gardens to grow

URBAN HORTICULTURE FOR INNOVATIVE AND INCLUSIVE EARLY CHILDHOOD EDUCATION

Technical guidelines for garden schools

Co-funded by the Erasmus+ Programme of the European Union

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1. Project background

1.1 INTRODUCTION

School gardens are spreading all over Europe, as natural places where children can have: real contact with nature, discover the origin of their food, observe flowers and vegetables growing, experiment with natural growth and learn life skills such as responsibility, cooperation and self-confidence through achieving. However, the permanent exploration of school gardens is often difficult to achieve due to several factors: unsuitable school location (land availability or contamination), difficultly accessing water, lack of funds, access and maintenance limitation during the school holidays and lack of specialised teachers or personnel for permanent and expert garden care besides pedagogical activities.

GARDENStoGROW Urban Horticulture for Innovative and Inclusive Early Childhood Education is a project co-funded by the Erasmus+ Programme of the European Union, that aims to create educational gardens and training courses for early childhood teachers and school managers to develop basic, civic and transversal skills for the 3-6 age group.

The GARDENStoGROW project has been created because the improvement of education in the earliest stages of development can reduce disparities and inequalities from the beginning this can give a considerable socio-economic return in later years. The Commission has emphasised that "access to universally available, high quality inclusive Early Childhood Education and Care (ECEC) services is beneficial for all. It not only helps children to unlock their potential, but can also contribute to engaging parents and other family members with related measures to improve employment, job-related training, parent education, and after school activities" (Report of the Working Group on ECEC).

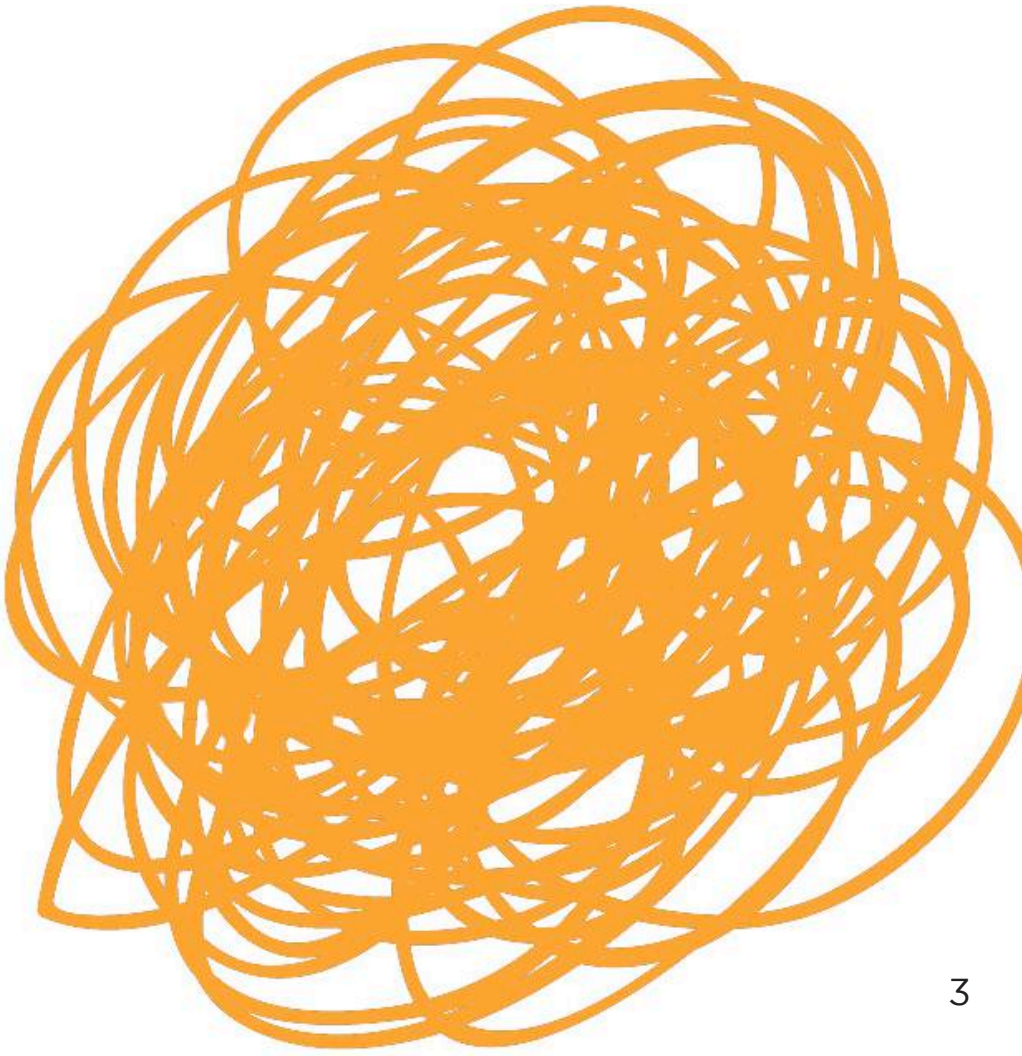
According to the Commission Communication "Early Childhood Education and Care: Providing all our children with the best start for the world of Tomorrow", "high quality early childhood education and care can make a strong contribution – through enabling and empowering all children to realise their potential – to achieve two of the Europe 2020 headline education targets: reducing early school leaving to below 10% and lifting at least 20 million people out of the risk of poverty and social exclusion" (COM(2011) 66 final). The project also refers to the Strategic framework – Education & Training 2020, more specifically to the EU benchmark for 2020 "at least 95% of children (from 4 to compulsory school age) should participate in early childhood education".

The project encourages the adoption of innovative and inclusive pedagogical practices at pre-school level, based on urban and social horticulture, through a series of outputs and a flexible and open training programme, so that ECEC teachers can transform gardening into inclusive and effective educational activities for the development and acquisition of transversal, social, civic and intercultural competences.
Gardens created within the GARDENStoGROW project will allow children from different backgrounds to participate in an inclusive learning environment, with no prejudice to any kind of discrimination, enhancing the access, participation and learning performance of disadvantaged learners.

The project also aims to strengthen the profile of the teaching profession, by: making the careers of teachers and school leaders more attractive through a European opportunity; supporting teachers in dealing with diversity in the classroom (including pupils with a migrant background), through hands-on and non formal activities based on horticulture, supporting them in adopting collaborative and innovative practices; strengthening leadership in education, through an active involvement from the school leaders.

This publication is the result of the output “GARDENStoGROW Methodology Guidelines”, that provides early childhood teachers and school managers with technical information on how, when and where to build different types of gardens, together with a background on inclusion and a series of annexes.

The Guidelines will be useful for teachers and school managers who are willing to create vegetable gardens in their schools and will be followed by educational materials and training courses, based on the pilot gardens implemented by GARDENStoGROW, to be used when necessary.



1.2 PROJECT PARTNERS

The GARDENStoGROW Methodology Guidelines include the collaboration of partners from Italy, Bulgaria, UK and Spain:

EXPLORA:

Explora is a privately run non-profit children's museum based in Rome, a permanent structure dedicated to children aged 0 to 12 years, schools and families. It fosters and helps children's natural urge to learn with exciting suggestions and exhibits, designed for all age groups; offers parents and children a chance to share this exciting experience, which will allow children to grow up and adults to rediscover childhood; offers teachers and children exciting and innovative non-disciplinary experiences to be followed up in class; creates interest and positive attitudes in children and their caregivers towards cultural interaction, cooperation, respect for other people and the environment; brings children and adults closer to science and research by promoting culture, knowledge and new technologies;

UNIVERSITÁ DI BOLOGNA DEPARTMENT OF AGRICULTURAL AND FOOD SCIENCES:

Provides leadership in research, teaching and extension in the subjects of horticulture, crop production, sustainable agricultural systems and environment and applied plant ecology. Its mission is to develop and deliver educational and research programmes enabling students to become highly skilled and creative graduates and fostering the adoption of profitable, environmentally sound and socially responsive agricultural systems. It has a world leading experience in the area of urban farming in Europe and in developing countries especially in the development of sustainable small scale horticultural cropping systems;pect for other people and the environment; brings children and adults closer to science and research by promoting culture, knowledge and new technologies;

UNIVERSITÁ DEGLI STUDI DI PARMA DEPARTMENT OF HUMANITIES, SOCIAL SCIENCES AND CULTURAL INDUSTRIES:

Is considered one of the main research areas of the University. Scholars working in the Department have considerable experience in social development, emotional competence, teaching and learning processes, discursive interactions. Their research is mainly conducted within a socio-constructionist theoretical framework based on multimethod approaches. The Department offers a Master Degree in Clinical and Applied Psychology, Bachelor and master in Education, and a Master of Applied Behavior Analysis (A.B.A.), of particular relevance for the training of teachers;

STEPS:

Works nationally and internationally to promote educational research, reflection and rethinking of traditional learning approach. Furthermore, STePS pioneers approaches to formal and non-formal learning to enable personal growth as well as inclusive and sustainable change in organizations and territories. Over the last years, STePS has become increasingly committed to initiatives designed to overcome the very strong national differences in the preparation of ECEC workers (curriculum design) and their educational practices (learning standards);

ISTITUTO COMPRENSIVO CLAUDIO ABBADO:

Istituto Comprensivo Claudio Abbado (ICCA) was created on 1st September 2012 and groups 3 school complexes ("plesso"):

- Plesso Pistelli: pre-primary (7 classes) and primary school (40 classes);
- Plesso Giovanni XXIII: secondary school (12 classes);
- Plesso Vaccari: pre-primary (3 classes) and primary school (7 classes).

According to the 3-year plan of educational offer, the school mission is to:

- guide learners through cooperation, solidarity and active citizenship, with a focus on:
- special education needs of pupils, integration of marginalised pupils, including those with learning disabilities;
- emerging educational needs, strengthening the level of English and scientific education;
- collaboration with families and an hopening of the school to the local community with extra-curricular initiatives.

The vision is a school that can combine innovation and inclusion, open to the challenges of XXI century, to develop key competences necessary for economic, civic and social life, by fully respecting the educational needs of all.

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MUZEIKO FOUNDATION:

The Children's Museum of Sofia is the biggest science centre in Eastern Europe specifically targeting children. It specializes in science communication for children and informal learning. MUZEIKO is working within a social context, which is specific with more then 30% of the population living under the poverty line and the particular geographic position of Bulgaria on major roads of migration;

COSMOS KIDS:

Is an English language Nursery and Kindergarten aiming to introduce children to multilingual environment based in Sofia, Bulgaria. The world to the COSMOS KIDS children is an invitation to learning and discovery. The children in COSMOS KIDS are from different nationalities and they grow up open and tolerant to race and religious background. Cosmos Kids is established in 2009, is a part of Piccolingo Campaign for early foreign language learning since 2011.

Cosmos Kids started using Jolly Phonics and Jolly Grammar in 2015 – a synthetic multi-sensory phonics method of teaching the letter sounds in a way that is fun and enables children to become fluent readers.

Cosmos Kids became a member of NDNA National Day Nurseries Association UK in 2016.

Cosmos Kids follows the requirements of the National Curriculum of UK since 2016.

