type may have to be used to achieve uniform control across a variety of different situations and climates. *Diadegma*, a parasite of diamond back moth, for example, only works well in cooler upland climates and is not suited for the hotter lowland conditions. The lady beetle feeds on aphids, however, only after the colonies have been established. Virus diseases may have been already transmitted by the aphids before being eaten by the lady beetle.

4.4.5. Pheromone Traps

What are pheromones?

- Pheromones are a class of semiochemicals that insects and other animals release to communicate with other members of the same species.
- Pheromones have several desirable characteristics, in that they are specific to one pest species, active at low concentrations and safe to other living organisms.

How are pheromone traps used in crop protection?

- Pheromone traps can be used either to monitor or to control pest populations.
- Pheromone concentrations of as little as 10^{-8} g/cm^3 of air are enough to sexually arouse the male and cause it to search for the odor source resembling a female.
- Pheromone traps are usually yellow since this color is additionally attractive to insects.
- A cotton ball inside the yellow container is baited with a pheromone plus some drops of an insecticide.
- The male insect comes in contact with the poisonous cotton ball and dies before mating with a female.

Will these traps catch all insects?

- No. Pheromone traps are species specific. They are designed to catch either one species or several closely related species.

Despite the traps, I still can see insects. What else can I do?

- Pheromone traps are meant to be used as part of an integrated approach to pest control. Sanitation, inspection, and removal of infested material are equally important.

Where can I get pheromones?

- Several products are currently available for vegetable pests at agricultural supply stores.

4.4.6. Soil Solarization

What is soil solarization?

- Soil solarization is a simple non-chemical technique that captures radiant heat energy from the sun. This energy causes physical, chemical, and biological changes in the soil.
- These changes lead to control or suppression of soil borne plant pathogens such as fungi, bacteria, nematodes, and pests along with weed seed and seedlings.

How to solarize soil?

- The area to be solarized should be leveled and free of debris and large clods.
- The soil should be moist since water is a good energy conductor.
- Place plastic mulch over the soil surface and bury the edges. The plastic should be left in place for 2 to 4 weeks to allow the sun energy to raise soil temperature to lethal levels.

4.4.7. Nematode-Suppressive Cover Crops

- Marigold (*Tagetes* species) is one of the most highly studied crops for its ability to suppress nematodes with antagonistic phytochemical exudates released from its roots.
- However, only certain varieties of the French dwarf (*Tagetes patula*), the African (*T. erecta*) and South American (*T. minuta*) marigolds may significantly reduce numbers of root lesion and root-knot nematodes.
- The most effective marigold cultivars are those that germinate quickly, grow vigorously, and have deep root penetration.
- The marigold crop should be left in the ground for at least 2 months at a high enough density to produce a concentration that is lethal to the nematodes.
- It is important to identify the nematode species in the field - and know what their plant hosts and antagonists are - before planning a cover-cropping strategy.
- An additional advantage of a marigold pre-crop is that it suppresses weed growth and loosens even the hardest soil, which becomes soft and friable after uprooting the plants.

4.5. Weed management

- A weed is defined as any plant that is a hazard, nuisance, or causes injury to humans, livestock or desired crops.
- Weeds compete for light, space, water and nutrients and may also harbor insects, diseases, and nematodes which may reduce crop yield and quality and interfere with efficient harvest.

4.5.1. Techniques for Controlling Weeds

- Cut or dig out weeds using a knife or hoe. If you use drip irrigation materials, be sure not to damage the laterals.
- Cover the ground with mulch to prevent weeds from receiving sunlight.
- Weeds cut by hoe or knife can be used as mulching material or for composting.
- Quick-growing vine plants will also reduce weeds by covering the ground (such as legumes, squash and sweet potato).
- Application of herbicides may be an alternative if weed growth cannot be controlled by other means.
- Post-emergent herbicides kill weeds that are actively growing while pre-emergent ones prevent weed seeds from germinating.

- If herbicides are applied, use a special sprayer allocated only for this purpose. If the sprayer is also used for fungicide or insecticide applications, herbicide residues may cause harm to the plant sprayed.

4.6. Mulching

Mulching is the process of covering the soil surface with either inorganic or organic materials to achieve the following advantages:

- Weed control:
  - Weed growth on the bed covered with mulch is retarded or prevented because sunlight cannot penetrate through it.
- Reduced evaporation or moisture loss:
  - Soil moisture loss is reduced under mulch. However, it also requires a drip irrigation system to supply sufficient water amounts if plastic mulches are used.
- Reduced fertilizer leaching:
  - Soil nutrients are not lost through leaching because rain water runs off the mulch.
- Cleaner product:
  - The edible products from the vegetable crops are cleaner and less subject to rot because the marketable plant parts do not have contact with the soil and soil is not splashed on the plants or fruits.

The following materials can be used as mulching agents:

- Plastic mulch:
  - In the tropics, silver coated plastic mulches are preferred compared to black ones since they do not heat up as much. The silver coating also acts as a repellant to sucking insects such as aphids. Unlike with organic mulches, this can be used for more than two cropping seasons if properly cared for and maintained.
- Rice straw, rice hulls, shredded corn cobs, dried leaves:
  - Usually these materials are cheaper compared to plastic mulches if available. However, they may host pathogens and pests and can be used for one cropping only.
- Wild peanut (*Arachis pintoi*):
  - Is considered a “living mulch” that can be used permanently as a soil cover. However, it competes for nutrients and water, but may provide atmospheric nitrogen to the main crop.

The following serves as a guide in placing plastic mulch:

- Bed must be well prepared and drip irrigation installed.
- Place the plastic mulch on the bed and secure the sides with stones or bamboo clips.

- Holes are made for each hill using a heated can with approximately 10 cm rim diameter.

4.7. Water Management

- Proper water management is one of the most crucial points for successful vegetable production since most crops are in general very sensitive to any kind of water stress, either to drought or to water logging.
- The water amount stored in the plant root zone determines whether a crop will have adequate water and aeration for maximum non-water limiting yields, or whether too much or too little water will cause crop damage.

For practical application of irrigation scheduling, the following soil "feel and appearance " method can be considered as adequate:

Available water	Fine textured soil (clay and clay loam)	Water management
100 % (field capacity)	Appears very dark, leaves slight moisture on hand when squeezed, will ribbon[1] out about 4 cm	Discontinue irrigation
70 - 80 %	Quite dark, ribbons and slicks easily, makes firm ball[2]	No irrigation
60 to 65 %	Fairly dark; forms firm ball; ribbons out (0.5 to 1 cm)	No irrigation
50 %	Balls easily; small clods flatten out rather than crumble; ribbons slightly	Start irrigation
35 to 40 %	Slightly dark, forms weak balls; clods crumble	Continue irrigation
< 20 % (wilting point)	Hard, baked, cracked, light color	Continue irrigation

[1] = ribbon is formed by rolling soil between thumb and forefinger;

[2] = ball is formed by squeezing soil hard in fist

4.7.1. How to Manage Soil Moisture during Dry Season

General:

- If water is limited, select crops that will grow well under drier conditions (e.g. mungbean, cassava, eggplant).
- Select short-term vegetable crops that can be grown near a source of water such as a water well, the drain from washing areas or a water tank.
- Where feasible and affordable, use drip irrigation systems to maximize water usage efficiency.

Above the soil surface:

- Cover the soil around plants with a mulch of leaves, cut grass or rice straw.
- If plastic mulch is used, only silver-coated ones should be applied since black mulches heat up too much and can cause burning of stems and other plant parts.
- Provide young plants with shade - such as banana bracts - to keep them cool.
- Remove weeds because they compete with the plant's moisture intake.

Below the soil surface:

- Incorporate compost or other organic materials into the soil.
- One sack of compost is sufficient for an area of about 10 m^2 (corresponding to 2 ½ sacks per bed) to be applied before the start of the dry season.

4.7.2. How to Manage Soil Moisture during Wet Season

Above the soil surface:

- Plant crops in permanent raised beds to improve aeration and to avoid water logging.
- Plant crops that like to grow in wet areas, such as taro (*Colocasia esculenta*) and kangkong (*Ipomea aquatica*).
- Use coconut fronds or other materials to protect young plants and those with tender leaves from heavy rain.
- Grow vine plants up onto a trellis.

4.7.3. Drip Irrigation

Why use drip irrigation?

- Successful vegetable production requires sufficient amounts of evenly distributed water. Drip irrigation enables an efficient use of scarce or expensive water resources.
- Drip irrigation saves up to 60% of water over traditional methods since water is delivered directly to the roots of a crop; less water is lost to evaporation.
- Less weed growth occurs between plant rows during dry season.
- Fewer occurrences of diseases since only the root zone is wetted but not the leaf area.
- Precise application of nutrients is possible by applying water soluble fertilizers through drip irrigation (also termed as *fertigation*).
- Fertilizer costs can be reduced. Nutrient applications can be better timed according to plants' needs.

- Proven yield and crop quality responses to drip irrigation have been observed in many vegetable crops.

What is barrel drip irrigation?

- Water is supplied from an elevated barrel (not by a pump), thus utilizing the free gravitational force to run the system.
- Very applicable for areas smaller than one hectare.

Table 4: Components of barrel drip irrigation system

Component	Purpose/s
Water Drum/Barrel	Water storage for the drip system
Drip Stand	Holds the drum at a certain elevation so that the water can flow using the gravitational force (60 cm – 100 cm)
Filter	Screens particles that might clog the emitters
Main line	Conveys water from the drum towards the submain
Submain line	Conveys water from the main towards the laterals
Laterals	Conveys water from the submain to the emitters
Fittings (elbow, tee, coupling, union)	Important components for a flexible pipe system
Control Valve	To open/close the system and regulate the flow

What are the disadvantages of drip irrigation?

- Clogging of the emitters. Filters and laterals need regular flushing.
- Leakage at connections must by avoided.
- The laterals may be easily damaged during weeding or if people carelessly step on them.
- Rodents can cause damage of laterals.
- Initial investment for one parcel is between 7,000 to 10,000 Pesos. However, the system can be used for several years provided that it is well taken care off.

Where can I purchase drip irrigation systems?

- Several companies are selling drip irrigation systems in the Philippines.
- It is recommended that quality material be purchased only and from companies that provide good technical services.

What are the things that I must consider in operating and maintaining it?

- Make sure that the laterals are well placed. It is not necessary that there is one emitter per plant as long as the water is distributed evenly around the emitters.
- During the growing season, periodically check the entire system to make sure that it delivers water efficiently. That means uniform application, no leaks, no clogging.
- If you identify the damaged components, immediately repair or replace them if necessary.
- Clean the filter regularly.
- After the cropping season, flush the system thoroughly by allowing the water to flow through the laterals with their respective ends opened for several minutes. This will remove the particles deposited inside.

4.7.4. Treadle Pump

What is a treadle pump?

- A treadle pump is a foot operated water lifting device that can irrigate small plots of land in areas that have a water table which is not deeper than 7 to 8 m.
- Depending on the head, it can lift three to seven thousand liters of water per hour from shallow wells and boreholes as well as from surface water sources such as lakes and rivers.
- It is a low cost system, simple in design and easily manageable that appropriately answers the irrigation needs for small farmers who cultivate less than one hectare of land.

Advantages of treadle pumps:

- A treadle pump can be fabricated entirely from locally-available materials and can be manufactured using welding equipment and simple hand tools in the metal workshops commonly found in the Philippines.
- Since the treadle pump employs the user's body weight and leg muscles in a comfortable walking motion, use of the pump can be sustained for extended periods of time without excessive fatigue.
- The treadle pump is much less tiring to operate than other manual pumps that utilize the upper body and relatively weak arm muscles.
- It is gender sensitive since the pump can easily be operated by women, contributes to increase household food security and decreases the labor required to fetch water.

Disadvantages of treadle pumps:

- It is only suited for shallow wells with less than 7 m depth.

4.8. Crop Rotation

Crop rotation is the practice of alternating crops belonging to different botanical families in the same space in sequential seasons for various benefits such as:

- To avoid the build up of pathogens and pests.
- To balance the fertility demands of various crops to avoid excessive depletion of soil nutrients.
- To improve soil structure and fertility by alternating deep-rooted and shallow-rooted plants.
- To create biologically and economically durable crop systems.

4.9. Companion Planting

What is companion planting?

- Companion planting can be described as the establishment of two or more plant species in close proximity so that some cultural benefit (pest control, higher yield, etc.) is derived.

What are the positive effects of companion planting?

- Symbiotic nitrogen fixation:
  - Legumes have the ability to fix atmospheric nitrogen for their own use and for the benefit of neighboring plants.
- Biochemical pest suppression:
  - Some plants exude chemicals from roots or aerial parts that suppress or repel pests and protect neighboring plants.
- Physical spatial interaction:
  - The diverse canopy resulting when tall crops are companion-planted with shorter crops is believed to disorient the insects from finding and damaging them.
- Beneficial habitats:
  - The benefit is derived when companion plants provide a desirable environment for beneficial insects.
- Security through diversity:
  - A more general mixing of various crops and varieties provides a degree of security to the grower.

Although there are several references about beneficial relationships between plants, the science of companion planting is often anecdotal. The following tables suggest which vegetables and herbs should be planted close or far from each other, and list a number of pests as well as plants that are said to repel them.

Table 5: Good neighbors – Bad neighbors

Vegetable family	Good neighbors	Bad neighbors
Alliaceae (*onion, garlic*)	Solanaceae, Crucifers Cucurbits, Asteraceae, Herbs: *dill, parsley*	Legumes
Asteraceae (*lettuce*)	Legumes, Cucurbits, Alliaceae, Poaceae, Solanaceae Herbs: *basil*	Crucifers Apiaceae (carrots, celery) Herbs: *parsley*
Crucifers/Brassicas (*pak choy, cabbage, cauliflower, broccoli*)	Alliaceae Herbs: *thyme, mint, rosemary, coriander*	Solanaceae, Asteraceae
Cucurbits (*bittergourd, cucumber, bottlegourd, squash*)	Alliaceae, Legumes, Apiaceae Herbs: *dill, lemonbalm*	Solanaceae
Fabaceae/Legumes (*beans*)	Cucurbits, Asteraceae, Poaceae, Herbs: *rosemary, coriander*	Solanaceae, Alliaceae
Poaceae (*sweet corn*)	Legumes, Cucurbits, Asteraceae Herbs: *dill, amaranth*	Solanaceae, Apiaceae
Solanaceae (*tomato, eggplant, bell & hot pepper*)	Alliaceae, Legumes, Herbs: *basil, mint, oregano, lemon balm*	Crucifers, Legumes, Poaceae Herbs: *dill*

Table 6: Some pests and the plants that may repel them

Pest	Repellant Plant
Ants	Onion, Mint
Aphids	Chives, Coriander, Marigold, Mint
Bean Beetle	Rosemary
Cabbage Moth	Rosemary, Thyme, Coriander
Cabbage Worm	Celery, Thyme, Tomato, Dill, Lemongrass
Corn Earworm	Marigold
Cucumber Beetle	Marigold
Cutworm	Amaranth
Flea Beetle	Garlic, Mint
Nematodes	Marigold
Snails	Garlic, Rosemary
Spider Mites	Coriander
Whitefly	Basil, Marigold, Oregano, Mint

5. Standard Operating Procedures (SOPs) for Different Vegetable Crops

5.1. Solanaceae (Nightshade Family)

5.1.1. Tomato (*Lycopersicon esculentum*)

Local Name:	Kamatis
Recommended Cultivar:	'Hybrid # 17', '# 15', '# 10', '# 7' (Acosta Foundation Inc.)
Planting Distance:	2 plants/hill 40 cm between hills, two rows/bed (70 cm between rows)
Plant Density:	100 hills/bed (= 200 plants/bed) 27,778 hills/ha (= 5.6 plants/m^2)
1000-seed weight:	3.3 g (= 0.7 g/bed)

Climatic and soil requirements:

- Tomatoes usually set fruit only when night temperatures are below 20 °C. Certain cultivars, however, are also adapted for warmer climates of the tropical lowland and will bear fruit.
- Soil should be well-drained, not waterlogged and rich in organic matter, with a pH preferably ranging from 5.8 - 6.5.
- In tropical countries production of tomatoes is primarily limited by bacterial wilt (*Ralstonia solanacearum*), a soil born disease. The bacteria enter the plant through the roots with bacterial slime clogging the plant's water system and finally causing wilting and death.

Sowing and seedling establishment:

- Use multi-cellular plastic trays or "*lokong*";
- Sow 2-3 seeds per cell and cover with soil (depth of hole shall not be more than twice the size of the seed).

Transplanting:

- Tomato seedlings are placed outside the nursery 14 days after sowing for hardening; transplant 18 - 22 days after sowing;
- Do thinning within 10 - 14 days after transplanting to maintain 2 plants/hill;
- Plastic mulch is not recommended because burning of the sensitive seedlings was observed in many cases. However, organic mulches may be used to control weeds and maintain adequate soil moisture.

Trellising:

- Trellising is done after the 2nd sidedress to support the tomato vines and to prevent them from touching the ground.
- It also facilitates easier management and aeration of the crop, thus, reducing the risk of infestation with diseases.
- Trellis materials that can be used are bamboo or wooden poles for the base, GI wire and nylon string for tying the vines.

Fertilization scheme:

	Type and amount of fertilizer (gram/hill)						
Schedule of application	Chicken dung	DAP (18-46-0)	Urea (46-0-0)	MoP (-0-0-60)	Kieserite	Zinc Sulfate	Solubor
Basal (*at transplanting*)	100.0	10.0					
1st sidedress *(1 WAT)**			3.9	5.8	2.7	0.4	0.4
2nd sidedress *(3 WAT)*			7.9	5.8	2.7	0.3	0.3

**WAT = week(s) after transplanting*

Major pests:

- Tomato fruitworm (*Helicoverpa armigera*)
- White fly (*Bemisia tabaci*)
- Aphids (*Aphis* sp.)
- Nematodes

Control measures against pests are the use of appropriate pesticides. Tomato fruit worm can also be controlled by timely release of the egg parasitoid *Trichogramma chilonis*, if available. The control of aphids and white flies is important since they are carriers of different viruses. Nematodes can be prevented by planting marigold (*Tagetes* sp.) prior to the crop (see chapter 4.4.7).

Major diseases:

- Bacterial wilt (*Ralstonia solanacearum*)
- Early blight (*Alternaria solani*)
- Late blight (*Phytophthora infestans*)
- Tomato mosaic virus (TMV)
- Tomato yellow leaf curl virus (TYLCV)

Control measures:
- o Use of tolerant or resistant cultivars.
- o Good sanitation (i.e. timely removal and burning/burying of diseased plant parts).
- o Use of appropriate pesticides. It is important to also include the underside of the leaves in the spraying schemes to protect them from bacterial and fungal infestation (the spraying movement should correspond to the letter "C").
- o A "No smoking" policy in the garden can prevent the spread of TMV.

Nutrient deficiencies:
- o Blossom end rot is a calcium deficiency symptom often caused by poor management practices, such as giving too much or too little water and applying excess amounts of potassium and magnesium fertilizers.
- o If symptoms occur, foliar application of calcium-based fertilizers using knapsack sprayer at a rate of 5 to 10 grams fertilizer per liter of water may be done.

Harvesting:
- o The first harvest is 60 to 70 days after transplanting depending on the desired maturity (green mature, breaker, full red) of the fruit and continues thereafter on a weekly basis for a period of one month.

5.1.2. Eggplant (*Solanum melongena*)

Local Name:	Talong
Recommended Cultivar:	'Casino 901' (East West Seed Company)
Planting Distance:	1 plant/hill 40 cm between hills, two rows/bed (70 cm between rows)
Plant Density:	100 hills/bed (= 100 plants/bed) 27,778 hills/ha (= 2.8 plants/m^2)
1000-seed weight:	4.0 g (= 0.4 g/bed)

Climatic and soil requirements:
- o Eggplant is a warm weather crop and grows best under temperatures between 21 to 29 °C.
- o It can tolerate drought and excessive rainfall but becomes more vegetative if temperatures and humidity are high.
- o Eggplant prefers well-drained soils rich in organic matter, with soil pH ranging between 5.8 - 6.5.

Sowing and seedling establishment:

- Use multi-cellular plastic trays or "*lokong*", sow 1-2 seeds per cell and cover with soil.

Transplanting:

- Plastic mulch is recommended to reduce weed growth and to prevent the larvae of the eggplant fruit and shoot borer to enter the soil for pupation.
- Place plastic mulch on the prepared bed 2-3 weeks before transplanting. Irrigate the bed up to water saturation to allow sterilization through solar heat (see chapter 4.4.6 for more details).
- Eggplant seedlings are placed outside the nursery 21 days after sowing for hardening; transplant them 25-28 days after sowing at a seedling height of 7-10 cm.
- Do thinning within 10-14 days after transplanting to maintain 1 plant/ hill.

Fertilization scheme:

	Type and amount of fertilizer (gram/hill)						
Schedule of application	Chicken dung	DAP (18-46-0)	Urea (46-0-0)	MoP (-0-0-60)	Kieserite	Zinc Sulfate	Solubor
Basal (*at transplanting*)	100.0	10.0					
1st sidedress (*1 WAT*)			3.9	5.8	2.7	0.4	0.4
2nd sidedress (*3 WAT*)			7.9	5.8	2.7	0.3	0.3

WAT = week(s) after transplanting

Weed management:

- Since eggplant grows rather slowly, it cannot compete with weed growth, which may harbor damaging insects and diseases. Placement of mulch can reduce the need for frequent hand weeding.

Major pests:

- Eggplant Fruit and Shoot Borer/EFSB (*Leucinodes orbonalis)*
- White fly (*Bemisia tabaci*)
- Aphids (*Aphis sp.)*
- Eggplant Leaf Roller (*Eublemma olivacea*)
- Mites

The EFSB is difficult to control once the larvae are inside the fruit and the shoots. Hence, it is important to apply insecticides shortly after they hatch from the eggs because this is their only vulnerable stage. The use of pheromone traps can give an indication of the mating time of the adults, thus, enabling determination of the time of egg deposit. At this stage, the gardener has to continuously look for egg deposits near the fruits and shoots with the larvae hatching a few days thereafter. Once the fruits and shoots are infested, they have to be continuously pruned and removed.

The control of aphids and white flies is equally important since they are carriers of different viruses. Appropriate insecticides and miticides may be used if other preventive measures have failed.

Major diseases:
- Powdery mildew (*Levillula taurica*)
- Anthracnose fruit rot (*Colletotrichum melongenae*)
- Fusarium wilt (*Fusarium oxysporum*)

Control measures against diseases are the use of tolerant or resistant cultivars, good sanitation and use of appropriate pesticides.

Harvesting:
- First harvest is 60 days after transplanting, and continues on a weekly basis for a period of 2-3 months.

5.1.3. Sweet Pepper (*Capsicum annuum*)

Local Name:	Atsal
Recommended Cultivar:	'Yolo Wonder' (*bell pepper type*) (Ramgo) 'Majesty' (*plastic pepper type*) (EastWest Seed Company)
Planting Distance:	2 plants/hill 40 cm between hills, two rows/bed (70 cm between rows)
Plant Density:	100 hills/bed (= 200 plants/bed) 27,778 hills/ha (= 5.6 plants/m^2)
1000-seed weight:	5.5 g (= 1.1 g/bed)

Climatic and soil requirements:
- Sweet pepper prefers temperatures between 21 and 24°C.

- It grows best in well-drained soils with good water-holding capacity, rich in organic matter, and a soil pH between 5.5 and 6.8.

Sowing and seedling establishment:

- Sow 2-3 seeds per cell of multi-cellular plastic trays or "*lokong*" and cover with soil.

Transplanting:

- Plastic mulch is recommended to reduce weed growth.
- Place plastic mulch on the prepared bed one week before transplanting. Irrigate the bed up to water saturation to allow sterilization through solar heat ("soil solarization").
- Pepper seedlings are placed outside the nursery 21 days after sowing for hardening; transplant 25-28 days after sowing at a seedling height of 7-10 cm.
- Do thinning within 10-14 days after transplanting to maintain 2 plants/ hill.

Fertilization scheme:

	Type and amount of fertilizer (gram/hill)						
Schedule of application	Chicken dung	DAP (18-46-0)	Urea (46-0-0)	MoP (-0-0-60)	Kieserite	Zinc Sulfate	Solubor
Basal (*at transplanting*)	100.0	10.0					
1st sidedress (*1 WAT*)			3.9	5.8	2.7	0.4	0.4
2nd sidedress (3 *WAT*)			7.9	5.8	2.7	0.3	0.3

WAT = week(s) after transplanting

Major pests:

- Thrips (*Thrips palmi*)
- White fly (*Bemisia tabaci*)
- Aphids (*Aphis* sp.)
- Fruitworm (*Helicoverpa armigera*)

Control measures against pests are the use of appropriate pesticides. Fruit worm can also be controlled by timely release of the egg parasitoid *Trichogramma chilonis*, if available. The control of thrips, aphids, and white flies is very important since they are carriers of different viruses.

Major diseases:
- Antracnose (*Colletotrichum piperatum*)
- Bacterial wilt (*Ralstonia solanacearum*)
- Bacterial soft rot (*Erwinia carotovora*)
- Bacterial spot (*Xanthomonas campestris*)
- Phytophthora blight (*Phytophthora capsici*)
- Cucumber mosaic virus (CMV), chilli veinal mottle virus (ChiVMV), tobacco mosaic virus (TMV)

Control measures against diseases are the use of tolerant or resistant cultivars, good sanitation and use of appropriate pesticides. Thrips prefer to stay in the flowers of pepper. Hence, it is important to include the flowers in the spraying scheme. A "No smoking" policy in the garden can prevent the spread of TMV.

Harvesting:
- Harvest starts about 60 days after transplanting (35–40 days from flowering), and continues on a weekly basis for a period of 2 months.
- Sweet pepper should be harvested when fruits reach full size and become firm, but before turning color (unless they are intended for mature color yellow, orange, or red).
- Since stems of pepper plants are very fragile, a knife should be used to harvest fruits. Mechanical transmission of viruses can be avoided by dipping knives routinely in milk.

5.2. Fabaceae (Legumes)

5.2.1. String Bean (*Vigna unguiculata* subsp. *sesquipedalis*)

Local Name:	Sitaw
Recommended Cultivar:	'Sierra Madre' (EastWest Seed Company) 'Bush sitaw' (Acosta Foundation Inc.)
Planting Distance:	2 plants/hill 30 cm between hills, two rows/bed (70 cm between rows)
Planting Density:	133 hills/bed (= 266 plants/bed) 37,038 hills/ha (=7.4 plants/m^2)
1000-seed weight:	270 g (= 72 g/bed)

Climatic and soil requirements:
- Optimum growth is at a temperature range of 20-35 ºC.
- String bean thrives in a wide range of soil types from sandy to clay soils and is generally tolerant to acidic soils.

- Although it is an all-season crop, it is susceptible to both drought and waterlogging. Heavy and continuous rain during the wet season may induce rotting of pods.
- When grown under a long period of cloudy days, string beans become excessively vegetative.