Cosmos Kids applies the Common Core State Standard in observation, education and assessments since 2016.

Cosmos Kids uses Mathematics and Science with Cambridge curriculum since 2018.

In the GardenstoGrow project participate all children from the Kindergarten children from groups aged 3-4 years old, 4-5 years old, 5-6 years old, 6-7 years old.

SOUTH WEST COLLEGE STEM CENTRE:

South West College is one of the largest vocational and technical Colleges in the United Kingdom employing over 900 staff, servicing some 22,000 full-time and part-time students, with an annual turnover of £42 million. The College is rurally located in the western region of Northern Ireland, and offers modern technical, vocational and social based curriculum to support the local and regional economy. The College has a strong reputation across the United Kingdom and beyond for excellence in service delivery, consistency of performance and a commitment to continuous improvement. It is involved with the STEM centre, the UKs first teaching facility focused exclusively on delivering educational and interactive activities in the areas of Science, Technology, Engineering and Maths;

DUNGANNON PRIMARY SCHOOL:

Has served Dungannon town (Northern Ireland) and the surrounding areas for over forty years, and has become an integral part of the community. The school caters for almost 250 pupils, who are taught in nine mainstream classes and three Learning Support Classes. Integration with mainstream classes is seen as a major part of each pupil's overall educational experience, with every opportunity being taken to ensure this on a daily basis;

FUNDACIÓN TIERRA INTEGRAL:

Was created in 2000 to implement and develop agroecology knowledge and environmental education. It promotes cooperation of all kinds of intellectual, scientific, social and cultural activities in the rural areas. In 2007 the Foundation opened the Centre for Agroecology and Environment in Bullas (Murcia, Spain). The aim of this centre is to preserve biodiversity and demonstrate good practices in agriculture and construction.

ESCUELA DE EDUCACIÓN INFANTIL EL CASTELLAR:

Is a public childhood school (2nd cycle of pre-school education with children aged 3 to 5), located in Bullas (Murcia, Spain) which has a population of approximately 12,200 inhabitants within an area of 82.2 km2. The origin of the pupils is Bullas, in a high proportion, mainly influenced by the proximity.

Some the school's objectives:

- to actively promote democratic values;
- to be an open, active, participatory and inclusive school;
- to achieve the development and promotion of positive attitudes regarding the habits of individual and collective health, consumer and environmental conservation and nature;
- to work for continuous training of all the people of the educational community, incorporating new technologies and becoming aware of the importance of languages for personal development, social acceptance and understanding of external reality.

2. Educational school gardens

2.1 INTRODUCTION

School gardening activities can encourage lifelong learning among students by fostering the acquisition of key competences that are fundamental for each individual in a knowledge-based society. The promotion of didactic horticulture activities in the schools aims to encourage the adoption of innovative and inclusive pedagogical practices at preschool level, based on urban and social horticulture, through a series of outputs and a flexible and open training programme, so that Early Childhood Education and Care teachers can transform gardening into inclusive and effective educational activities for the development and acquisition of transversal, social, civic and intercultural competences.

The adoption of schools gardening including both Simplified Soilless Horticulture (SSH) and On Soil Horticulture could guarantee a constant production of fresh vegetables into the schools. The vegetables are indispensable to satisfy the daily demands of vitamins (strengthen our immune system), mineral salts (important for the fluid balance and the muscles), fibers (aid digestion) and iron (strengthen the metabolism).

Small urban gardens for horticultural purposes are widespread around the world and have similar origins everywhere, linked to food production and food security. Low cost appropriate technologies for efficient food production are important to increase food self-suffiency in the population.

The most relevant innovations of the proposed actions concern the introduction of the Soil Horticulture (where suitable soil is available) in four schools in Italy, Bulgaria, Spain and Northern Ireland.

The main objective of this manual is to contribute and help the school staff in charge of the school gardening established within the project, to ensure long term sustainability and easy replicability of all the systems introduced by the projects. We hope this material will bring a new dimension to the school work and inspire in turning greener the school and city life.

2.2 THE IMPORTANCE OF VEGETABLES FOR HUMAN DAILY DIET

Some of the world's most widespread and debilitating nutritional disorders, including birth defects, mental and physical retardation, weakened immune systems, blindness and even death, are caused by diets poor in vitamins and minerals (commonly referred to as "micronutrients"). Low intake of fruits and vegetables is a major contributing factor to such micronutrient deficiencies.

Encouraging people to eat more fruits and vegetables is therefore often at the top of nutrition educators' to-do list. Still, most populations are not consuming nearly enough, according to the FAO/WHO Expert Report on Diet, Nutrition and the Prevention of Chronic Diseases, released earlier this year.

Vegetables are full of vitamins and minerals, which serve an array of important functions in the body: Vitamin A, for instance, maintains eye health and boosts the body's immunity to infectious diseases; Potassium promotes proper nerve and muscle functioning; and B-vitamins are necessary for converting food into energy. Folate, one of the most common B-vitamins found in products, can also reduce significantly the risk of neural tube birth defects in newborns and contributes to the prevention of heart diseases.
Other micronutrients in fruits and vegetables, such as Vitamin C and Vitamin E, serve as powerful antioxidants that can protect cells from cancer-causing agents; Vitamin C can increase the body's absorption of calcium — an essential mineral for strong bones and teeth — and iron from other foods. Low iron levels can lead to anemia, one of the most severe nutrition-related disorders, affecting about 2 billion people worldwide (FAO, 2003). Many fruits and vegetables are also very high in dietary fibers, which help to move potentially harmful substances through the intestinal tract and to lower blood cholesterol levels.

It is necessary to encourage people/producers/farmers to follow good agricultural practices and develop a general framework for food production systems that are both economically and environmentally sustainable.

Vegetable intake in different combinations is essential for the maintenance of a healthy life-style and normal body functioning but also to investigate the effect of cooking and storage conditions of these valuable nutrients (Hanif, Rumeza, et al. 2006). The adoptation of either Simplified Soilless Horticulture System or Soil Horticulture System could significantly contribute to improve student's environmental knowledge as well as the access to vegetables, encouraging local communities to grow and consume a variety of vegetables.

Table. Nutritional intake of vegetables that have a positive impact on human health.

Constituent	Sources	Established or proposed effects on human-wellness
Vitamin C (ascorbic acid)	Broccoli, cabbage, leafy greens, pepper, potato, tomato.	Prevents scurvy, aids wound healing, healthy inmune-system, cardiovascular-disease
Vitamin A (carotenoids)	Dark-green vegetables (such as collards, spinach, and turnip greens), vegetables (such as carrot, pumpkin, and sweet potato), tomato.	Night blindness prevention, chronic fatigue, psoriase, heart disease, stroke, caratacts.
Vitamin K	Green onions, crucifers (cabbage, broccoli, brussel sprouts), leafy greens.	Synthesis of pro-coagulant factors, osteoporosis.
Vitamin E (tocopherols)	Corn, dry beans, lentils and chckpeas, dark-green leafy vegetables.	Heart-disease, LDL-oxidation, immune-system, diabetes, cancer.
Fibre	Most fresh vegetables, nuts, cooked dry beans and peas.	Diabetes, heart disease.
Folate (folicin or folic acid)	Dark-green leafy vegetables (such as spinach, mustard greens, lettuce, broccoli, brussels sprouts, and okra), legumes, (cooked dry beans, lentils, chickpeas and green peas), asparagus.	Birth defects, cancer, heart disease, nervous system.
Calcium	Cooked vegetables (such as beans, greens, okra and tomatoes) peas, snap beans.	Osteoporosis, muscular/skeletal, teeth, blood pressure.
Magnesium	Spinach, lentils, okra, potato, banana, nuts, corn, cashews.	Osteoporosis, nervous system, teeth, immune system.
Potassium	Baked potato or sweet potato, cooked dry beans.	Hypertension (blood pressure) stroke, arteriosclerosis.

2.3 SCHOOL GARDEN IMPLEMENTATION CHECK LIST

The purpose of a school gardening calendar is to provide a guide that helps you to manage and maintain the garden during the whole school year.

The calendar must be divided into administrative, community – based and gardening tasks to be distributed over the whole year including Christmas, Easter and Summer Holidays.

An example of a yearly school garden calendar could be the following:

SEPTEMBER-OCTOBER

- Schedule Garden Council meetings for the year (consider assigning classes to garden plot/box).
- Create calendar (e.g. Google Calendar) to determine who will be assigned to which garden chore and when.
- Prepare the Autumn – Winter gardens.
- Capture garden observations in your record keeping system: What grew well? What didn't?
- Early September is your last chance to plant cool season crops such as kale, spinach, radishes, lettuce, mustard and asian greens, and cover crops. You can replace finished summer plants with these crops.
- Keep the garden clean.
- Start saving seeds for the next year.

NOVEMBER - DECEMBER

- Capture the full season in your record keeping system.
- **Do not forget to plan the management of the garden during the Christ mas period (especially frost protection).**
- Develop budget(s) (In – Out).
- Plan your crop rotation for the next year.
- Order your seed catalogues for the next season.
- Add mulching on the gardens to protect them from the winter.
- Keep the garden clean to mantain it in good conditions when the school will open after the Christmas period.

JANUARY – FEBRUARY

- Order seeds.
- Plan your garden for the year.
- Think about:
- Including vegetables, herbs, flowers that attract beneficial insects.
- Crop rotation. Planting vegetables from the same family in the same spot every year may wear out the soil. Check your notes from last year: what and where did you plant? Plan to rotate each area to a different family every season. Here is a list of the plant families:

Beet: beets, spinach, chard
Parsley:carrots, celery, parsnips, parsley, fennel, cilantro, anise, dill, cumin
Sunflower: lettuces, salad greens, sunflowers
Onion: garlic, onions, chives, leeks, shallots, cipollini onion cipollini
Grass: corn
Solanaceae: tomatoes, potatoes, peppers, eggplant
Leguminosae: beans, peas
Squash: cucumbers, gourds, melons, squashes, pumpkins
Brassica: broccoli, cabbage, kale, cauliflower, collards, radishes, rutabaga, turnips, mustard, kohlrabi, Brussels sprouts
Mint: basil, mint, rosemary, sage, savory, marjoram, oregano, thyme, lavender
Morning Glory: sweet potatoes
Mallow: okra

- Winter prune hardy fruit trees (apples, pears, plums, figs, cherries), grapevines and shrubs.
- Maintain your garden tools. Clean and sharpen pruners, remove rust from shovels and rakes.

MARCH -APRIL

- Make notes in your garden observation notebook.
- **Do not forget to plan the management of the garden during the Easter period (especially frost protection).**
- Begin indoor transplants under grow lights: early March (broccoli, kohlra bi, kale, lettuces); late March (tomatoes, peppers, eggplants).
- Prepare your garden beds around the first week in April: add compost and turn soil when thawed.
- Sow spring seeds (peas, spinach, beets, radishes, lettuce) outdoors, and plant seedlings (kale, chard, collards, etc.).
- Check the weather for frost. protect new plants from frost with plastic sheeting or row cover cloth.

- Connect municipality, well water/rainwater harvesting system (clean and repair if necessary) with the irrigation system.
- Uncover cool season crops (if any overwintered under cover/cloche), but remain wary of low night-time temperatures until last frost.
- Care for garden perennials: compost and mulch your plants.