Seed preparation:

- If the area is to be planted with beans for the first time, seeds should be treated with a *Rhizobium* inoculant to enable uptake of atmospheric nitrogen.
- Make sure that the inoculant is suited for the specific bean planted.
- Different *Rhizobium* strains are available at the Department of Agriculture.

Direct seeding:

- Apply basal fertilizer according to recommendation below.
- Cover fertilizers with 2 cm soil before sowing 2-3 seeds per hill at 30.0 cm distance between hills. This will avoid burning of the germinating seedling.
- Cover seeds with 2-3 cm soil after planting.

Fertilization scheme:

	Type and amount of fertilizer (gram/hill)	
Schedule of application	Chicken dung/ Compost	Complete (14-14-14)
Basal	50.0	10.0
1st sidedress (*2 weeks after sowing*)*		10.0
2nd sidedress (*4 weeks after sowing*)*		10.0

** On an as needed basis if plants show nutrient deficiency symptoms*

Trellising:

- Trellising is done 2 weeks after sowing to support the vines and to prevent pods from touching the ground.
- It also facilitates easier management and aeration of the crop, thus, reducing the risk of infestation with diseases.
- Trellis materials that can be used are bamboo or wooden poles for the base, GI wire and nylon string for tying the vines.
- The cultivar 'bush sitaw' does not necessarily need trellising since vines are shorter.

Mulching:
- Mulch with plastic sheets, rice straw or other organic materials to control weeds and regulate soil moisture.
- If plastic mulch is used, it has to be installed prior to sowing.

Major pests:
- Cutworm (*Spodoptera litura*)
- Aphids (*Aphis* sp.)
- Thrips (*Thrips palmi*)
- Leaf miner (*Lyriomiza* sp.)
- Bean fly (*Ophiomyia phaseoli*)
- Leafhopper (*Empoasea* sp.)
- Legume podborer (*Maruca vitrata)*

Control measures:
- Aphids have to be controlled in the early stage of the crop to minimize the risk of virus infestation.
- Leaf miners may appear in the vegetative stage of the crop and reduce photosynthetic active areas of the leaves, thus reducing yield potential.
- The legume podborer is a key pest of legume crops in Southeast Asia. The larvae attack flower buds, flowers and young pods.
- Conventional insecticides can control insect pests effectively. Alternatives are botanical pesticides such as neem (*Azadirachta indica*) and papaya (*Carica papaya*) extracts.

Major diseases:
- Damping-off
- Different viruses

Control measures:
- The use of tolerant or resistant cultivars, proper crop rotation and sanitation can reduce the impact of these diseases.

Harvesting:
- String beans can be harvested 45-65 days after plant emergence. Green tender pods are harvested 7-10 days after flowering when seeds are partly developed but hardly evident from the outside of the pod.
- Pods are picked at a 2-day interval to prolong the productive life of the crop. If pods are allowed to mature, the overall plant life will be shortened.
- Harvesting should be done early in the morning so as not to expose the pods to sunlight, thus, minimizing transpiration.

5.2.3. Winged Bean (*Tetragonolobus purpureus*)

Local Name:	Seguidellas, quatro kantos
Recommended Cultivar:	any open pollinated cultivar
Planting Distance:	1 plant/hill 50 cm between hills, two rows/bed
Plant Density:	80 hills/bed (= 80 plants/bed) 22,222 hills/ha (= 2.2 plants/m^2)
1000-seed weight:	500 grams (= 40 g/bed)

Climatic and soil requirements:

- Winged bean grows abundantly in hot, humid climates and does well in areas with high rainfall.
- However, most winged beans cultivars are daylength sensitive and flower only during short days (from October to March).
- Hence, sowing should be done in the months September to January only to ensure flowering and pod development.
- In the remaining months of the year, winged bean tends to stay vegetative only, i.e. it will produce shoots and leaves only, but no flowers and pods.

Seed preparation and inoculation:

- If the area is to be planted with beans for the first time, seeds should be treated with a *Rhizobium* inoculant.

Fertilization scheme:

	Type and amount of fertilizer (gram/hill)	
Schedule of application	Chicken dung/ Compost	Complete (14-14-14)
Basal	50.0	10.0
1st sidedress (*2 weeks after sowing*)*		10.0
2nd sidedress (*4 weeks after sowing*)*		10.0

** On an as needed basis if plants show nutrient deficiency symptoms*

Direct seeding:

- Apply basal fertilizer according to recommendation above.
- Cover fertilizers with 2 cm soil before sowing 1 seed per hill at 50 cm distance between hills. This will avoid burning of the germinating seedling.
- Cover seeds with 2-3 cm soil after planting.

Trellising:
- Trellising is done two weeks after sowing to support the vines and to prevent pods from touching the ground. It also facilitates easier management and aeration of the crop, thus, reducing the risk of infestation with diseases.
- Trellis materials that can be used are bamboo or wooden poles for the base, GI wire and nylon string for tying the vines.

Mulching:
- Mulch with plastic sheets, rice straw or other organic materials to control weeds.
- If plastic mulch is used, it has to be installed prior to sowing.

Harvesting:
- Winged bean can be harvested 60-90 days after plant emergence. Harvest green tender pods.
- Aside from the pods, its young leaves and shoots may also be eaten either as leafy vegetables or pickled. The ripe seeds can be roasted as a substitute for peanuts.
- Winged beans have numerous edible roots which grow at shallow depth and become thick and tuberous. The roots contain about 20 % crude protein (as compared to potatoes or yams that usually have less than 7% protein).

5.2.3 Yambean (*Pachyrrhizus erosus*)

Local Name:	Singkamas
Recommended Cultivar:	any locally available cultivar
Planting Distance:	1 plant/hill 20 cm between hills, three rows /bed (35 cm between rows)
Plant Density:	300 hills/bed (= 300 plants/bed) 83,333 hills/ha (= 8.3 plants/m^2)
1000-seed weight:	300 grams (= 90 g/bed)

Climatic and soil requirements:
- Yambean, also known as jicama, is a legume crop grown for its large tuberous roots which can be eaten raw or cooked. It prefers warm, dry climates and can be grown year round.
- It prefers light (alluvial) and well drained soils, as these remain loose after rain or irrigation.
- Heavy soils are not desirable because of their poor drainage. They may also cause deformation of the tubers.

Cultural management practices:
- o Bed preparation must be thorough to a depth of 0.25 m.
- o Smooth the surface to ensure an even germination.

Seed preparation:
- o Seeds should be inoculated with *Rhizobium* on the day of planting.

Fertilization scheme:

	Type and amount of fertilizer (gram/linear meter)		
Schedule of application	Chicken dung/ Compost	DAP (18-46-0)	MoP (0-0-60)
Basal (*before sowing*)	250	80	32

- o Fertilizer is applied evenly in furrows using the row placement (band) and covered with 2-3 cm of fine soil. Seeds are drilled above the covered fertilizers and covered with a further 3-4 cm layer of soil.

Weeding:
- o Weeding is done at least twice during the first couple of months to eliminate weeds and to hill up the ridges to cover the growing tubers.

Water management:
- o The initial irrigation is crucial for even germination.
- o Once the crop is well established, a suitable soil moisture content must be maintained.

Pruning:
- o Removal of reproductive shoots is necessary to obtain maximum tuber yields.

Major pests:
- o Yambean produces a natural insecticide in the above ground plant parts, which protects the plant from harmful pests.

Major diseases:
- o Bean common mosaic virus (BCMV)
- o Witch's broom disease (mycoplasma-like organism)
- o Root rot (*Pythium* spp.)

Harvesting:
- o To avoid splitting or cracking of the tubers, care should be taken not to irrigate during the two weeks prior to harvest.
- o Harvest takes place once the tuberous roots have attained marketable size (depending on whether small, medium sized or large tubers are preferred by consumers).

- Harvest the tubers by hand, using a hoe.
- Leave the vegetative top in the bed to be incorporated into the soil (green manuring) or use it for composting.
- Dry lifted tubers in the sun for 1-2 weeks before selling to increase the sugar content by conversion of the starch.

5.2.4. Mungbean (*Vigna radiata*)

Local Name:	Monggos
Recommended Cultivar:	Any available local cultivar
Planting Distance:	1 plant/hill 5 cm between hills, three rows/bed
Plant Density:	1200 hills/bed (= 1200 plants/bed) 333,333 hills/ha (= 33.3 plants/m^2)
1000-seed weight:	30 grams (= 36 g/bed)

Cultivar selection:

- Recommendations for suitable cultivars can be obtained by the Department of Agriculture as well as the World Vegetable Research and Development Center (AVRDC) in Taiwan which is the international center for mungbean research.

Climatic and soil requirements:

- Mungbean grows best on fertile sandy loam soils with good internal drainage and prefers soil pH values ranging from 6.2-7.2.
- Mungbean is responsive to length of daylight. Short days hasten flowering and long days delay it.

Inoculation:

- Seeds are placed in a container and sprinkled with small amount of water, followed by the inoculant powder (appropriate *Rhizobium* strain). These are mixed thoroughly until the seeds are coated with the inoculant and appear almost dry.
- 500 g inoculant is recommended to coat 50 kg of seeds.
- Immediately sow the inoculated seeds. If sowing will be delayed, inoculated seeds should be protected from high temperature, drying, and direct sunlight until used. Exposure will destroy the rhizobia and render inoculation ineffective.
- The inoculant should be refrigerated and used before the expiration date indicated on the package.

Direct seeding:

- Before direct seeding, the bed has to be soaked up to saturation.
- Fertilizer is applied using the row placement (band) method using the amounts indicated below.

- The fertilizer is applied evenly in furrows and covered with 2 or 3 cm of fine soil to avoid burning of the germinating seedlings.
- Cover seeds with 1 cm soil after planting.

Fertilization scheme:

	Type and amount of fertilizer (gram/linear meter)		
Schedule of application	Chicken dung/ Compost	DAP (18-46-0)	Muriate of Potash (0-0-60)
Basal (*before sowing*)	250	80	32

** Note: fertilizer amounts are given per linear meter, not per hill*

Water management:

- Although mungbean is drought tolerant, adequate irrigation is required from flowering to late pod fill to ensure good yield.

Major pests:

- In general, mungbean does not require insecticide sprays to control problems in the field. Occasional grasshopper or caterpillar infestation could occur and result in defoliation. Podborers may affect developing seeds. Weevils can attack the seed in storage.

Major diseases:

- Mungbean is susceptible to the usual array of pathogens which attack other legumes such as *Phytophthora*, mildew, bacterial rots and *Rhizoctonia*. Proper crop rotation, tillage practices, and water management (avoid excess irrigation) can be effective in reducing the impact of these diseases.

Harvesting:

- Pod maturity is not uniform because the plants flower over an extended period. This makes it difficult to decide when to harvest.
- Generally, harvest begins at 60 days after sowing when 1/2 to 2/3 of the pods are mature.
- As many as 5 harvest rounds may be done on some cultivars.

Drying and storage:

- Harvested pods are placed in mosquito nets or empty sacks. Slightly step on them until all pods are open and seeds are released.
- Prior to storing, remove all leaf material, stems, immature pods, dirt, insect parts and other debris.
- Expose beans to full sunlight until they are fully dried. You can assess the exact dryness by biting some of the seeds. If the seed separates, then they are dry.

5.2.5. Ricebean (*Vigna umbellata*)

Local Name:	Tahore
Recommended Cultivar:	Any available local cultivar
Planting Distance:	1 plant/hill 5 cm between hills, three rows/bed
Plant Density:	1200 hills/bed (= 1200 plants/bed) 333,333 hills/ha (= 33.3 plants/m^2)
1000-seed weight:	68 grams (= 82 g/bed)

- Ricebean is considered as one of the under-utilized indigenous legumes of the Philippines. It can also be used as a soil improving, nitrogen-fixing green manure crop (see also chapter 4.3.4).
- Its cultural management practices correspond to those described for mungbean.

5.3. Brassicaceae (Crucifers)

5.3.1. Cauliflower (*Brassica oleracea* var. *botrytis*)

Local Name:	Koliflawer
Recommended Cultivar:	'White Island' ('SC2-45') (Sakata; Allied Botanicals) 'White Coral F1' (Kaneko)
Planting Distance:	1 plant/hill 30 cm between hills, four rows/bed
Plant Density:	267 hills/bed (= 267 plants/bed) 74,105 hills/ha (= 7.4 plants/m^2)
1000-seed weight:	3 grams (= 0.8 g/bed)

Climatic and soil requirements:

- Cauliflower usually forms curds only when night temperatures are below 20 °C.
- Certain cultivars, however, are also adapted for warmer climates of the tropical lowland and will develop curds.
- Cauliflower grows best on well-drained, loamy soils with high levels of organic matter and a soil pH of 6.0 - 6.8.

Nursery:

- Sow 1 to 2 seeds per cell either in plastic trays or *lokong*.
- Cover the seedtrays/*lokong* with coconut leaves or empty sacks for about 1 week until germination.
- If necessary, spray with fungicides to prevent damping-off.

- Protect the young seedlings with (mosquito) net until transplanting (21-25 days after sowing) to prevent insects from depositing their eggs.
- Water regularly.

Transplanting:

- Moisten bed one hour before transplanting to prevent transplanting shock.
- Transplant only healthy seedling free from insect damage, egg deposits and disease symptoms.
- Place 100 g of chicken dung and 10 g of Diammonium phosphate into the planting hole and cover with a soil layer of about 4 cm to avoid burning of roots before setting the seedling.
- Cover seedlings with banana bracts if available and water them.

Fertilization scheme:

	Type and amount of fertilizer (gram/hill)						
Schedule of application	Chicken dung	DAP (18-46-0)	Urea (46-0-0)	MoP (-0-0-60)	Kieserite	Zinc Sulfate	Solubor
Basal *(at transplanting)*	100.0	10.0					
1st sidedress *(1 WAT)*				3.8	3.6	0.5	0.5
2nd sidedress *(3 WAT)**			4.6				

** at start of curd/head forming*

Irrigation:

- Irrigate regularly but do not over-water in the first 2-3 weeks after transplanting.
- Never allow plants to wilt, especially when the crop arrives at the 6-7 leaf stage so that the curds will not be affected.

Weed management:

- Continuously remove weeds until plants have been fully established.

Major pests:

- Diamond back moth (*Plutella xylostella*)
- Flea beetle (*Phyllotreta cruciferae*)

- Aphids (*Aphis* sp.)
- White fly (*Bemisia tabaci*)

Control methods:

- Diamond back moth is the most prevalent pest of cauliflower and other brassicas. Insects have developed resistance to most pesticides (including biological ones), hence, a combined strategy of using different classes of insecticides and biological control methods is the most promising one.
- Parasitoids:
  - *Diadegma semiclausum* and *Cotesia plutella* are parasitizing larvae of diamond back moth, with *Diadegma* preferring cooler climates than *Cotesia.* Release must be done in weekly intervals.
  - *Trichogramma chilonis* parasitizes eggs of diamond back moth. So-called "tricho-cards" containing eggs of trichogramma are released to the field when egg deposit of diamond back moth has started at weekly intervals.
- Biological insecticides:
  - Several strains of *bacillus thuringiensis* (Bt) are effective against diamond back moth, although resistances have been reported.
- Botanical insecticides:
  - Extract of neem tree seeds or leaves can also be used with seed extracts being more effective.
- Chemical insecticides:
  - Pyrethroids (i.e. Karate, Ripcord, etc) and organophosphates (Selecron, etc.) should be alternately applied to avoid build-up of resistances.

Important:

- Since biological, botanical and chemical insecticides have to be ingested by the larvae, it is essential to mix them with a sticker (Hoestick, etc.). Since the leaf surface of cauliflower and other brassicas is waxy, insecticides tend to pearl off without sticker, thus making them ineffective.
- Since the parasitoids described above are also insects, it is important to release a new batch after each insecticide application.

Major diseases:

- Head rot (*Rhizoctonia solani)*
- Clubroot *(Plasmodrophora brassicae)*

Control measures:

- Head rot, a firm to slimy dark decay at the base of the outer leaves which wilt and turn to black near the main stem, can be controlled by application of appropriate fungicides and proper sanitation (removal and burning of leaves).
- If symptoms of clubroot are observed (abnormal enlargement of roots; tops become stunted, yellowish and wilt), discard affected plants and do not plant crucifers for the next three years. Liming to a soil pH to 6.5 or higher can avoid occurrence of this disease.

Physiological disorders and their causes:

- Hollow flower stalks:
  - too rapid vegetative growth due to excess nitrogen.
- Ricey:
  - high temperatures during curd development.
- Leaves in curd:
  - revision to vegetative growth (too much nitrogen).
- Yellow, green curds:
  - excessive exposure to sunlight and resultant chlorophyll formation. This can be avoided by closing the wrapper leaves around the forming curd with a toothpick or rubber band 1 to 2 weeks before harvest.
- Browning of curds:
  - Boron and calcium deficiency and certain diseases.
- Purple curd discoloration:
  - over maturity, poor leaf cover, phosphorous deficiency.
- Internal cavitations:
  - high nitrogen and water rates, boron deficiency.
- Buttons:
  - premature shift to generative stage (using plants that are quite large at the time of transplanting; severe nitrogen deficiency).
- Blindness:
  - growing prints damage from insects.
- Witches brooming:
  - Boron deficiency.

Harvesting:

- Cauliflower is ready for harvesting about 45 to 60 days after transplanting, depending on cultivar and season.
- Harvest cauliflower heads when they are 12 to 15 cm in diameter. They should be firm, white, not discolored, ricey or blemished.

- Cauliflower harvest starts when about 10 % of the heads are ready and is continued for 5 to 6 times at an interval of 4 to 8 days.
- The curds get easily damaged, hence handle them with great care.

5.3.2. Broccoli (*Brassica oleracea* var. *italica*)

Local Name:	Brokkoli
Recommended Cultivar:	'Tenjiku' (Kaneko Seeds)
Planting Distance:	1 plant/ hill 30 cm between hills, four rows/bed
Plant Density:	267 hills/bed (= 267 plants/bed) 74,105 hills/ha (= 7.4 plants/m^2)
1000-seed weight:	3 grams (= 0.8 g/bed)

The standard operating procedures for broccoli correspond to those of cauliflower (chapter 5.3.1).

Harvesting:

- Depending on the variety and season, broccoli is ready for harvest at 45 to 60 days after transplanting, when the heads - whether large or small, central or side - are well developed and compact, with buds unopened. Any appearance of yellow petals in the heads indicates overmaturity.
- After harvesting heads, broccoli stems are trimmed to 10 to 20 cm long and the leaves removed.

5.3.3. Head Cabbage (*Brassica oleracea* var. *capitata*)

Local Name:	Repolyo
Recommended Cultivar:	'Apo Verde' (EastWest Seed Company)
Planting Distance:	1 plant/hill 30 cm between hills, four rows/bed
Plant Density:	267 hills/bed (= 267 plants/bed) 74,105 hills/ha (= 7.4 plants/m^2)
1000-seed weight:	4 grams (= 0.8 g/bed)

The standard operating procedures for head cabbage correspond to those of cauliflower (chapter 5.3.1).

Harvesting:

- Harvest starts 50-60 days after transplanting.
- Heads should be firm to hard at harvest. The heads are cut at the base and the outer leaves are trimmed off.

5.3.4. Pak Choy/ Bok Choy (*Brassica rapa* var. *chinensis*)

Local Name:	Pechay
Recommended Cultivar:	'Pavito','Black Behi' (EastWest Seed Company)
Planting Distance:	1 plant/hill 20 cm between hills, four rows/bed
Planting Density:	400 hills/bed (= 400 plants/bed) 111,111 hills/ha (=11.7 plants/m^2)
1000-seed weight:	3 grams (= 1.2 g/bed)

Climatic and soil requirements:

- Pak choy requires 8 hours direct sunlight and grows best on well-drained, loamy soils rich in organic matter and a soil pH between 6.5-7.0. It is sensitive to acidic conditions below pH 6.0.

Sowing and seedling establishment:

- Use multi-cellular plastic trays or "*lokong*" and sow 1-2 seeds per cell.
- Cover with empty sacks until seeds germinate.

Transplanting:

- Transplant seedlings 21 days after sowing.
- Do thinning 1 week after transplanting to maintain 1 plant/hill.
- Provide some protection from the wind since young plants can bruise easily in windy conditions.

Fertilization scheme:

	Type and amount of fertilizer (gram/hill)	
Schedule of application	Chicken dung/ Compost	14-14-14
Basal *(at transplanting)*	100.0	10.0

Irrigation:

- Pak choy is shallow-rooted and requires frequent watering.

Major pests:

- White fly (*Bemisia tabaci*)
- Aphids (*Aphis* sp.)
- Diamond back moth (*Plutella xylostella*)
- Flea beetle (*Phyllotreta cruciferae*)

Major diseases:

- Head rot (*Rhizoctonia solani)*
- Clubroot *(Plasmodrophora brassicae)*

The control measures for pest and diseases follow those described for cauliflower (chapter 5.3.1). Large amounts of nitrogen may increase the incidence of bacterial soft rots.

Harvesting:

- Pak choy is usually harvested by hand, cut off at the base 35 to 50 days after sowing (2-4 weeks after transplanting).
- Harvest when leaves are fresh and crisp, and before the outer leaves turn yellow.

Post-harvest handling:

- Remove any dead or damaged leaves, trim the base and wash the plant.
- Harvested pak choy is very susceptible to wilting.

5.4. Cucurbitaceae (Cucurbits)

5.4.1. Bittergourd (*Momordica charantia*)

Local Name:	Ampalaya
Recommended Cultivar:	'Jade Star', 'Galaxy' (East West Seed Co.)
Planting Distance:	1 plant/hill 50 cm between hills; two rows/bed
Plant Density:	80 hills/bed (= 80 plants/bed) 22,222 hills/ha (= 2.2 plants/m^2)
1000-seed weight:	60 grams (= 4.8 g/bed)

Climatic and soil requirements:

- Bittergourd thrives well in hot and humid climates.
- Soil must be well-drained and rich in organic matter with a pH ranging from 5.5 – 7.0.

Direct seeding:

- Bittergourd is preferably planted by direct seeding into the beds rather than transplanted.
- To promote germination, soak seeds in water 24 hours before sowing. Seeds are planted the following day or as the radicle breaks.
- Place 1-2 seeds per hill about 2 cm deep. The seeds will germinate in 2-3 days.
- Do thinning after 2-3 weeks to maintain one plant per hill.

Mulching:

- Mulching can help to prevent fruit from touching the ground. It also conserves soil moisture and prevents weeds from growing.

Irrigation:

- Irrigate cucurbit crops daily, especially during dry season. However, provide adequate drainage to avoid water logging.

Trellising:

- Use trellis to prevent the fruits from rotting and malformation.
- Construct vertical and overhead trellis using ipil-ipil or bamboo poles with a combination of GI wire or nylon string.

Crop maintenance:

- Vines should be pruned at the tips when female flowers start developing to encourage branching and fast bearing.

Fertilization scheme:

Schedule of application	**Type and amount of fertilizer (gram/hill)**	
	Chicken dung/ Compost	Complete (14-14-14)
Basal application	100.00	18.0
1st sidedress (*3 WAT*)		9.0
2nd sidedress (*6 WAT*)		9.0

WAT = weeks after transplanting

- Water immediately after applying fertilizers, since cucurbits are sensitive to high salt concentrations.

Major pests:

- The fruit is subject to attack by fruit flies (*Bactrocera cucurbitae*) which can be prevented by wrapping fruit with newspaper when they are a few centimeters long.
- Other major insect pests are the squash beetle (*Epilachna philippinensis*) and aphids (*Myzus persicae*).

Major diseases:

- Watermelon mosaic virus and other cucurbit viruses can be prevented by controlling vectors such as aphids and other sucking insects.
- Powdery mildew (*Erysiphe cichoracearum, Sphaerotheca fuliginea*) can be controlled by sulfur dust.
- Proper field sanitation such as the removal and burning of infected plant parts, as well as crop rotation, are preventive measures.

Harvesting:
- o Harvesting starts 45 to 50 days after seeding.
- o Harvest fruit every 2-3 days when it is light green, tender and juicy with white flesh.
- o Regular picking, as well as removal of deformed and damaged fruit is important to promote the growth of new fruit.
- o Allow some healthy fruit to reach full maturity from which to harvest seeds for subsequent crops.
- o When fully mature, the fruit will break open and release brownish seeds which can be collected, dried and stored.

5.4.2. Bottlegourd (*Lagenaria sicenaria*)

Local Name:	Upo
Recommended Cultivar:	'Dalisay' (East West Seed Company)
Planting Distance:	1 plant/hill 50 cm between hills, two rows/bed
Plant Density:	80 hills/bed (= 80 plants/bed) 22,222 hills/ha (= 2.2 plants/m^2)
1000-seed weight:	150 grams (= 12 g/bed)

Climatic and soil requirements:
- o As other cucurbits, bottle gourd prefers the climate of the tropical lowland. Soil should be well-drained and rich in organic matter with a pH ranging from 5.5 – 7.0.

Crop maintenance:
- o The standard operating procedures for bottlegourd correspond to those of bittergourd (see chapter 5.4.1).
- o Bottle gourd is a vigorous climbing vine with large leaves. It grows fast and may begin to flower in only 2 months after seeding.
- o The white flowers are borne singly on the axils of the leaves, the males on long peduncles and the females on short peduncles.
- o Fruit set can be improved by hand pollination

Harvesting:
- o The fruit of bottlegourd develops fast and requires much attention at harvest time. It usually takes only 15 days from the day of fruit set for fruit to reach marketable stage. Cut the peduncle to approximately 5 cm in length.
- .o When bottle gourds are to be used as containers, the gourds are permitted to obtain maximum maturity on the vine before harvest.

5.4.3. Sponge gourd (*Luffa cylindrica*)

Local Name:	Patola
Recommended Cultivar:	'Esmeralda' (East West Seed Company)
Planting Distance:	1 plant/hill 50 cm between hills; two rows/bed
Plant Density:	80 hills/bed (= 80 plants/bed) 22,222 hills/ha (= 2.2 plants/m^2)
1000-seed weight:	90 grams (= 7.2 g/bed)

The climatic and soil requirements as well as the crop production procedures for sponge gourd correspond to those described for bittergourd in chapter 5.4.1.

5.4.4. Cucumber *(Cucumis sativus*)

Local Name:	Pipino
Recommended Cultivar:	'Green Beret', 'Big C' (East West Seed Company)
Planting Distance:	1 plant/hill 40 cm between hills, two rows/bed
Plant Density:	100 hills/bed (=100 plants/bed) 27,778 hills/ha (= 2.8 plants/m^2)
1000-seed weight:	25 grams (= 2.5 g/bed)

Climatic and soil requirements:

- Cucumber is a warm season crop and grows best on soils with a pH of 5.8 - 6.5, which should be rich in organic matter and well-drained.