MAY – AUGUST

- Write down observations in the garden notebook.
- **In May/June plan the management of the garden during the summer especially weeding and watering may need to be done daily).**
- Harvest!
- Keep on top of weeds!
- Be water-wise: water well in the coolest moments of the day — morning and evening.
- Connect municipality, well water/rainwater harvesting system (clean and repair if necessary) with the irrigation system.
- Uncover cool season crops (if any overwintered under cover/cloche), but remain wary of low night-time temperatures until last frost.

All the mentioned topics have to be developed through awareness trainings during all the stages of the garden implementation. It is crucial to make the actors aware about the important role of school gardens. A clear understanding of the objectives of school garden implementation by the actors/beneficiaries will contribute to the medium-long term sustainability of the gardens.

- **Carry out a local market survey**, in order to identify the most suitable and easily available materials for the garden construction and management.

- **Identify the most suitable crop to grow according to the local context and climate.**

Helpful hints:

- Do you know your growing zone? Find it by using the USDA's Plant Hardiness Zone Map.
- Try to select plants based on a theme, such as a storybook or science lesson, to connect with what is being taught in the classroom.
- Procure and distribute materials and inputs at school level (seeds, fertilisers and organic pesticides).
- Build and use the garden.

In order to keep the garden working properly over the whole year, it is essential to carry out daily monitoring to solve possible technical problems asap: water stress, nutrient deficiency, pest and disease.

Encourage the students to share their ideas to be included in the building and planting phases of the garden – trying to get their hands on the soil every step of the way. Their participation will instil a sense of ownership, pride and responsibility among students. Use the garden to connect students to the source of their food. Plant herbs, fruits, and vegetables that are easy to grow, pick and cook.

Many different materials are needed to construct and manage a garden. It is important to take care of the materials and store them well. The tools belong to the group members and they will be used for the proper construction and management of the different growing systems. It is therefore essential that tools and materials will be carefully taken care of by the people in charge to allow the proper management of the garden and to have the opportunity to build new ones.

3. Step-by-step construction of school gardens

3.1 ON SOIL GARDEN

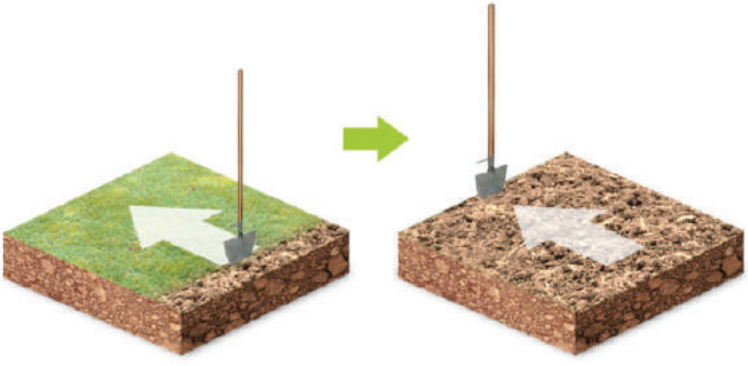
The on soil vegetables gardens have to be organized in single plots. An average of five plots for vegetables production could be a proper number to get a good production to satisfy didactic, consumption and surplus purposes. The plots orientation and preparation have to be perpendicular to the ground slope and to the runoff direction of water.

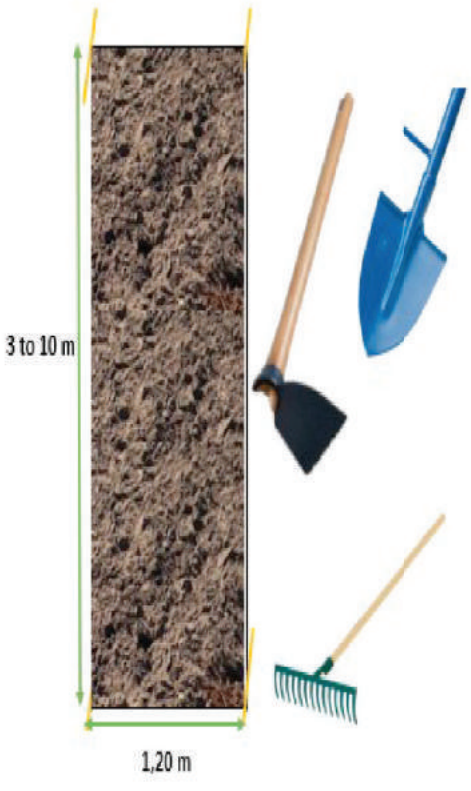
The phases to build our on soil vegetables gardens are the following:

1. Drawing the perimeter of the plots: using some simple wood stick sand the nylon string, we can start to draw on the ground the perimeter of our plots that could have different size from 1 m x 3 m (3 m^2) to 1m x 10 m (10 m^2). Between the plots we have to leave a space approximately 40 cm wide; it will facilitate both the maintenance and the harvesting process.

2. Digging the soil: overturn and dig the soil with the spade as shown in the picture below. These activities could be done also by hoe. During this phase, it is recommended to add mature cattle/goat/ chicken manure (see next chapter).

3. Rise the growing plot: take the soil between the plots and make the frame of the plots up to a high of 15 to 20 cm and leveling the plots with rake and compact the border by using the back of hoe;





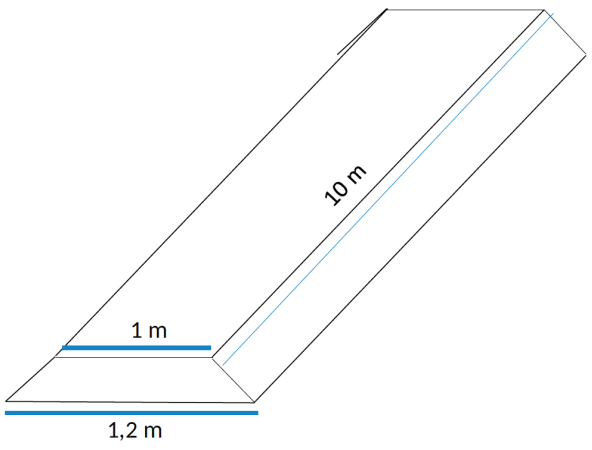
Organic and Inorganic Fertilization

All inorganic fertilizers contain the elements that are easily absorbed in a greater quantity by plants and that are essential for growth and for an adequate execution of all vital functions.
Organic fertilizers (cattle or goat manure) have the advantage of operating at the soil level (improving its physical-chemical characteristics) as well as at the plant level. Therefore, once the plot has been dug, a 15 to 20 cm layer of organic matter is distributed on the whole soil surface of each pot.

Starting fertilization

- Organic fertilizer releases nutrients slowly and decreases the risk of over-fertilization. The slow release of nutrients also means they are available for a longer period of time. Many organic fertilizers improve the soil, by increasing soil's ability to hold water and nutrients. They will also help to decrease erosion and hard, packed soil due to wind and rain. Organic fertilizer adds natural nutrients, feeds important microbes, and improves the soil structure.
- The amount of organic fertilizer for m^2 to be distributed is depending from the chemical-physical soil features. A chemical and physical soil analyses it is recommended before implementing the on-soil vegetables gardens.
- In general, a recommended fertilization could be the following: around 1 to 1,5 kg/m^2 of compost or cattle/goat manure or 50 gr/m^2 pelletized poultry manure. It is important to abound with the amount of organic matter, if you are dealing with a new plot or if the soil is too sandy or clayey; conversely, the amount should be decreased, if the soil is cultivated for long time. Once the entire plot has been covered, the organic matter must be mixed with the soil by a 15 – 20 cm depth tillage with a hoe;
- The soil analysis will give also information on soil pH. It is a measure of the acidity or basicity (alkalinity) of a soil. For vegetables production, pH should stay between 5,5 to 6,5 to allow the availability of the major nutrient for the plants. If soil pH is acid (between 5 and 6), it is needed to add lime. Usually, 100 – 200 gr/m^2 of lime it is enough to rise the pH at normal level.
- On the downside, organic fertilizer is released slowly, so your plants will be nutrient deficient until the decomposing process is completed. For this reason, it is suggested to add, at the beginning of schools garden activities, fast-acting organic fertilizers, such as "Complex mineral fertilizer authorized in biological agriculture" named **K-BIO NPK 3-5-10 (15C org.)**. For vegetables production, 400 – 700 gr/10 m^2 it is recommended.

In the following table it is reported an example of staring fertilization for 10 m^2 gardening plot.



15 kg of matured cattle, goat or chicken manure;
500 gr of NPK 3-5-10;
If soil pH is acid, add 200 gr of lime;

Transplant

Seedlings are ready for transplant when they have around 4-5 leaves. It is better to avoid the transplant of stunted, weak, or even too developed seedlings. Prepare the holes or grooves before transplanting to reduce the direct exposure of roots to the sun. It is also important to irrigate the seedlings few hours before transplanting to avoid damages when removing from the seedbed. It is important that the groove/hole respects the development of roots and aerial part of the plant and that the collar (transition zone between root system and aerial part of the plant) is slightly higher, so that after soil adaptation it will be positioned at ground level as occurs in nature.

More advices:

- The seedling must be positioned lower than the soil level;
- Roots should be covered with soil;
- The collar should be positioned so that it is higher than the soil level;
- The soil should be pressed firmly in order to give stability and to make the roots stick to the ground.

Crop rotation and intercropping

The accumulation of crop residues in the soil and the presence of specific parasites can be avoided adopting rotation and intercropping. To rotate crops means not to put on the same plot/area of land by similar crops, for at least three cycles. Similarly, intercropping can improve growth conditions of individual crops by exploiting characteristics and functions of other crops. For example, it is recommended the intercropping of carrot with leek or onion, which have a repellent capacity against insects, or corn with bean, in a way that the former provides support, and the latter is capable of fixing nitrogen.

Suitable crop rotation for the school garden: *Lettuce (Asteraceae Family), Carrot (Apiaceae Family), Cow Pea (Leguminosae Family), Tomato (Solanaceae Family).*

Good practices for irrigation

When?
Irrigation is performed in different ways according to the season. During the hottest period (June–July–August), irrigation should be carry out every day in the morning as well as in the evening, in order to avoid the hottest periods of the day (central hours). It is also very important to learn to observe the plant. A dehydrated plant during the hottest hours of the day is not necessarily “thirsty”. Yet in the evening and then during the night, the plant will recover turgor. Vice versa, if the dehydration symptoms appear in the morning the plant should be immediately watered. A good rule to understand when irrigation is required during the other seasons, is to look at the soil and see when 3-5 cm above the surface are completely dry.

Where?
In order to increase the efficiency of irrigation, the water should be provided (with watering can or dripper) near the plant roots.

How?
There are many different irrigation methods. When using a watering can, the water should be directed to the roots of the plant, using the rose and avoiding wetting the leaves. When using drip irrigation system, it is important to assure that the dripper is close to the roots of the plants.