Crop maintenance:

- The standard operating procedures for cucumber correspond to those of bittergourd (see chapter 5.4.1), except that only one sidedress fertilizer application is needed due the shorter production cycle.
- Poorly developed or misshapen fruit may be the result of poor pollination (absence of pollinators such as bees; prolonged periods of rainfall) or due to nutrient deficiency, particularly lack of boron.
- Cucumber requires a constant water supply to reach high quality yields.

Harvesting:

- Pick cucumbers while they are still tender, crisp and green. Remove large fruits from the vine so that new fruits are encouraged to grow. Small young cucumbers may be harvested to be used for pickling.

5.5. Alliaceae (Onion Family)

5.5.1. Bulb Onion (*Allium cepa*)

Local Name:	Sibuyas bombay
Recommended Cultivar:	'Red Pinoy' (East West Seed Company)
Planting Distance:	1 plant/hill 15 cm between hills, six rows/bed
Plant Density:	800 hills/bed (= 800 plants/bed) 222,222 hills/ha (= 22.2 plants/m^2)
1000-seed weight:	3 grams (= 2.4 g/bed)

Climatic and soil requirements:

- Onions grow well in friable and well-drained loamy soil with good water holding capacity and a pH ranging between 6.0-7.0.
- Onions require cooler weather during the early stages of growth and a dry atmosphere with moderately high temperature for bulb development and maturation.

Seedling production:

- Prepare a separate seedbed (1 m wide; length as needed) and incorporate compost and rice hulls into the top soil.
- Sow seeds thinly and evenly in rows set across the bed 7-10 cm apart.
- Cover the seeds lightly with compost and mulch (either rice straw or grass clippings).
- Maintain adequate soil moisture.
- Protect the seedbed against direct sunlight and rain with appropriate materials.
- Reduce watering and expose seedlings to full sunlight for one week before transplanting (approximately 4 to 6 weeks after sowing).

Transplanting:

- Seedlings are transplanted about 4-6 weeks after sowing.
- Gently uproot the seedlings to prevent root damage.
- Use markers for proper spacing between hills and between rows to facilitate transplanting. After marking, use dibbles to make holes.
- Plant at a distance of 15 cm between hills and 15 cm between rows.
- Plant deep enough, but not too deep.
- Place the white portion of the plant below the soil surface.

- Care must be taken so as not to damage the basal portion of the plant.
- Press the soil firmly around the basal portion.
- Irrigate the field before and after transplanting.

Irrigation:
- Onions require adequate moisture for steady, continuous and desirable growth.
- Stop irrigation 2-3 weeks before harvest, or when 20-30 % of the leaf tops fold over.

Weed control:
- Combine herbicide application with hand weeding to produce a good quality crop.

Fertilization scheme:

	Type and amount of fertilizer (gram/m^2)			
Schedule of application	Compost	Ammonium Sulfate (21-0-0)	Super phosphate (0-18-0)	Muriate of potash (0-0-60)
Basal application	100.00	21.25	33.00	5.00
1st sidedress (*30 DAT*)		7.50	-	2.50
2nd sidedress (*45 DAT*)		7.50	-	2.50
3rd sidedress (*60 DAT*)		7.50	-	2.50

DAT = days after transplanting
Note: fertilizer amounts are given on a per square meter basis

Major pests:
- Thrips (*Thrips tabaci*)
- Armyworm (*Spodoptera exigua*)
- Cutworm (*Spodoptera litura*)
- Leafminer (*Liriomyza spp.)*

Control measures:
- Manage weeds properly.
- Maintain sufficient population of natural enemies.
- Crop rotation.
- Application of appropriate insecticides as last resort.

Major diseases
- Purple blotch (*Alternaria porri*)
- Leaf blight (*Botrytis* sp.)
- White-tip disease (*Phytophthora porri*)
- Downy mildew (*Peronospora destructor*)
- Pink root (*Pyrenochaeta terrestris*)
- Bacterial soft rot (*Erwinia carotovora*)
- Onion smut (*Urocystis cepulae*)

Control measures:
- Use resistant cultivars if available.
- Eliminate debris from previous crop and remove infected leaves.
- Practice crop rotation and soil solarization prior to planting.
- Regulate humidity through proper irrigation and drainage.
- Maintain good air circulation during curing, packing and storage.
- Application of appropriate fungicides.

Harvesting:
- Harvest when the leaf tops begin to fold over.
- Pull mature plants/bulbs manually from the soil.

Post-harvest handling:
- Dry harvested bulbs for 10-14 days in a sunny, well-ventilated area.
- Align onions in such a way that the leaves of one onion cover the bulb of another.
- Clip dried leaves 4 cm from the stem and remove all roots.
- Grade bulbs according to size and quality.
- Pack in jute or net sacks for storage.

5.5.2. Bunching onion (*Allium fistulosum*)

Local Name:	Sibuyas dahonan
Recommended Cultivar:	Any locally available cultivar
Planting Distance:	1 plant/hill 15 cm between hills, six rows/bed
Plant Density:	800 hills/bed (= 800 plants/bed) 222,222 hills/ha (= 22.2 plants/m^2)

- Bunching onion does not form a real bulb. The plant has a green leaf portion and a long blanched white stalk portion. It grows in clumps with several tillers bunched together.
- They are known by several names such as scallions, green onions, spring onions and Welsh onions.

Climatic and soil requirements:

- Requires a cool climate, but can also grow in areas without extremes of heat and cold, and excessive rainfall.
- Grows well in friable and well-drained soils with good water holding capacity and a pH ranging between 6.0 – 7.0.

Fertilization scheme:

	Type and amount of fertilizer (grams/m^2)		
Schedule of application	Compost	Complete fertilizer (14-14-14)	Urea (46-0-0)
Basal application	100.00	20.00	-
Sidedress (*3 WAT*)	-	-	10.00

WAT = weeks after transplanting

Planting:

- Bunching onion is usually planted using tillers, although seeds of different cultivars are also available in the Philippines.
- Use only planting material free of diseases and insect pests.
- Trim the top portion of the tiller and the lower portion of the roots to reduce transpiration and increase plant survival.
- Transplant tillers at a distance of 15 cm x 15 cm after applying basal fertilizers.
- Plant deep enough, but care must be taken not to damage the basal portion of the plant.
- Press the soil lightly around the basal portion.
- Make sure that the root is in full contact with the soil.
- Irrigate the field before and after planting.

Crop maintenance:

- Blanching of the stem is achieved by hilling-up soil during growth.
- Since bunching onions are shallow-rooted, watering has to be done regularly.

Harvesting:

- Start harvesting when there are more than five new tillers bunched together or when onions are 1 to 1.5 cm in diameter at the base. There should be at least 4 - 5 cm of white shank.
- Bunching onions are hand pulled without undercutting.

Postharvest handling:

- Washing with cold water removes field and ambient heat.
- Green tops are usually trimmed to 25 - 30 cm.

5.6. Poaceae

5.6.1. Sweet Corn (*Zea mays* var. *rugosa*)

Local Name:	Mais
Recommended Cultivar:	'Sweet Grande'. 'Macho' (East West Seed Company) 'Sugar 73'; 'Sugar 75' (Syngenta)
Planting Distance:	1 plant/hill 30 cm between hills, two rows/bed
Plant Density:	133 hills/bed (= 133 plants/bed) 37,037 hills/ha (= 3.7 plants/m^2)
1000-seed weight:	133 grams (= 17.7 g/bed)

Climatic and soil requirements:

- Sweet corn can adapt to a wide range of soils with pH values ranging from 5.3 – 7.3.
- It prefers well-drained soils that are rich in organic matter.

Seedling preparation:

- Sweet corn can be direct seeded but it grows best and more uniformly if transplanted.
- The preferred nursery media is composed of a mixture of compost and vermicast at a ratio of 1:1.
- 1 seed is placed in each cell of the seed tray at a depth of 1 cm.

Transplanting:

- Seedlings are transplanted into the prepared beds 8-10 days after sowing, preferably in the afternoon after 3 pm.

Irrigation:

- Since sweet corn has a relatively shallow root system it requires adequate watering, particularly during silking, tasseling and ear development.

Weeding:

- Remove weeds to avoid competition for water and nutrients and to provide an unfavorable environment for rodents and other pests.
- Weeds are removed manually 10-15 days after transplanting before the 1st sidedress fertilizer application.
- Before the 2nd sidedress application, weeds should be removed again either manually or by using contact herbicide (e.g. gramoxone).

Fertilization scheme:

Schedule of application	**Type and amount of fertilizer (gram/hill)**			
	Chicken dung	Complete (14-14-14)	Urea (46-0-0)	MOP (0-0-60)
Basal application	100.00	7.0	-	-
1st sidedress (*1 WAT*)	-	-	4.0	-
2nd sidedress (*4 WAT*)	-	-	7.0	4.0

WAT = weeks after transplanting

Major pests:

- Cutworm (*Spodoptera litura)*
- Cornborer (*Ostrinia fornicales*)
- Earworm (*Helicoverpa armigera*)

Field scouting:

- Scout corn areas weekly from seedling emergence until the corn is knee-high for insect damage to determine if control measures are needed. Thereafter, scout fields periodically until tasselling and during ear formation.
- Corn insect pests can be divided into the following categories:
  - Insects that feed on seedlings, reducing plant stand and health;
  - Insects that feed on tassels and silks, interfering with pollination;
  - Insects that feed on ears and individual kernels;
  - Insects that attack the stalk, causing lodging and ear loss.

Control measures:

- First application of 3 g furadan per cell during sowing in seed trays; this will protect the crop for 30 days.
- Second application of 3 g furadan per hill during second sidedress.
- Hanging of trichocards 30 and 60 days after transplanting.
- In case trichocards are not available, application of appropriate insecticides will do as a follow-up application if any earworms attack.
- *Bacillus thuringiensis* (Bt) products are a suitable biological insecticide alternative.
- If insecticides are used, choose a sprayer that is suitable for sweet corn plant architecture, such as a mist sprayer. Control of insects such as the earworm requires that sprays are directed on the green silk. Spraying may be necessary every seven days depending on pest pressure.

Major diseases:
- Stalk rot (*Fusarium* spp.)
- Southern leaf blight (*Bipolaris maydis*)

Control measures:
- *Fusarium* fungi survive on corn residues in soil and on seed. Stalk rot is associated with moisture stress and over-fertilization. It is controlled by good field sanitation, rotating with non-related crops, planting in well drained soils, and by avoiding excess nitrogen applications.
- As a preventive measure against *fusarium*, 1 pack of *Trichoderma harzianum* is diluted in one sprinkler (8 l) and evenly applied to sweet corn seedlings in the nursery 1 week after sowing, shortly before transplanting.
- If the disease has occurred already, 2 packs of *Trichoderma* are mixed thoroughly in one knapsack sprayer (16 l) and applied to affected plant parts.
- Use plants that are resistant to Southern leaf blight as first line of defense against this disease. If necessary, fungicides such as Chlorothalonil and Mancozeb can also be used.

Physiological disorders:
- Incomplete kernel development or shriveled kernels may be caused by poor pollination during hot and dry weather. Heavy rains during tasseling can wash off pollen or cause it to stick to the tassel, thereby reducing pollination.

Thinning:
- Thinning of ears to maintain only one cob per plant is done to attain good size and quality.

Harvesting:
- Sweet corn is ready to harvest about 3 weeks after silk emergence or 70 – 75 days from planting.
- Ripe ears have dried silk and are full to the touch.
- Ripe kernels will squirt a milky liquid when punctured by a thumbnail.
- Sweet corn should be harvested when field heat is low, preferably in the morning.

Post-harvest handling:
- If the sweet corn is to be sold in a distant market, the ears can be cooled in water to remove any field heat.
- Most sweet corn cultivars have a shelf life of 4 to 6 days while the supersweet varieties can have a shelf life of up to 10 days.

5.7. Malvaceae

5.7.1. Ladies' Finger (*Abelmoschus esculentus*)

Local Name:	Okra
Recommended Cultivar:	'Smooth Green' (East West Seed Company)
Planting Distance:	1 plant/hill 30 cm between hills, two rows/bed
Plant Density:	133 hills/bed (= 133 plants/bed) 37,037 hills/ha (= 3.7 plants/m^2)
1000-seed weight:	30 grams (= 4 g/bed)

Climatic and soil requirements:

- Okra is a warm weather plant, which thrives well at a temperature range from 22 °C to 35 °C.
- It prefers well-drained soils rich in organic matter and with a pH of 5.8 to 6.5.

Seedling production:

- Either "*lokong*" or multi-cellular trays are used for seedling establishment.
- Sow 1-2 seeds per cell/*lokong*.

Transplanting:

- Seedlings are transplanted after they have 3-4 true leaves.
- They are placed on top of the basal fertilizers which are covered with a thin layer of soil.
- Do thinning to maintain 1 plant/hill before the 1st sidedress.

Fertilization scheme:

Schedule of application	**Type and amount of fertilizer (gram/hill)**	
	Compost	Complete (14-14-14)
Basal application	150.00	15.0
1st sidedress (*3 WAT*)		10.0
2nd sidedress (*6 WAT*)		10.0
3rd sidedress (9 *WAT*)		10.0

WAT = weeks after transplanting

Crop maintenance:

- All mature pods have to be removed from the plants as soon as possible since any mature pods left on the plant will reduce future yield.

Major pests and diseases:

- Okra is very susceptible to damage by nematodes. Okra should not follow vine crops such as squash and sweet potatoes. These crops tend to increase nematode population.
- Practice crop rotation. Marigold as a pre-crop is recommended.
- Maintain sanitation within the field and its periphery, prune all leaves below the lowest fruit and burn infected leaves to prevent the spread of fungal diseases.
- The incidence of Fusarium wilt is much greater when root-knot nematodes are present. Nematode control is a major practice in reducing the presence of Fusarium wilt.
- Other pests of okra are aphids, stink bugs and corn borers.