Watering can and drip irrigation system combined with organic mulching

How much?
With a drip irrigation system, the flow rate is determined by the water pressure and by the dripper flow rate (e.g. 2 litres per hour). In order to get the recommended water flow, the water in the leveling pipe should be between the recommended range. In Italy, during the hottest period, 15 minutes a day in the morning and 15 minutes in the evening are sufficient for guaranteeing the right moisture for the plants.

Watering can and drip irrigation system combined with organic mulching

Lessons learned

1. **Seed saving** is an ancient practice where farmers and gardeners choose the best of their crops to save seed for the next growing season. This makes a great in-garden activity, as well as a history or math lesson! Some seeds, like peppers can be dried right on the plant. For others, like tomatoes and cucumbers, the seeds are removed from the flesh of the fruit, and then washed, dried, and stored.
2. **Mulch is important!** Mulch is a protective layer of material spread 6-15 cm deep on top of exposed soil between plants. Mulch is by far the best way to preserve the water in the soil. It can be a very effective way of feeding the soil just as regulating temperature. Mulch can be almost anything: straw, grass clippings, corn cobs, river stones, pea gravel, chipped bricks, bark chips, leaves, Peat Moss, seaweed, wood ashes, sawdust and so on. Mulch helps to preserve water and regulate the temperature in the soil but it also prevents the growth of weeds, protects soil from compaction, cuts down on erosion and, if organic, feeds your soil. As the mulch decomposes, it provides vital organic matter to the soil, encourage microbe growth and shelter earthworms. All that organic matter keeps the soil loose, so that it can retain moisture and promote root growth.
3. In order to guarantee the **sustainability of the school gardens**, the presence of a constant monitoring throughout the duration the whole school period is a key aspect;
4. **Compost** is an important ingredient of good gardening. It provides nutrients to make the soil rich and fertile and keeps it moist and airy by opening the soil, and trapping and draining water.
5. General rules for **processing food** are:

a. Harvest in the cool of the evening;
b. Choose ripe, undamaged items;

c. Cut out any damage or rotten pieces;
d. Sterilize equipment and wash hands.

3.2 BOX SYSTEM

How to build a Simplified Box Substrate System?

The box system is substantially a wood box made of raw wood and recycled pallets, where plants are grown in a substrate.
The selection of the proper box type and size is crucial, and it shall consider different factors: available space, technical and economic means, needs and aspirations of the family or group involved in the activities.
Past experiences suggest a size of about 1 m^2 (1.2 x 1 m) with borders at least 30 cm high. It is suggested that boxes shall be elevated by means of 4 or more supports to allow good air circulation underneath and to avoid excessive heating exchange from the soil. In this way, root overheating and poor oxygenation of the water are avoided. The system has been successfully used in a wide range of climates and resulted to be more suitable for medium-bigger sized vegetables such as tomato, pepper, cucumber, eggplant and chili pepper, which need more space for root development. Indeed, it is also good for carrots or leafy vegetables (lettuce, spinach, etc.). It shall be considered that, as compared to other systems, the box system presents lower water use efficiency due to the higher evaporative surface of the exposed substrate. However, water saving as compared to traditional on-soil agriculture is still greatly appreciable.

How to assemble a Box System wooden container?

The box system: instructions

Phase 1:

- Select the more suitable pallets (3 units) paying attention to the size and strength of the pallets. Instead of 3 pallets it is possible to use only one pallet and four small wheels fixed under the pallet;
- Smooth the wood surface of the pallets and all the boards;
- Assemble the 3 pallets together (one over the other).

Phase 2:

- Fix on the lower pallet four wooden boards 30 – 35 cm high, which are going to-constitute the edges of the container. These edges should assure a depth of around 30 cm, necessary for the roots' growth. To set up the boards, start on the shorter sides fixing the upper board directly on the pallet with screws. Once the wooden container has been assembled, it is good to use a wood impregnating agent to make the wood waterproof and resistant.
- Make a 12 mm hole on the shorter board (the hole must to be done in the center and in the lowest part of the board).

30 cm

Phase 3:

- The internal part of the box must be covered by newspapers;
- The internal part of the container is sealed with waterproof sheets. It is important to leave some openings to allow a good drainage. For this purpose, a hole in the water-proof sheet is needed at the same level of the hole made in the wood.

Phase 4:

- The box system is composed by a wooden container made waterproof with plastic ilm and filled up with the growing substrate. The substrate suggested is: 1 part of vermiculite, 5 parts of Peat Moss.

As a substrate it is possible to use also the following inputs:

- cattle or goat manure and normal soil. The proportion is: 1/3 of cattle / goat manure and 2/3 of normal soil;
- coconut fiber.

The depth of the substrate must be at least 25 cm from the base of box.

Phase 5:

- Transplant: Plants are transplanted or sown directly into the Box System.
- Before the transplant, the substrate inside the box must be mixed and wet. Watering the substrate up to the water drains from the drainage pipe.

The base of the system must be slightly declined (2% slope) and the exceeding solution flows to a tank (a 10 litres bucket) placed below, to be recycled.

Table: List of some plants that can be planted in the box system

SPECIES	Plants Density				Sowing/ Transplant	Optimal Germination T(°C)	Minimal T (°C)
	Between rows (cm)	In the row (cm)	Area 1 plant	Nº of Plant/ m^2			
Lettuce	25	25	0,6	16	Transplant	15-20	5
Rocket	25	25	0,6	16	Transplant	27	5
Cucumber	55	30	1,7	6	Transplant	25	15
Parsley	15	5	0,1	133	Sowing	15-20	5
Tomatoes	55	30	1,7	6	Transplant	20-22	12-13
Eggplant	55	35	1,9	5	Transplant	22-24	15
Sweet Peppers	55	30	1,7	6	Transplant	20-25	15
Beans	60	25	1,5	7	Sowing	25	15
Carrot	20	5	0,1	100	Sowing	18	6
Cabbage	60	60	3,6	3	Transplant	18-20	6
Chard	40	40	1,6	6	Transplant	25	7-8
Chicory	25	25	0,6	16	Transplant	27	5
Spinach	30	30	0,9	11	Transplant	21	5
Zucchini	100	100	10	1	Transplant	25-30	15
Pea	40	10	0,4	25	Sowing	15	5
Fennel	60	20	1,2	8,3	Transplant	20	6
Onion	20	10	0,2	50	Sowing	15-20	5
Garlic	25	10	0,3	40	Sowing	15-20	5
Strawberry	50	30	1,5	6,7	Transplant	15-20	5

It is suggested to sow carrot, radish and beans directly into the box system. For the other plants, it is better to do the sowing in the seedling trays and transplant.

Season by season, it is suggested to sow/transplant in the same box different plant families such as:

Autumn – Winter: Cabagge (Brassicacea), Fennel (Apiacea), Chicory (Asteracea) and Chard (Chenopodiaceae).

Spring - Summer: Tomatoes (Solanacea), Lettuce (Asteracea), Carrot (Apiacee), Beans (Leguminose), Flowers (Tagetes) and Aromatic Plants (Mint, Salvia, Basil).

Such associations will allow to get a balanced agrosystem that will help to manage pests and diseases of plants.

Table: Yearly crop calendar

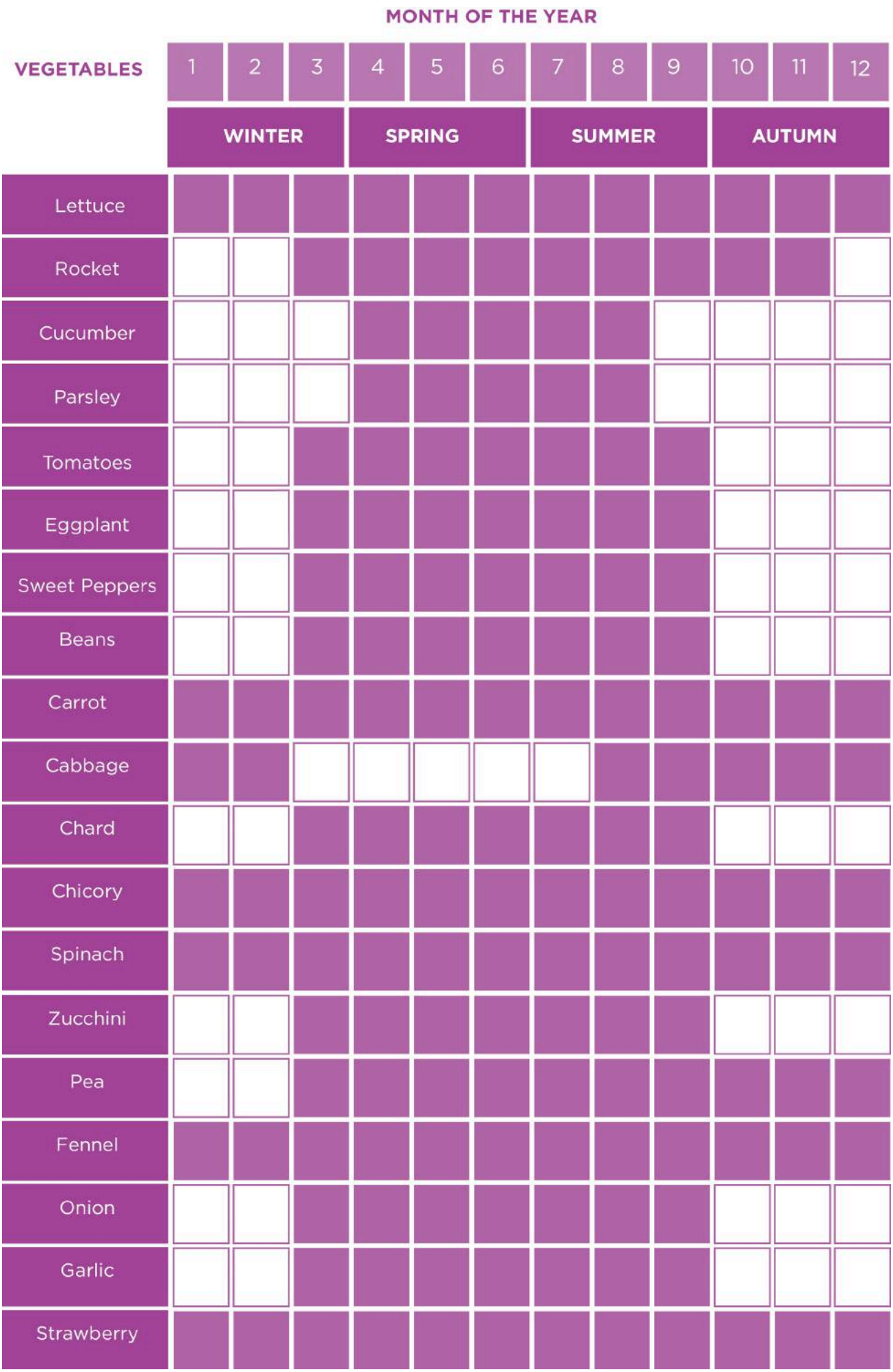
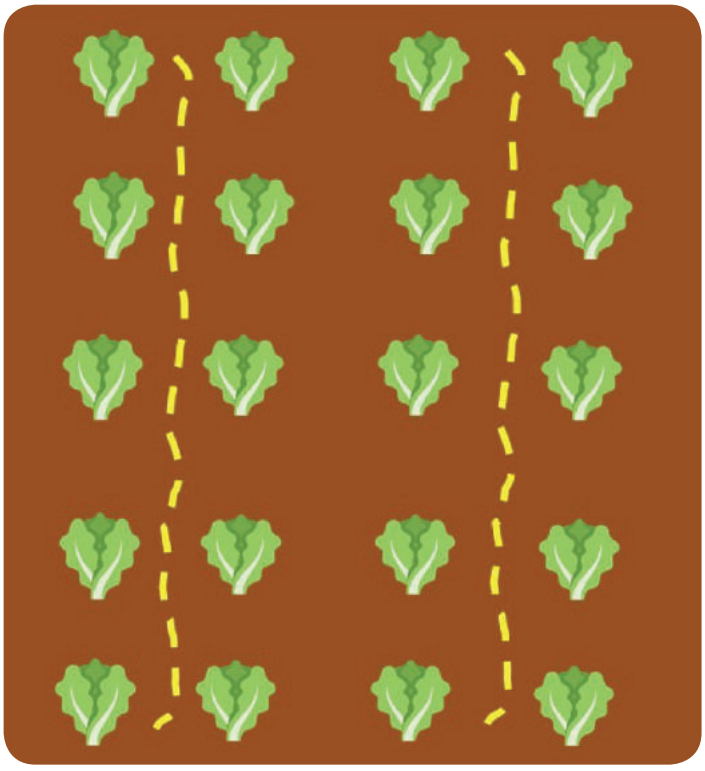


Figure: Spring-Summer vegetables garden association (Lettuce, Cucumber/Tomatoes, Beans, Salvia, Basil and Tagetes)

The fertilizer application

The fertilizer could be applied in two ways:

1. Mix with organic fertilizer substrate before transplant. It is possible to use cattle or goat manure well matured (0,5 kg/box);
2. If mineral fertilizer is allowed during the growing period we could apply directly in the substrate 6 gr of mineral fertilizer (ex. 13-13-13 + TE)for each row. If we have 5 rows of vegetables, we add fertilizer in 4 lines as it is illustrated in the figure beside;
3. It is possible to apply the fertilizer in the water (1 gr pf mineral fertilizer/litre of water) and apply the nutrient solution by watering can on the base of the plant paying attention not to wet the leaves.



Simplified Box System management

The following phases are important to guarantee a proper performance of the system:

- Daily check of the substrate humidity by squeezing some soil, taken from the bottom, into the fist, taking care not to damage the roots.
- If no water drops fall, irrigate with the watering can at the base of the plants (no water on the leaves) with half watering can (2,5 litres) in total.
- **Every two weeks apply the fertilizer as illustrated in the figure above.**

At least every two weeks, overturn the surface of the substrate with your hands, taking care not to damage the roots.

- Make sure the drain is clean and there is no accumulation of water at the bottom of the box.
- Monitor if pests and diseases are affecting the system.
- **Remark: if the weather temperature is very high (e.g. during summer season), it is suggested to cover the gardens with a shadow net (50%)**. At the same time, the net will allow to protect the vegetables from birds that could eat the vegetables.

Below, there are some pictures related to good management of box system:

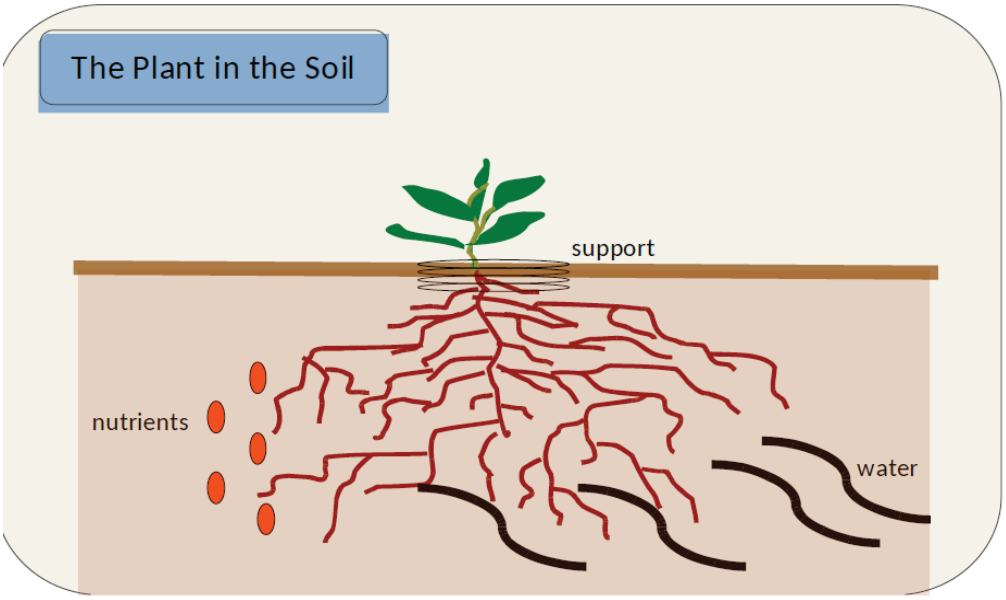
BoQ Box System (1m^2)

Pallet (1,20 x 100cm)	3	unit
Wooden boards (1,20 m length; 30 cm wide; 2 cm thickness)	2	unit
Wooden boards (1,03 m length; 30 cm wide; 2 cm thickness)	2	unit
Wood impregnating agent	3	liter
Plastic sheet black and white 1,60 m x 1,80 m	1	unit
Vermiculite	60	liter
Peat Substrate (liter)	250	liter
12 mm green pipe	0,5	m
Super glue	1	unit
Sand (small bag)		
Screws		
10 liter buckets	1	unit
5 or 7 liter watering can	1	unit
Newspapers	5/6	unit

3.3 FLOATING SYSTEM

All plants grow in the soil which provides them with the mechanical support. The plants are fed by the nutrients existing in the soil conveyed by the water available.

Hydroponics is a technology thanks to which plants grow without soil. It needs less space and less labor, less external inputs and time. However, proper management is required. Hydroponics is often defined as *"the cultivation of plants in water or soilless":* plants ' roots absorb a balanced nutrient solution dissolved in water that meets all developmental requirements needed by the plants.



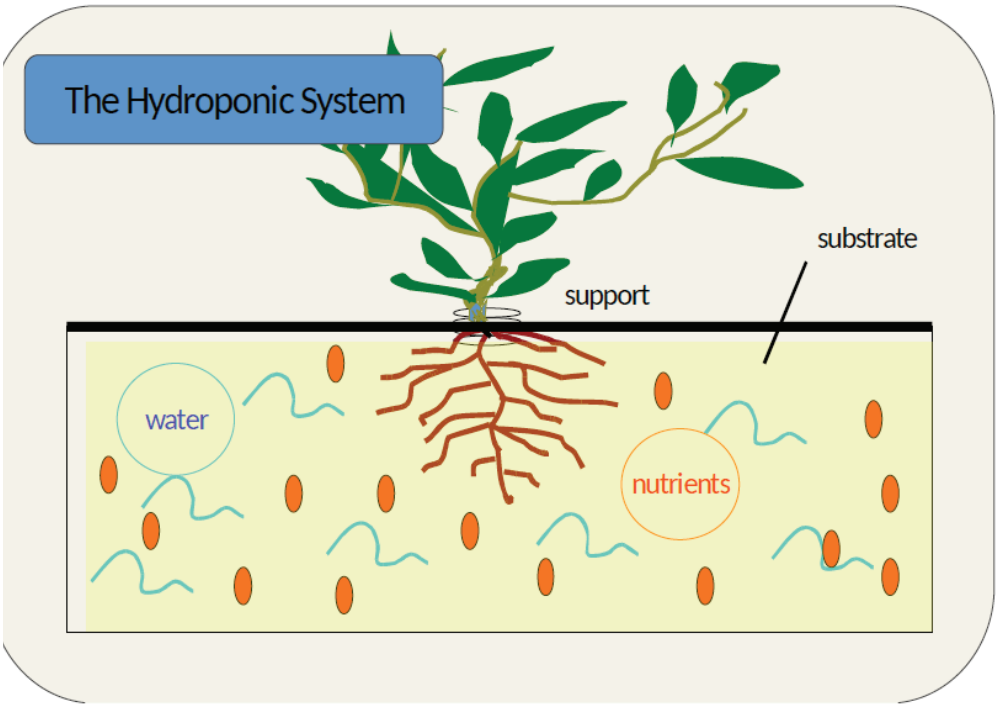


Figure 1: On Soil crop system
Figure 2: Soilless crop system

A Simplified Hydroponic System (SHS) is easier compared with a conventional hydroponic system, which is far more expensive; it needs many different materials and the use of electricity.
A SHS successfully deals with the problem of high costs of infrastructures because it uses locally available materials. Moreover, the electrical systems needed in conventional hydroponic systems to decrease the high temperature, such as fans and/or air con, and to make the water circulate into the hydraulic system, are not necessary.

The main advantages of hydroponic technology are the following:

- The space needed for the crops is always minimum: the number of plants that can be hosted in the same unit of surface is higher;
- Water efficiency: all the water, except for the evaporated portion, is absorbed by the plants without losses in the soil;
- Nutrient efficiency: all the nutrients are absorbed by the plants since the fertilizers will never reach the groundwater;
- The problems related to the soil-borne diseases are avoided;
- The accumulation of soil toxins is avoided too;
- The pest management is reduced because this is a closed system;
- It needs less labor and time to be managed compared with conventional hydroponic systems.

But it needs proper management.

This technique allows production in abundance of healthy fresh vegetables, ornamentals, aromatic and medicinal plants and suits the food's requirements.
When the technology is well managed, the productivity generated by SHS is greater than the one from traditional soil gardening. It is a perfect technology for urban/semi-urban and sub-arid areas as well as at school's level when soil is poor or polluted.
Small hydroponic units can be operated easily by individual and by families. Some special hydroponic techniques have been developed, especially for limited spaces and for those who do not own private lands.

Hydroponics has many advantages:

1. A higher water use efficiency (90% reduction of total water requirement).
2. Can produce all year round irrespective of soil quality or weed problems;
3. Allows the use of recycled materials.

As example, at regime, 1 m^2 box system made by wood structure may host around 20 – 25 plants. Based on mean consumption of 210 g of fresh vegetables per day (Orsini et al., 2014), less than 3 m^2 of garden is enough to satisfy the mentioned amount of vegetable/day/person.

Construction phases

The general characteristic of a floating system is that the plants are fixed on polystyrene beds which float over a tank. In the hereby presented case, plants are located into net pots (filled with a growing substrate as mechanical support) placed on holes made in polystyrene boards. These boards float on the nutrient solution surface, in which the roots of the plants are constantly dipped. In this way, the water surface is completely covered by the floating bed, which allows a very limited growth of algae and at the same time the nutritive solution is oxygenated by a pump to allow better conditions in the liquid medium. In general, the floating system does not allow growing a big range of vegetables and it is commonly used for growing leafy vegetables like lettuce, leaf beet and celery, or aromatic herbs such as basil, coriander and parsley. For the technical aspect regarding density, sowing and transplant time, see the table in the Box System section at page 26 .