Harvesting:

- Fresh market okra is usually graded into these sizes:
  - Fancy (pods up to 9 cm long)
  - Choice (pods form 9 – 11.5 cm long)
  - Jumbo (pods over 11.5 cm but still tender)
- Pods develop very fast. It takes only eight days from bloom to the reach jumbo pod size.
- To get a maximum of fancy and choice pods, harvest must be done daily using a sharp knife.

5.8. Convolvulaceae (Morning Glory Family)

5.8.1. Sweet Potato (*Ipomea batatas*)

Local Name:	Kamote
Recommended Cultivar:	'JKO 18' (NOMIARC)
Planting Distance:	1 plant/hill 30 cm between hills, two rows/bed
Plant Density:	133 hills/bed (= 133 plants/bed) 37,037 hills/ha (= 3.7 plants/m^2)
Planting Material:	terminal cuttings of 30 cm length

Climatic and soil requirements:

- Sweet potatoes require well-drained, light, sandy loam, or silt loam soil with pH ranges from 5.0 to 7.0. Heavy soils tend to produce low quality yields.
- Both surface and internal drainage are important in selecting a field. Soils with poor internal drainage cause sweet potato roots to be large, misshapen, cracked, and rough skinned.

Planting and fertilization:

- Beds have to be well prepared to make the soil friable and free of weeds.
- Fresh terminal cuttings of 30 cm length are used as planting material. These distal tips are usually free of weevil eggs and larvae; older portions of the vines may be infested.
- Cuttings may be soaked in an insecticide solution prior to planting to prevent weevil outbreak.
- Apply 100 g of compost and 10 g of DAP per hill and cover fertilizer with a thin layer of soil to avoid direct contact with the cuttings.
- Plant 1 cutting per hill spaced at 30 cm between hills.

Irrigation:

- Sweet potato needs sufficient moisture for the first two months after planting.

Weeding and hilling-up:

- Weeding and hilling-up should be done 25-30 days after planting.
- Thereafter, spot weeding is sufficient until vines cover the bed.

Major pests:

- The sweet potato weevil (*Cylas formicarius*) attacks both stem and roots.
- To control the pest, use crop rotation and practice proper field sanitation. If water availability is not a problem and if feasible, flood the field for one or two weeks to kill weevils by drowning.

Major diseases:

- Plants infected with the stem and foliage scab (*Sphaceloma batatas)* show oblong to elongated scab lesions on the stems and leaves.
- As preventive measure, use disease free cuttings and practice crop rotation.
- Copper and manganese fungicides may effectively control the disease.

Harvesting:

- Harvesting is done at 110 to 120 days after planting.
- Roll vines for easy location of sweet potato roots, and use bolo in digging the roots.

Post-harvest handling:

- Clean but do not wash sweet potato before storing.
- Sort the roots by separating the bigger from the smaller ones.

5.8.2. Upland Kangkong (*Ipomea reptans*)

Local Name:	Kangkong, Tangkong
Recommended Cultivar:	'Tsina LP' (East West Seed Company)
Planting Distance:	1 plant/hill 5 cm between hills, four rows/bed
Plant Density:	1600 hills/bed (= 1600 plants/bed) 444,444 plants/ha (= 44.4 plants/m^2)
1000-seed weight:	80 grams (= 64 g/bed)

Climatic and soil requirements:

- Kangkong produces optimum yields in tropical lowlands under stable high temperatures and short daylengths.
- It prefers soils with high levels of organic matter and pH levels of 5.6 to 6.5.

Direct seeding:

- Kangkong is usually directly seeded. However, cuttings may also be used for propagation.
- Make shallow lines (10 cm deep) along the bed before sowing.
- Drill 200 g of complete fertilizer (14-14-14) per linear meter.
- Cover the complete fertilizer with compost at a rate of 500 g per linear meter.
- Place 1 seed per hill on top of the compost and cover with topsoil.

Irrigation:

- Water the plants regularly.
- Mulch with rice straw or rice hull to reduce frequency of irrigation.

Pest and disease management:

- Caterpillars, whiteflies and aphids may cause serious damage.
- Control diseases such as white rust by regular pruning of stems.
- Crop rotation, field sanitation and adequate plant spacing can reduce occurrence of insect pests and diseases.

Harvesting:

- Harvest by cutting young shoots about 5-10 cm above the ground at 18-25 days after sowing and subsequently at regular intervals.
- Uprooting of the whole plant can also be practiced at 18-25 days after sowing, depending on market demand.
- This will also minimize incidence of pests and diseases.

Seed production:

- Select plants that are vigorous, disease-free and uniform in plant characteristics for seed production. It will take 5–6 months to complete the seed cycle.
- Sun-dry until the husk is brittle enough for seed extraction.
- Each fruit contains 3-4 seeds.

5.9. Asteraceae (Compositae)

5.9.1. Lettuce (*Lactuca sativa*)

Local Name:	Letsugas
Recommended Cultivar:	'Box Hill' (*head type*) (Yates) 'Simpson' (*loose leave type*) (Ramgo)
Planting Distance:	1 plant/hill 30 cm between hills, three 3 rows/bed
Plant Density:	200 hills/bed (= 200 plants/bed) 55,400 hills/ha (= 5.5 plants m^2)
1000-seed weight:	3.3 grams (= 0.7 g/bed)

Selection of cultivar:

- Lettuce is a cool season crop that does not usually form heads under the climatic conditions of the tropical lowland. A few cultivars, however, form heads during the cooler months of the year.
- Loose leaf type lettuce is more suitable for lowland areas. It matures quickly and can be constantly harvested.

Climatic and soil requirements:

- Optimum night temperature for head formation is below 20 ºC.
- Lettuce requires well-drained, fertile soils with high organic matter content and good water-holding capacity.
- Soil pH should be between 6.0 to 6.8 since lettuce is very sensitive to soil acidity.

Nursery:

- Sow the seeds in rolled banana leaves (*lokong*) or in seed trays using plain vermicast or compost (1 seed per cell).
- Drench the soil media with a *trichoderma* solution (1 pack *trichoderma* per sprinkler) to minimize soil-born diseases.
- Cover seed trays/*lokong* with sacks until germination.
- Observe regular watering using a fine sprinkler or a knapsack sprayer to maintain ideal soil moisture.

- Harden the seedlings one week before transplanting.
- Transplant the seedlings 21 days after sowing when they have 4-6 true leaves.

Transplanting:

- Lay out the bed for transplanting using quincunx style at 3 rows per bed and 30 cm distance between hills.

Fertilization scheme:

	Type and amount of fertilizer (gram/hill)				
Schedule of application	Compost	Complete (14-14-14)	Urea (46-0-0)	Kieserite	Solubor
Basal (*at transplanting*)	100.0	10.0			
1st sidedress (*1 WAT*)		-	-	3.6	0.5
2nd sidedress (*3 WAT*)		-	3.5	-	-

WAT = weeks after transplanting

Water management:

- Since lettuce is shallow rooted, it requires frequent watering to maintain enough available moisture which is needed to keep plants actively growing.

Major pests and diseases:

- Although lettuce is not subject to much attack by insects, some damage may be caused aphids, white flies, leaf miner and leafhopper.
- Some diseases such as damping-off, downey mildew and bottom rot may occur.
- Numerous cultural practices can reduce the incidence of these diseases, including crop rotation, field sanitation and adequate plant spacing.

Harvesting:

- Harvesting should be done early in the morning when leaves are crispy.
- Head lettuce will be ready for harvesting 50-60 days after transplanting; cut only those heads that are firm. Leave 3-4 “wrapper” leaves to protect the head.
- Most leaf types are ready for harvest 35-45 days after transplanting.
- Harvest has to be done every 2-3 days, depending on moisture and temperature.

Post-harvest handling:
- o Pre-cool head lettuce to a desired transit/storage temperature soon after harvest to remove field heat.
- o Loose leaf lettuce is soaked in clean chlorinated water to remove soil particles.

5.10. Basellaceae

5.10.1 Malabar Spinach (*Basella rubra*; *Basella alba*)

Local Name:	Alugbati
Recommended Cultivar:	any locally available cultivar
Planting Distance:	3 cuttings/hill 30 cm between hills, three rows/bed
Plant Density:	200 hills/bed (= 600 plants/bed) 55,556 hills/ha (= 16.7 plants/m^2)

There are two common types of Malabar spinach. *Basella alba* has dark-green, oval or almost round leaves while *Basella rubra* has green, oval-round leaves, and red stems.

Climatic and soil requirements:
- o Malabar spinach grows well in hot, humid climates. Partial shading will produce larger leaves as compared to when it is grown under full sunlight.
- o Daylengths shorter than 13 hours result in flowering.
- o The crop grows best on soils supplied with organic matter and can tolerate a soil pH ranging from 5.5 to 8.0.

Cultural management practices:
- o Basella is usually transplanted using cuttings but can also be directly seeded.
- o Direct seeding is appropriate when plenty of seeds are available.
- o Bed should be well prepared prior to planting.
- o Fertilize with 100 g chicken dung and 10 g complete (14-14-14) per hill before planting. Cover fertilizer with soil to avoid burning.
- o Plant 3 cuttings in each hill at 20-25 cm length/cutting with leaves removed.
- o Cultivate by hilling up the soil with a garden hoe.

Major pests and diseases:
- o Basella is susceptible to damage by foliar insects such as leafminers and cutworms.
- o Root-knot nematode may sometimes be a serious pest.

- *Cercospora* and *Alternaria* leaf spot are major diseases.
- Crop rotation, field sanitation, and adequate plant spacing can reduce the incidence of these diseases.

Harvesting:

- Harvest starts 28 days after planting.
- Cut the shoots 15 to 30 cm long with a harvesting knife.
- Weekly or bi-weekly harvesting may follow if there is vigorous and abundant growth.
- Frequent harvesting delays flowering and stimulates growth of side shoots.

Post-harvest handling:

- Malabar spinach has a large surface-to-volume ratio and loses water easily.
- To reduce water loss, harvest during the cooler time of day, such as early morning or late afternoon. Keep the produce in a cool shaded place.

5.11. Herbs

Herbs for culinary purposes, for scents and fragrances, for medicinal uses or others (such as dyes and dried floral arrangements) are becoming increasingly popular in the Philippines and offer a niche market for allotment gardeners. Some of these herbs also have insect repellant effects and may be used for ecological pest management strategies (see chapter 4.9 for details).

Among the herbs that are already grown in some of the allotment gardens of Cagayan de Oro are different kinds of basil (*Ocimum basilicum*), chives (*Allium schoenoprasum*), coriander/cilantro (*Coriandrum sativum*), dill (*Anethum graveolens)*, lemon grass/tanglad (*Cymbopogon* sp.), lemon balm (*Melissa officinalis*), marjoram (*Origanum majoran),* European oregano *(Origanum vulgare),* Philippine oregano/kalabo (*Coleus amboinicus*), Italian parsley *(Petroselinum hortense),* peppermint (*Mentha piperita*), stevia (*Stevia rebaudiana*), rosemary (*Rosmarinus officinalis*), rocket/rucola (*Eruca sativa*) and thyme (*Thymus vulgaris*).

General guidelines for the production of herbs are:

- Herbs are usually propagated by sowing or through cuttings.
- Fertilizer requirements are basic, usually being limited to N, P, & K.
- Herbs are seldom attacked by insects. Proper rotation and field sanitation can reduce the risk of many diseases.

- Harvest timing is specific to the herbs being produced.
- The harvested product often requires immediate special handling to best preserve its color, aroma, flavor, and the integrity of its appearance.

5.12. Other Vegetables

In additon to the vegetables and herbs described earlier, many more crops can be planted either in beds or as border crops. The following list is not complete, but suggests some of the possible choices:

Botanical Family	English Name	Local Name	Botanical Name	Harvested Plant Part
Amaranthaceae	Amaranth	Kulitis	*Amaranthus viridis*	Leaves
Apiaceae	Celery	Kintsay	*Apium graveolens*	Leaves
Araceae	Taro	Gabi	*Colocasia esculenta*	Tubers, Leaves
Cucurbitaceae	Melon	Milon	*Cucumis melo*	Fruits
Cucurbitaceae	Squash	Kalabasa	*Cucurbita maxima*	Fruits
Cucurbitaceae	Watermelon	Pakwan	*Citrullus lanatus*	Fruits
Cucurbitaceae	Winter melon	Kondol	*Benincasa hispida*	Fruits
Dioscoreaceae	Purple yam	Ube	*Dioscorea alata*	Tubers
Fabaceae	Pigeon pea	Kadios	*Cajanus cajan*	Seeds
Fabaceae	Sesban	Katuray	*Sesbania grandiflora*	Flowers
Fabaceae	Vegetable soybean	Edamame	*Glycine max*	Young pods
Moringaceae	Horseradish tree	Malunggay	*Moringa oleifera*	Leaves
Solanaceae	Pepper (hot)	Sili	*Capsicum frutescens*	Fruits
Tiliaceae	Jute	Saluyot	*Corchorus olitorius*	Leaves
Zingiberaceae	Ginger	Luy-a	*Zingiber officinale*	Rhizome

6. Ecological Sanitation

6.1. Conventional Sanitation Systems

One person produces about 500 liters of urine and 50 liters of faeces per year, and, if using water for flushing, produces about 10,000 to 20,000 liters of wastewater, depending on the local situation. In the Philippines as in most developing countries, more than 90% of the sewage is discharged without treatment, polluting rivers, lakes and coastal areas, thus, causing serious problems of pollution and public health.