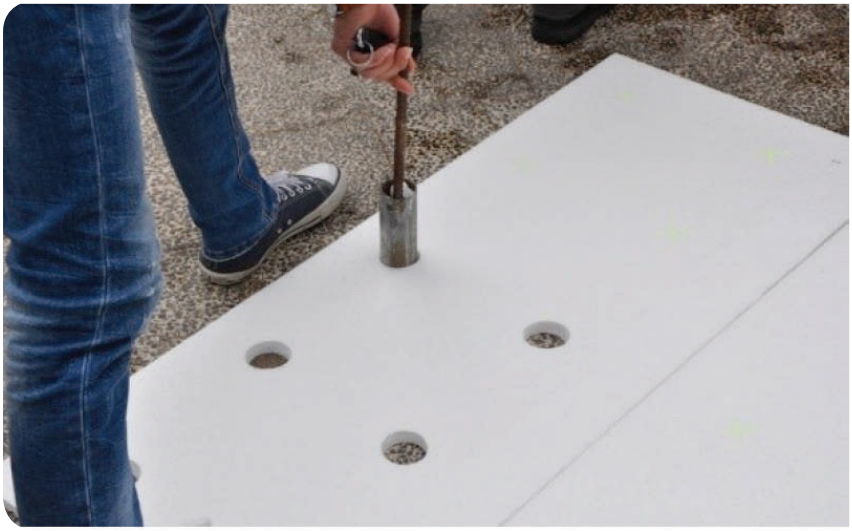
The methodology to assemble the box for the Floating System is the same as the one illustrated in the chapter related to the Box System (see page 22-25).

The innovative phases are the following:

1. Fill the tank with water (25-30 cm deep) and add mineral fertilizer (ex. 13-13-13+TE - 1 gr of fertilizer for one litre of water).

It is not needed to make the hole for the drainage, but the water is kept inside the box with a depth of at least 25 cm.

2. Prepare polystyrene sheets and make 20-30 equidistant holes of the right size to host the plastic glasses at 2/3 of their depth. It is possible to make the hole in the polystyrene sheet by knife, scissors or hot iron tip 8 cm diameter as illustrated in the picture below.



3. Make 3 holes at the bottom of the plastic glasses and 3-5 on their side part using a hot iron tip 12 mm diameter; fill the glasses with a substrate and transplant the vegetables adapted to this system.

4. Insert the glasses in the holes made in the polystyrene;

Floating system management

Plants are sown directly or transplanted into the system. Roots will exit from the bottom of the polystyrene panel and absorb water and nutrients from the nutrient solution beneath. Until sufficient root development, seedlings shall be manually watered, or panels may be gently pressed down to increase the substrate moisture.

To guarantee a good functioning of the floating system, it **is important to oxygenate constantly the nutrient solution below the polystyrene boards**. As a matter of fact, the basic concept of hydroponics is that roots suspended in moving water absorb food and oxygen rapidly and consequently of special concern is the availability of oxygen.
The grower's task is to balance the combination of water, nutrients and oxygen with the plant needs to maximize yield and quality. The oxygenation can be achieved by vigorously moving the water by hand or with a piece of wood twice per day, paying attention not to break the plastic film.

The following phases are important to guarantee a proper performance of the system:

1. Daily check of the water level in the box and refill with nutrient solution up to the level as per needed.
2. Once a day, shake the water with your hands or a pipe to oxygenate the solution.
3. Monitor if pests and diseases are affecting the system.

If the weather temperature is very high (e.g. during summer season), it is suggested to cover the gardens with shadow net (50%). At the same time, the net will protect the vegetables from birds that could eat the vegetables.

Tools needed for the construction of a Simplified Hydroponic System

Tool	Quantity	Tool	Quantity
Hammer	1	Chisel	1
Saw for wood	1	Miter gauge	1
Saw for iron	1	Buckets	1
Auger	1	Watering Can	1
Pincers	1	Nebulizer 2 Lt	1
Scissor	1	Sand Paper	1
Levelling pipe	1	Shovel	1
Chisel	1	Chisel	

BoQ Floating System (1m^2)

Pallet (1,20 x 100cm)	3	unit
Wooden boards (1,20 m length; 30 cm wide; 2 cm thickness)	2	unit
Wooden boards (1,03 m length; 30 cm wide; 2 cm thickness)	2	unit
Wood impregnating agent	3	liter
Plastic sheet black and white 1,60 m x 1,80 m	1	unit
Screws		
Newspapers	6	unit
Net pot 8 cm diameter	21	unit
Plants	21	unit

3.4 TRELLIS/VERTICAL GARDENS

The trelliswork, the typical trellis of classical gardens can be made of various materials such as wood, iron, plastic or steel, each of which presents different maintenance needs.

Selection and installation of a wiring system is determined by the plants to be planted. Systems can be very varied and consist of:

- vertical cables for plants with twining stems in which they can be rolled
- horizontal cables for climber trellises
- gridded cables to hold several species of climbing plants

The most recommended cables and anchors are stainless steel because of its high durability.

On Soil

If the vegetables are planted directly on the ground, the plants have a greater ease of rooting and better moisture conditions than if they are in pots. It should be a fresh and deep soil, to avoid saturation of water. The greater the proportion of organic matter in the soil, the better it will retain moisture and fertilizers.

Soilless

Soil can be obtained from soil bags prepared for gardening or:
- a mixture of land soil or coconut fiber (2 parts) with goat/cattle manure, compost, Peat Moss or earthworm humus (1 part). The best compost is the one made out of our own organic waste;
- a mixture of Peat Moss (5 parts) with perlite or vermiculite (1 part).

Plant selection

The number of climbing plant species available for warm climates is much higher than those that grow in temperate or cold climates. It is important, then, to choose the species according to their temperature needs, because the aesthetic effect is basic in vertical gardens. It is wise to be prudent and choose plant species based on the most rigorous temperatures.

Among the most suitable plants for this structure are:

- Grape ivy, *Parthenocissus tricuspidata*
- Ivy, *Hedera*
- Honey suckle, *Lonicera periclymenum*
- Passion flower, *Passiflora caerulea*
- Jasmine, *Jasminum grandiflorum*
- Bouganvillea, *Bouganvillea glabra*
- Wisteria, *Wisteria floribunda*
- Clematis, *Clematis*
- Podranea, *Podranea ricasoliana*
- Ficus pumila, *Climbing fig*

Construction phases:
1. Dig a gap of about 30 cm.
2. Place the poles in the gap with a space of 20 cm among each other.
3. Pressure the poles towards the ground to be able to tie them.
4. Tie the upper part of the poles all together with a rope.
5. Fill the gap with soil.
6. Set a string or wire perpendicularly to the poles.
7. Tie the plants as they grow with a cotton string or similar to the poles or wires.

SOIL IN PALLETS (SOILLESS) (attached to a wall)

Soil

Soil can be obtained from soil bags prepared for gardening or:
- a mixture of land soil or coconut fiber (2 parts) with goat/cattle manure, compost, Peat Moss or earthworm humus (1 part). The best compost is the one made out of our own organic waste;
- a mixture of Peat Moss (5 parts) with perlite or vermiculite (1 part).

Vertical structure for attachment

The design must take into account that in the vertical structures attached or anchored to a wall it is advisable to leave a space of at least 5 cm, to allow air circulation and to improve the conservation of both the wall and the plants.

Determinants in the selection of the system for attachment

The choice of one type of structure for attachment or another is conditioned by:
- the vertical surface to be covered
- the constructive characteristics of the element on which the structure will be supported
- the selection of vegetation

The structure for attachment must be chosen according to the weight that can support, since the weight of the plants varies according to the species or growth conditions, can range between 1 and 50 kg / m2. Dew, rain or snow can mean an increase in weight that oscillates between twice, in the case of a deciduous plant, and triple for perennial plants.

Plant selection

Among the most suitable plants for a pallet structure are:

- Thyme, *Thymus vulgaris*
- Rosemary, *Rosmarinus officinalis*
- Sage, *Salvia atropurpurea*
- Lavender, *Lavandula officinalis*
- Santolina, *Santolina spp.*
- Wild strawberry, *Fragaria vesca*
- Parsley, *Petroselinum crispum*
- Valerian, *Valeriana officinalis*
- Lemon balm, Melissa officinalis
- Fennel, *Foeniculum vulgare*
- Oregano, *Origanum vulgare*
- Winter savory, *Satureja montana*
- Rue, *Ruta graveolens*
- Tasmanian Flax.Lily, *Dianella tasmanica*
- Stevia, *Stevia rebaudiana*
- Mint, *Mentha spicata*
- Lettuce, *Lactuca sativa*
- Escarole, *Chichorium endivia*
- Celery, *Apium graveolens*

Irrigation

It is advisable to have an automated irrigation system. The drip irrigation tubes can pass through the upper part of the beds ensuring an adequate water supply. The amount of water will vary depending on the soil and the climate conditions.

NOTE:
It is important to note that one of the sides of the pallet has the stamp with the IPCC logo and the letters HT, which means that it was given a heat treatment.

TYPE 1

Materials:

- 1 pallet
- 5 pallet boards
- 1 big pallet board
- hammer and nails
- jigsaw
- sandpaper
- 3 m of geotextile or sackcloth
- staple gun and staples
- 1 m of aluminium wire

Construction phases type 1:

1. Cover with boards three of the four sides of the pallet.

2. Place the geotextile mesh and staple.
3. Nail the big pallet board on the backside.

4. Place the geotextile mesh and staple.
5. Nail the big pallet board on the backside.

6. Sand the pallet, clean with vinegar, varnish with oil and paint.
7. Tie the pallet with nails and aluminium wire on the desired surface.
8. Add the soil and plant.

TYPE 2

Materials:

- 1 pallet
- 4 pallet boards
- jigsaw
- hammer and nails
- sandpaper
- 2 m of geotextile or sackcloth
- staple gun and staples
- 1 m of aluminium wire

Construction phases type 2:

1. Place 3 wooden boards to make the cubes to grow. Cut the boards to the appropriate size and nail them.

2. Cut out boards and place them on the back of the pallet to cover the holes of the grow cubes.

3. Sand the pallet, clean with vinegar, varnish with oil and paint.
4. Place the geotextile mesh in the grow cubes and staple.
5. Tie the pallet with nails and aluminium wire on the desired surface.
6. Add the soil and plant.

4. Technical information on school gardens

4.1 YEARLY CROP CALENDAR

See what fruits and vegetables are in season when:

- Autumn – Winter

Cabbage, Fennel, Chicory, Chard, Onion, Peas.

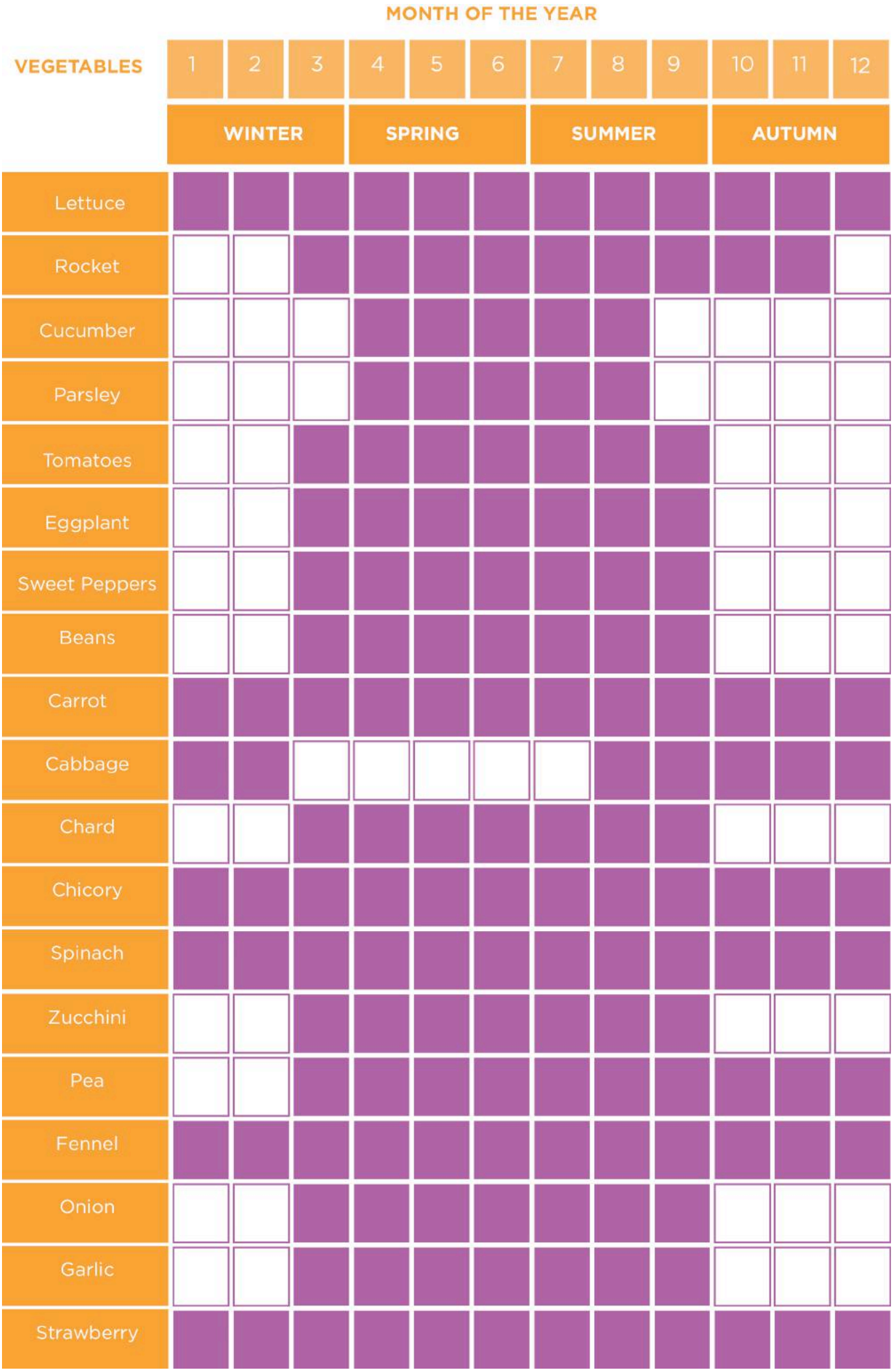
- Spring

Asparagus, Strawberry, Garlic, Carrot, Peas, Fennel, Potatoes, Radish, Pepper, Beans, Cucumber, Squash, Tomatoes, Lettuce, Carrot, Beans+Flowers (Tagetes) and Aromatic Plants (Mint, Salvia, Basil).

- Summer

Pepper, Eggplant, Beans, Watermelon, Melon, Cucumber, Pumpkin and Squash.

Table: Yearly crop calendar



4.2 SETTING UP THE NURSERY

(essential to guarantee the sustainability of the school garden)

1. It is suggested to use plastic or polystyrene tray cells to germinate the seeds. First of all we have to fill the holes with a small amount of substrate (Peat Moss, coconut fiber, cattle or goat manure mixed with normal soil), plant a seed in each hole and cover up with other small amount of substrate.

2. Remember that every seed must be buried in the substrate 3 or 4 times its length.

3. The trays must be kept moist and away from direct sunlight, watering when necessary to avoid the substrate becoming dry. We should expect a variable time to see the seeds germinate. We will continue to take care of the seedlings until they develop at least 4 or 6 true leaves. The time required depends on the type of plants that are being grown and the care. When the plants have grown enough, they can be transplanted into other types growing systems.

Nursery management: substrate preparation and sowing

Advices:

Seedlings quality is very important to achieve good productivity results and to shorten the plant cycle.

The first phases are the more delicate ones and require constant care, therefore some advice:

- Build the nursery in a good aerated area to avoid moisture stagnation, and choose an area with good sunlight;
- Build the nursery close to the box systems;
- Look frequently for fungus diseases or dangerous insects in nursery, and be ready to intervene immediately;
- Irrigations need to be well programmed and efficient to avoid water stagnation;
- Avoid mechanical damage caused by big drops from the watering can on young seedlings. Very small holes on the "rose" (a device like a cap) can be made in order to break up the stream of water into droplets to avoid excessive water pressure on young seedlings.
- Keep internal and external areas of the nursery clean from weeds.

Reduce the seedlings soon after germination to avoid competition among the seedlings. Leave only the seedling more developed or vigorous in central position.

4.3 TRANSPLANT

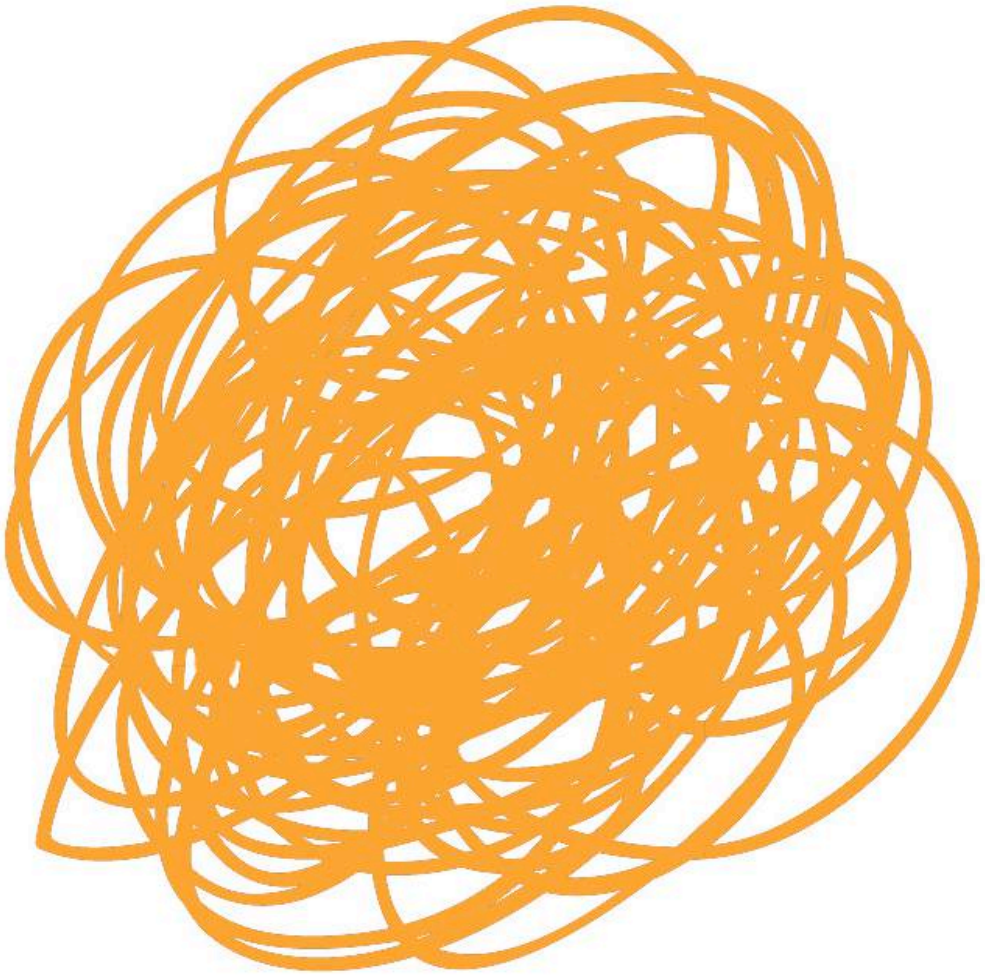
Seedlings are ready for transplant when they have around 4-5 leaves.

It is better to avoid the transplant of stunted, weak, or even too developed seedlings. Prepare the holes or grooves before transplanting to reduce the direct exposure of roots to the sun. It is also important to irrigate the seedlings few hours before transplanting to avoid damages when removing from the seedbed. It is important that the groove/hole respects the development of roots and aerial part of the plant and that the collar (transition zone between root system and aerial part of the plant) is slightly higher, so that after soil adaptation it will be positioned at ground level as occurs in nature.

More advices:

- the seedling must be positioned lower than the soil level;
- roots should be covered with soil;
- the collar should be positioned so that it is higher than the soil level;
- the soil should be pressed firmly in order to give stability and to make the roots stick to the ground.

The transplant should be preferably carried out in the evening or when the sky is cloudy. After transplanting, it is necessary to water the plants to reach an uniform soil moisture paying attention to avoid compaction.