6.2. Closing the Loop

Ecological sanitation is an alternative to the linear approaches to carry waste (excreta, soapy water, etc.) to water bodies. It is based on an ecosystems approach where the nutrients and organic matter contained in human excreta are considered as a resource, and are properly treated for contribution to food production.

Ecological sanitation can be viewed as a three-step process dealing with human excreta: (1) Containment, (2) Sanitization, (3) Recycling.

The objective is to protect human health and the environment while limiting the use of water in sanitation systems for hand (and anal) washing only and recycling nutrients to help reduce the need for artificial fertilizers in agriculture.

An essential step in the process of sanitation is the containment of pathogens that can cause disease. Without containment and sanitization, a vicious circle develops where the pathogens in excreta are released back into the environment, re-infect people through consumption of contaminated water or food, and are then excreted again, only to begin the cycle over.

6.3. Characteristics of Ecological Sanitation

Ecological sanitation systems are designed around true containment and provide two ways to render human excreta innocuous: dehydration and decomposition. The Ecosan concept is based on following principles:

- Prevent diseases (must be capable of destroying or isolating faecal pathogens);
- Protect the environment (must prevent pollution and conserve valuable water resources;

- Return nutrients (must return plant nutrients to the soil);
- Culturally acceptable (must be aesthetically inoffensive and consistent with cultural and social values);
- Reliable (must be easy to construct and robust enough to be easily maintained in a local context);
- Convenient (must meet the needs of all household members considering gender, age and social status);
- Affordable (must be affordable and accessible).

6.4. Urine-Diverting Dehydration Toilets

Urine-Diverting Dehydration Toilets (UDDT) have been established in all allotment gardens of Cagayan de Oro. They do not pollute nor produce waste water, since human waste is diverted, sanitized and recycled in a safe way. UDD toilets do not need a central water supply or sewage system. They collect and treat faeces and urine separately.

A special bowl ("UDD bowl") with two compartments for urine and faeces segregation is used, which is locally fabricated in Luzon. A special urinal for men can be added. The urine is stored in a plastic container and applied as fertilizer after one month of storage to ensure pathogen die-off.

The faeces are collected in a vault (substructure). The substructure must be constructed in such a way that there will be no leakages into the soil. It can consist of a single chamber with a mobile container or of 2 chambers. The 2-chamber model functions as collection and treatment unit at the same time. It has the advantage that the second chamber can be used while the faeces in the first chamber are left for storage. The design of the toilet makes it easily adaptable to different types of communities.

An essential step in introducing UDD toilets is social preparation of all stakeholders. Sustainability will only be achieved if the future users of the UDDT and of the treated excreta fully understand and accept the ecosan concept. Several interventions have to be conducted to ensure stakeholder participation right from the start. This should include an orientation about the Ecosan philosophy, technical, social and health aspects as well as the safe re-use of the treated excreta. It is recommended that user groups be established for information exchange and mutual support in operating the facilities.

6.4.1. Maintenance of a UDD Toilet

Well-constructed and well-maintained UDD toilets do not develop bad odors, nor attract flies. The following has to be observed:

- The design of the toilet must ensure that the urine is directly diverted and does not touch the faeces.
- The faeces are directed into a chamber or container and are covered with dehydration materials such as prepared soil, ashes, lime and/or sawdust/rice hulls.
- The faeces chamber must always be kept completely dry.
- An ample supply of covering material must be available.
- Always close the toilet bowl lid to prevent flies from entering.
- For wipers, throw toilet paper in separate trash can; since the toilet is dry, paper will not decompose.
- For washers, use the separate anal washing area.
- Make sure that water is always available for anal and hand washing
- Clean the bowl outside the toilet. A stick with a damp cloth can also be used to clean the bowl.
- Use a wet cloth to clean the floor; avoid getting the faeces wet.
- Place "user's guidelines" inside the toilet for those persons who are not familiar on how to use a UDD toilet.

6.5. Agricultural Aspects of Ecological Sanitation

A grown person produces an average of 500 liters of urine and 50 kg/ faeces per year. The following table converts this amount into nutrient equivalents for N, P and K:

Table 7: Estimated annual excretion of nutrients per person

	Nitrogen (kg/capita)	Phosphorous (kg/capita)	Potassium (kg/capita)
Urine	2.3	0.3	1.1
Faeces	0.3	0.1	0.4
Total	**2.7**	**0.4**	**1.5**

The nutrient values of Table 7 can be converted into the following fertilizer equivalents:

Table 8: Fertilizer equivalents (kg/capita/year) of annual excretion of nutrients per person

	Complete (14-14-14)	Urea (46-0-0)	MOP (0-0-60)
Faeces	1.60	0.17	0.44
Urine	4.93	3.48	0.52
Total	**6.53**	**3.65**	**0.96**

Table 9 shows the monetary value of these fertilizer amounts:

Table 9: Monetary equivalents* (PhP/capita/year) of annual excretion of nutrients per person

	Amount (kg/year)	Cost (PhP/kg)	Subtotal (PhP/year)
Complete (14-14-14)	6.53	35.60	232.47
Urea (46-0-0)	3.65	33.20	121.18
MoP (0-0-60)	0.96	38.00	36.48
Total			**390.13**

**Based on average fertilizer prices in Cagayan de Oro as of October 2008*

6.5.1. Reuse of Treated Urine

Storage (*Containment and Sanitization*):

- After the last urination, remove container from the UDD toilet and store urine undiluted in a closed container (if possible in full sunlight).
- Storage in a sealed container prevents contact with humans or animals and hinders evaporation of ammonia.
- During storage, the urine should not be diluted to provide a harsher environment for the pathogens contained in it.
- After one month, all pathogens in the urine will be destroyed due to the increase of pH to 8.5 to 9.0, the formation of ammonia and the exposure to UV radiation from the sun.

Application (*Recycling*):

- Urine can be considered as a liquid fertilizer since nutrients in urine are mostly water soluble, hence, are directly available for plant uptake.
- Urine is best utilized as a fertilizer for N-demanding crops such as corn and leafy vegetables which are not consumed raw (such as lettuce) to ensure acceptance by customers.
- Prior to the application to crops, dilute at a rate of 1 part urine with 3-5 parts of water in a separate pail.
- By using a dipper or an empty sardine can (*tinapa*) the diluted urine is applied to the soil at a distance of 10 cm from the plant and directly incorporated into it. This is done to avoid burning of the leaves and the roots and to prevent loss of nitrogen in the form of ammonia.
- Urine may also be applied through drip irrigation systems. However, clogging of emitters by salt precipitation may occur.
- Urine should not be sprayed on plants to avoid foliar burns.
- Observe a waiting period of one month from the last urine application before harvest of crops as another safety measure.

6.5.2. Reuse of Treated Faeces

General:

- Like other organic fertilizers, faeces improves the physical, chemical and biological properties of soils aside from providing plant nutrients.
- However, the risk of high concentrations of pathogens in faeces is large (especially for helminth ova). Thus, for the safe reuse of faeces in agriculture, it is critical that it be handled in such a way that the risk of disease transmission is minimized.

Storage (*Containment*):

- After the last defecation, faeces should be kept in the storage chamber of the UDD toilet for 6-12 months.

Secondary treatment (*Sanitization*):

- After the storage period is completed, the stored faeces is subjected to any of the following secondary treatments:
  - aerobic composting where a temperature of above 50°C should be achieved and maintained for a duration of at least one week in the compost heap (see chapter 4.3.2);
  - at least 60 days of vermicomposting (see chapter 4.3.3).

Application (*Recycling*):

- After secondary treatment has been completed, the processed faeces can be used like any other organic fertilizer where nutrients are slowly released as it is degraded in the soil by microorganisms.
- Although initial research trials show a safe product after secondary treatment for the present time, it is recommended that treated faeces be used not for vegetables but for (fruit) trees only to ensure acceptance of vegetable produce by customers and to minimize health risks.

6.5.3. Heavy Metals and Micro-pollutants in Human Excreta

- The presence of *heavy metals* is generally low or very low in excreta and depends on the amounts present in consumed product.
- *Hormones* are excreted with the urine and have been excreted by mammals in their terrestrial environments for thousands of years. Vegetation and soil microbes are adapted to and can degrade these hormones. Based on available data, hormones are probably a very low risk when applied to soil.
- *Pharmaceutical substances* are degraded in natural environments where a diverse microbial activity is present. The risks associated with them are considered small.

7. Special Allotment Garden Events

7.1. Launching of the Allotment Garden

The launching of the allotment garden is an activity wherein the project officially opens and promotes its socio-economic and environmental objectives and benefits to the public. The following are some guidelines for a successful launching activity:

- Identify those people who were involved and contributed to the project (e.g. Barangay Chairman and Council, City government, University, funding agencies), including other guests and speakers for the event.
- Install a signboard at the entrance of the allotment garden with the name of the garden, acknowleding the institutions that were essential in setting up and realizing the project.
- Make a program of activities:
  - Send invitations to all persons involved in the program as well as to all the guests two weeks before the launching.
  - Do not forget to follow up to confirm their participation so that in case they are not available, there is still time to look for other speakers. Do not forget to attach also a copy of the program with the sketch of the site.
  - Assign a master of ceremonies, who could be either from the Barangay or from among the organizers.
  - Invite the media (radio stations, newspaper, television, etc).
- Coordinate with the Barangay and the allotment gardeners through the technician assigned in the area to discuss their contribution and concerns for the launching, e.g. sound system, tables and chairs, flags.
- It is highly recommended that a Priest from the Barangay blesses the new garden.
- Assign a “person-in–charge” for every duty, to make the work easy and organized.
- Have a meeting, present and discuss the responsibilities of each person to make their assignments clear.
- Check which duties have been completed already:
  - Communication with the person in charge of every task is very important for better coordination.
  - Always update the coordinator and technician with the good and bad points to ensure that all of the tasks are properly carried out.

- Little things can be easily forgotten. Make a list of the materials needed during the launching. Examples are:
  - Scotch tape, ball pen, sign pen, stapler and staple wire;
  - Ribbons to officially open the ceremony;
  - Two pairs of scissors for the ribbon cutting;
  - Candles for the blessing of the site;
  - Guestbook, to identify the guests and their designation; it can be used during the acknowledgement of the guests and participants;
  - Information materials (e.g. signboard, streamers, posters);
  - Chairs and tables for the guests and project partners;
  - Sound system with microphone (including the National Anthem);
  - Other materials (e.g. back draft, flowers, tablecloth, canvas, consider the weather, flags);
  - Certificates or plaques to acknowledge the efforts of the people involved in establishing the garden;
  - Food for thanksgiving.

7.2. St. Gertrude Day

The patron saint of the gardeners is St. Gertrude of Nivelles. The different allotment garden associations alternate annually as the location for hosting the "St. Gertrude Day", which is celebrated every March 17 of the year. The event starts with a Catholic Mass at the garden site, which includes floral offerings and a special prayer for the gardeners.

This is followed by a colorful parade from the garden site to the barangay hall, where vegetables, flowers, fruits and other garden products are displayed and sold to the local community.

The event may also be used as a general assembly for the gardeners to discuss specific issues related to allotment gardening.

Other saints related to gardening are:

- St. Phocas (feast day celebrated on July 23) is the patron saint for agricultural workers, farm workers, farmers, and gardeners.
- St. Werenfrid (feast day on August 14) is venerated as the patron saint of vegetable gardeners.
- St. Fiacre (feast day on 30 August) is most known as the patron saint of growing food and medicinal plants, especially herbs.

7.3. Allotment Garden Day

The Cagayan de Oro Allotment Garden Day is an annual event jointly organized by Xavier University College of Agriculture and the Cagayan de Oro City Government to search for the best allotment garden and best allotment gardener of the city. Minor awards are given to the growers of the sweetest sweet corn, the longest bottlegourd, bittergourd and eggplant as well as the biggest squash.

Evaluators come from the academe, the city government and the private sector. At least three months prior to the event, the allotment gardeners are informed about the criteria in order to give them enough time to prepare for the evaluation.

7.3.1. Best Allotment Garden

The criteria for the best allotment garden are:

- Solid waste management (10 %)
  - Availability of waste segregation facilities
  - Area is trash free
- Maintenance of tool shed and nursery (25 %)
  - Nursery
  - Community tools
  - Pesticide cabinet
  - Tool cabinet
  - Rainwater catchment
- Compost area (10 %)
  - Amount of compost
  - General appearance
- Ecosan toilet (15 %)
  - Overall cleanliness
  - Reuse of urine
  - Secondary treatment of faeces
- Crop maintenance (20 %)
  - Family name of gardeners at parcela
  - Beds are labeled with plant name & botanical family
  - Diversity of crops planted
  - General crop stand
- Association activities (20 %)
  - Regularity of meetings
  - Function of members
  - Presence of saving account
  - Transparency of records

The garden with the highest score is selected as the best allotment garden of the city.

7.3.2. Best Allotment Gardener

Each allotment garden association nominates one candidate based on the following criteria:

- o General performance of crops grown (20 %)
  - Implements standard operating procedures.
- o Crops produced (20 %)
  - Based on production/sales record.
- o Relation with other gardeners (40 %)
  - Willing to help others *("bayanihan");*
  - Willing to share gardening experiences with others;
  - Willing to do community work for establishing and maintaining the allotment garden and its facilities;
  - Is considered a model for others.
- o Activities in allotment garden association (20 %)
  - Performance of function as association member.

The evaluation committee then selects the best allotment gardeners among the proposed candidates from the different associations.

8. Budget

8.1. Budget for Establishing one Allotment Garden

The costs for establishing an allotment garden greatly depend on the size of the garden, the number of gardening families, the period and degree of assistance. In Cagayan de Oro, the costs for the materials needed to establish an allotment garden for 10 families, including the seeds and other inputs for two cropping seasons, are about 300,000.00 Pesos. This amount does not include the salaries for the technicians, costs for capacity building activities, or overhead costs of the implementing organization. The budget details are as follows :

Land Preparation:

Qty.	Unit	Description	Amount (PhP)
1	unit	Transportation	3,500.00
1	unit	Plowing & Harrowing	7,000.00
2	years	Land Rental (0.5 ha)	12,000.00
Subtotal			***22,500.00***

Fencing Materials:

Qty.	Unit	Description	Amount (PhP)
15	rolls	Hog Wire	22,950.00
2	sacks	Cement	320.00
2	kg	Tie Wire	98.00
15	pcs	Angle Bars	6,000.00
1	pc	Metal Saw	25.00
1	load	Mixed Sand	350.00
3	pcs	6 mm Kabilya	150.00
3	loads	Crushed Gravel (1")	2,220.00
250	pcs	Hollow Blocks	1,250.00
250	pcs	Bricks	1,000.00
Subtotal			***34,363.00***

Tool Room:

Qty.	Unit	Description	Amount (PhP)
12	pcs	Columns 4x4x10	1,008.00
18	pcs	Trusses 2x3x10	864.00
9	pcs	Beams 2x3x10	342.00
18	pcs	Roof Support 2x2x10	576.00
24	sheet	Corrugated Sheets 30x12ft	5,256.00
13	sheet	Plywood 3/16	2,808.00
116	pcs	Wall Support 2x2x8	2,900.00
2	pair	Hinges 1/3	40.00
1	quart	Vulcaseal	290.00
Subtotal			***14,084.00***

Nursery:

Qty.	Unit	Description	Amount (PhP)
6	pcs	Columns 4x4x10	504.00
6	pcs	Trusses 2x3x10	288.00
6	pcs	Beams 2x3x10	228.00
12	pcs	Roof Support 2x2x10	384.00
40	pcs	Wall Support 2x2x8	1,000.00
16	pcs	Plastic Sheet 8ft	3,120.00
23	m	Mosquito Net	448.50
1	kg	Common Nails #1	44.00
8	kg	Common Nails #3	304.00
12	kg	Common Nails #4	432.00
6	kg	Common Nails #5	228.00
4	rolls	Cyclone Wire	1,560.00
4	kg	Umbrella Nails	220.00
Subtotal			***8760.50***

Tool Cabinet:

Qty.	Unit	Description	Amount (PhP)
4	pcs	Ply Board	2,100.00
10	pcs	Plywood 3/16	2,160.00
13	pair	Hinges 1/3	250.00
12	pcs	Coco Lumber 2x2x12	468.00
10	pcs	Coco Lumber 2x2x10	320.00
36	pcs	Coco Lumber 2x2x6	900.00
1	unit	Transportation	1,000.00
Subtotal			***7,198.00***

Community Tools:

Qty.	Unit	Description	Amount (PhP)
2	pcs	Hammer	472.00
2	pcs	Saw	600.00
2	pcs	Bolo/sundang	600.00
1	pc	Hole Digger	715.00
3	pcs	Wheelbarrow	7,500.00
2	pcs	Knapsack Sprayer	4,554.00
1	pc	Weighing Scale (10 kg)	530.00
1	pc	Weighing Scale (1000g)	530.00
2	pcs	Compost Turner	1,600.00
1	pc	Barrel (to catch water)	320.00
1	pc	Measuring Tape	150.00
1	pc	Barra	400.00
Subtotal			***17,971.00***

Family tools:

Qty.	Unit	Description	Amount (PhP)
10	pcs	Shovel (big)	2,600.00
10	pcs	Hand Shovel	600.00
10	pcs	Hand Cultivator	620.00
10	pcs	Hand Hoe	600.00
10	pcs	Bolo (*purok*)	1,000.00
10	pcs	Slashing Bolo (*lampas*)	1,600.00
10	pcs	Sprinkler	2,100.00
10	pcs	Tie Wire	500.00
10	pcs	Hand Gloves	350.00
10	pcs	Rake	2,000.00
10	pcs	Rain Boots	2,200.00
10	pcs	Raincoats	2,500.00
10	pcs	Pick mattock	1,700.00
10	pcs	Big Basket	600.00
10	kg	Tie Wire	600.00
Subtotal			***19,570.00***

Seeds:

Qty.	Unit	Description	Amount (PhP)
5	packs	Broccoli	1,500.00
5	can	Pak Choy	650.00
10	kilo	Kangkong	3,000.00
10	packs	Cucumber	400.00
20	packs	Bitter Gourd	800.00
10	can	Stringbeans	1,300.00
5	kg	Sweetcorn	5,000.00
10	packs	Eggplant	400.00
5	packs	Sweet Pepper	200.00
5	packs	Tomato	200.00
20	packs	Bottle Gourd	800.00
3	can	Okra	390.00
10	packs	Lettuce	400.00
30	kg	Green Onion	900.00
Subtotal			***15,940.00***

Pesticides:

Qty.	Unit	Description	Amount (PhP)
3	liter	Karate	2,625.00
3	liter	Selecron	3,000.00
2	kg	Daconil	1,900.00
8	sachet	Trigard (50 grams)	3,200.00
1	liters	Tamaron	1,200.00
2	liter	Hoestick	680.00
3	pcs	Fruit fly Pheromone	1,020.00
2	liters	Herbicide	780.00
3	liters	Sumeceden	1,290.00
2	liters	Perfection	1,700.00
2	liters	Siga	720.00
Subtotal			***18,115.00***

Fertilizers:

Qty.	Unit	Description	Amount (PhP)
120	sacks	Chicken Dung	9,600.00
4	sacks	Complete (14-14-14)	2,920.00
4	sacks	DAP (18-46-0)	5,040.00
4	sacks	Urea (46-0-0)	3,400.00
3	sacks	MOP (0-0-60)	1,710.00
2	sacks	Kieserite	800.00
4	kg	Solubor	400.00
4	kg	Zinc Sulfate	160.00
Subtotal			***24,030.00***

Irrigation materials:

Qty.	Unit	Description	Amount (PhP)
1	unit	Water Pump	15,000.00
Barrel Drip Irrigation			
10	sets	Familia Drip Irrigation	60,000.00
20	pcs	Barrels	16,000.00
Barrel Stand			
8	kg	cw nail #2	320.00
13	kg	cw nail #3	494.00
13	kg	cw nail #4	468.00
13	kg	cw nail #5	494.00

Pipes for interconnecting irrigation system

24	pcs	PVC Blue FM1	336.00
15	pcs	Elbow	225.00
18	pcs	PVC Tee	297.00
3	rolls	HDPE Pipe	9,000.00
9	pcs	Ball Valve	1,800.00
2	pcs	GI Bushing	160.00
20	pcs	PVC Blue ma	280.00
2	can	Pipe Bond 400cc	240.00
7	meter	Chem. Hose	490.00
25	pcs	GI Hose Clamp	200.00
1	quart	Vulcaseal	290.00
Subtotal			***106,094.00***

Others:

Qty.	**Unit**	**Description**	**Amount (PhP)**
120	pcs	Multiseed Tray	7,800.00
1	pc	Billboard	3,000.00
40	l	Fuel	1,800.00
Subtotal			***12,600.00***

8.2. Budget for Establishing one Ecosan UDD Toilet

The costs for establishing an ecosan urine-diversion dehydration toilet may range from 12,000 PhP up to 25,000 PhP. This is dependent on:

- the size of the toilet (double chamber or single chamber
- the type of the toilet (community-based or household-based)
- the materials used.

Blueprints of a two-chamber UDD toilet as well as other relevant information as regards ecological sanitation can be downloaded from the PUVeP website (www.puvep.com) as well as from other websites listed in chapter 9.2.

The following is a cost estimate (based on actual prices in December 2007) for the materials used in constructing one community-based UDD toilet with double chamber as established in the allotment gardens of Cagayan de Oro. Not included are costs for transportation of the materials to the actual site, the labor costs for construction, or the overhead costs of the implementing organization.

Qty	Unit	Item	Amount (PhP)
1	unit	Ecosan Bowl (incl. freight costs)	1,500.00
1	pc	Urinal (reused empty water gallon)	150.00
1	load	Sand (1 m^3)	770.00
1	load	Gravel (¾ ordinary)	1,100.00
20	bags	Portland Cement	3,564.00
		Coco Lumber (assorted)	3142.70
160	pcs	Concrete Hallow Blocks – 4”x8”x16”	880.00
5	Length	Deformed Bars – 8 mm Ø x 6m	176.00
16	Length	Deformed Bars – 10 mm Ø x 6m	1,953.60
2	kg	G.I. Tie Wire - #16	105.60
3	pcs.	¼” x 4’ x 8’ – Marine Plywood	950.40
3	pcs.	3/16” x 4’ x 8’ – Hardiflex Board	1,056.00
2	pcs	Plain G.I. Sheet – gauge #26 (3’ x 8’)	473.00
8	pcs	2” x 3” – Hinge	80.00
2	pcs	3” x 3” – Hinge	50.00
7	pcs	Door Pull - #5	126.00
1	kg	#1 – Common Wire Nails	50.60
1	kg	#1-1/2 – Common Wire Nails	48.40
0.5	kg	#2-1/2 – Common Wire Nails	23.10
3	kg	#3 – Common Wire Nails	132.00

Qty	Unit	Item	Amount (PhP)
1	kg	#4 - Common Wire Nails	34.00
0.5	kg	Flathead Nails	30.00
3	pcs	1”Ø x 10’ – PVC Pipe (blue)	455.40
10	pcs	1”Ø – PVC blue (elbow 90°)	209.00
2	pcs	1”Ø – PVC pipe (tee)	83.60
1	pc	4”Ø x 10’ – PVC pipe (orange)	297.00
1	pc	4”Ø – PVC pipe – Tee (orange)	74.80
120	pcs	Nipa Shingles	420.00
0.5	bundle	Rattan Strip	24.75
4	sheets	Bamboo Mat (*Amakan*)	484.00
100	pcs	Tiles (8 x 8)	1,210.00
1	can	Solvent cement – 400 grams	66.00
1	pc	Kitchen Sink – small	649.00
2	pcs	Water Lug - 20 (transparent) for urine	440.00
1	pc	Soap Case	22.00
1	pc	Plastic Waste Can (oval-small)	55.00
2	pc	Container (for sawdust and tissue)	220.00
1	pc	Container (for water)	110.00
1	pc	Water Ladle	16.50
1	pc	Cup (for ash)	22.00
1	quart	Black Paint	104.50
1	quart	Red Lead Paint	121.00
1	bottle	Paint Thinner	27.50
1	pc	Safety Jasp - #4	13.20
1	pc	Padlock – medium	62.70
1	pc	Barrel Bolt #3	13.20
1	gallon	Clear Gloss Varnish	418.00
1	bottle	Lacquer Thinner	343.20
2	pcs	Paint Brush – 2”	44.00
2	bundles	Bamboo	132.00
1	pack	Gloves	120.00
1	pack	Facial Mask	110.00
1	pc	Shovel	220.00
0.5	kg	White Cement	16.50
1	pc	Floor Mop	275.00
1	pc	Toilet Seat	260.00
1	pc	Plaque	500.00
1	pc	Info Poster (Do’s and Don’ts)	450.00
1	pack	Toilet Paper	200.00
Total			**24,685.25**

9. References

9.1. Books and Articles in Journals

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- MBRLC, 2004. How to Farm Better. Asian Rural Life Development Foundation, International. Bansalan, Philippines.
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9.2. Internet Resources

Vegetable Production Guidelines for the Tropics & Subtropics:

- The World Vegetable Center (AVRDC): http://www.avrdc.org/LC/home.html

Allotment Gardening Websites:
- Allotment Gardens of Cagayan de Oro: http://puvep.xu.edu.ph/ag/ag.htm
- Wikipedia: http://en.wikipedia.org/wiki/Allotment_gardens
- The Office International du Coin de Terre et des Jardins Familiaux: http://www.jardins-familiaux.org/

Seeds and Agricultural Inputs Philippines:
- Acosta Foundation Inc., Calanawan, 8703 Manolo Fortich, Bukidnon, email: afi_ilocos@yahoo.com
- East West Seed Corporation: http://www.eastwestseed.com/
- Harbest Agribusiness Corporation: http://www.harbest.com.ph/
- Kaneko Seeds: http://pilkanekoseeds.com.ph/index.htm/
- Ramgo Seeds International: http://www.ramgoseeds.com/
- Seed Base (Cebu): http://www.seedbase.com/

Drip Irrigation:
- Netafim Drip Irrigation: http://www.netafim.com/
- Plastro Irrigation systems: http://www.plastro.com/

Urban Agriculture Websites:
- City Farmer Urban Agriculture Notes: http://www.cityfarmer.org/
- Resource Centres on Urban Agriculture and Food Security (RUAF): http:/www.ruaf.org

Herbs/Companion planting:
- Medicinal Herbs Guide: http://www.herbsguide.net/
- Culinary Herb Guide: http://culinaryherbguide.com/
- Tinker's Garden: http://www.tinkersgardens.com/vegetables

Ecological Sanitation Websites:
- Philippine Ecosan Network: http://www.ecosan.ph/
- UNDP Ecosan Website: http://www.undp.org/water/ecol.html
- GTZ (Germany): http://www2.gtz.de/ecosan/english/
- SIDA (Sweden): http://www.ecosanres.org/
- SANDEC (Switzerland): http://www.sandec.ch
- Ecosan Service Foundation: http://www.ecosanservices.org/
- WHO guidelines for the safe reuse of excreta and greywater: http://www.who.int/water_sanitation_health/wastewater/gsuweg4/en/index.html

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