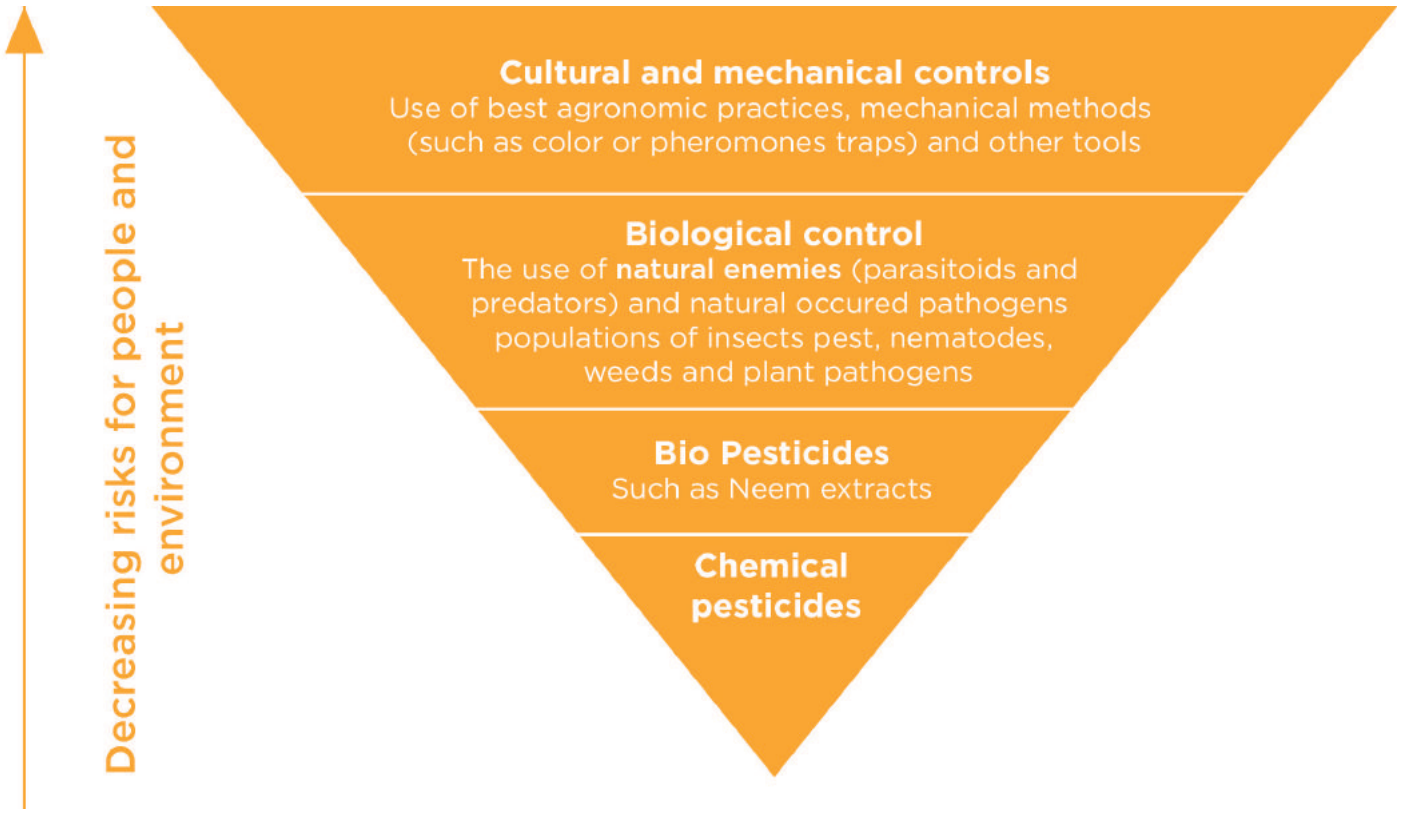


4.4 INTEGRATED PESTS AND DISEASES MANAGEMENT IN HORTICULTURE

Integrated pest management definition

Integrated Pest Management is an ecosystem approach that combines different management strategies and practices to grow healthy crops and minimize the use of pesticides.

CONTROL METHODS IN IPM PROGRAMS



Some definitions

Re-entry Statement: tell people how much time must pass before they can re-enter a treated area without appropriate protective clothing; If no re-entry statement appears on the label, then sprays must be dry or dusts must be settled before re-entering or allowing others to re-enter a treated area without protective clothing. This is the minimum legal re-entry interval.

Pre-harvest Interval (PHI)or withholding period (WHP): This is the amount of time that must elapse between making an insecticide application and harvesting the crop. PHIs vary greatly, depending on the insecticide being used and the particular vegetable crop being treated. For example, the PHI for Bordeaux mixture is 7 days on tomatoes, peppers and cucumber, and 14 days on lettuce.

Biological pesticide: Biological pesticide is a component of an integrated pest management strategy. It is derived from a variety of biological sources, including bacteria, viruses, fungi and rotozoa. They do not control pests in the same way as most broad-spectrum products. They are typically target-specific and have little to no impact on non- target organisms. The main advantages of biological control such as Bacillus thuringensis subsp. Kurstakior subsp. Aizawai; Boauveria bassiana.

ADVANTAGES OF ORGANIC CONTROL METHODS

- No impact on beneficiaries
- No withholding Period
- No residues
- No re-entry interval
- No restriction on the number of sprays
- Non-schedule, non – poisonous
- Organic

PPE (personal protective equipment) !!!

Personal Protective Equipment (PPE) is clothing and devices that protect the body from contact with chemicals such as pesticides.
For the application of organic pesticides, applicators and other handlers, you must at least wear:

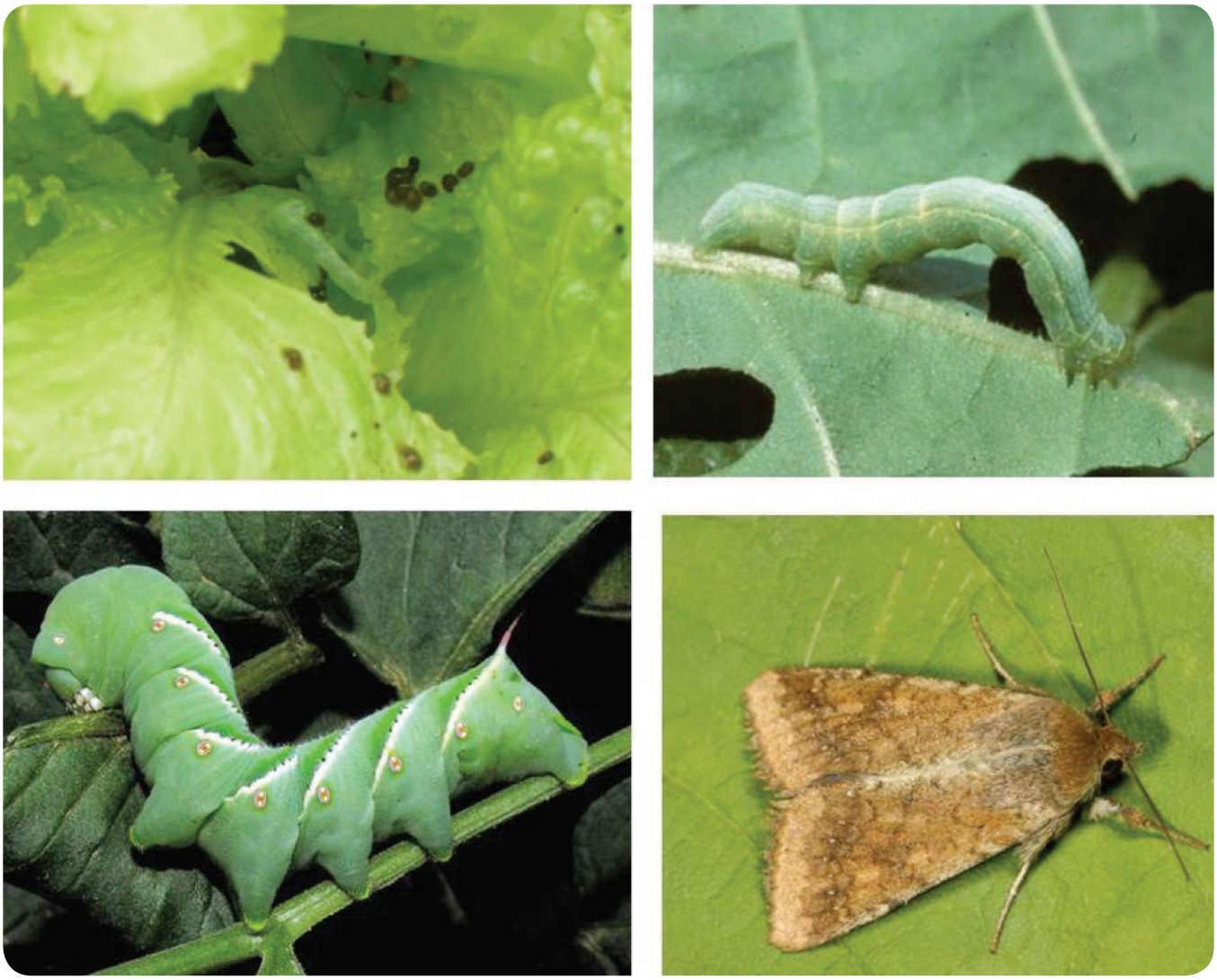
1. long-sleeved shirt and long pants;
2. waterproof gloves;
3. shoes plus socks.

Your health and safety and that of your workers can depend on it.

After spraying, the sprayers should be washed with soap or detergent in a special designated area to avoid contamination.

Practices for Integrated pest management (IPM) of Larvae

LARVAE OF LEPIDOPTERA



- *Scouting and larvae monitoring (observe larvaeexcrement and damage to the leave and catch larvaeearly in the morning, look on the undersides of one or two leaves per plant, for nymphs, pupaand adults.*

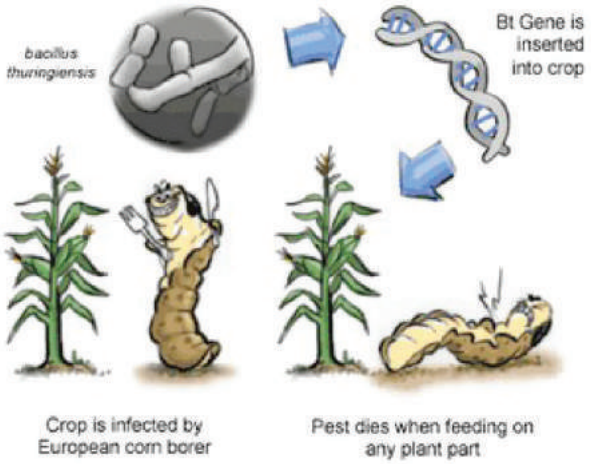
- *Use yellow sticky traps to monitor the Butterfly*

- *Begin treatments as soon as the first sign of infestation is noted and follow a good pesticide rotation program to slow the development of pesticide resistance.*

- *Using natural solution or "biorational" pesticides (e.g. soaps, oils neem products and Bacillus thuringiensis[Bt]* can play an important role in an IPM program for greenhouse vegetables.*

Bacillus thuringiensis subsp. Kurstaki

Toxicity Class: organic insecticide
Reentry Statement: nil(after sprays must be dry or dusts must be settled);
PHI: nil
Target pest: larvae
How it work?
Stomach poison that must be eaten by target insect to be effective.
Most effective against small, newly hatchedlarvae.
Insects stop feeding and die 1–5 days later.
Apply; 7 g / gallon



LARVAE OF LEPIDOPTERA

The insect (Neanide and Adult of Thrips)

Symptoms in Tomatoes and Basil leaves

Practices for Integrated pest management (IPM) for trips

Use blue sticky cards (approximately 20 x 40 cm) for the detection of onset of an infestation; collocate one cards each square meter;

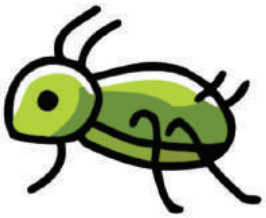
In Lettuce: With an average of 2 - 3 Thrips per traps (control every 2 days);
Shake the plants with a hand (early in the morning) in order to promote the flight of adults who will be attracted by the traps;
Two application a week with neem extract during dusk; wet the leaves completely during the treatment;

In Tomato, cucumber, etc.: 8 - 10 thrips (average) per trap;
If nearness there are lettuces the amount of thrips per trap that should be considered for the treatment is 3 -4;
Blue sticky cards should be placed just above the crop canopy;

- Begin treatments as soon as the first sign of infestation is noted and follow a good pesticide rotation program to slow the development of pesticide resistance.
- Using natural solution or “biorational” pesticides (e.g. soaps, oils neem products and Boauveria bassiana) can play an important role in an IPM programme for greenhouse vegetables.

APHID

What are aphids?



Aphids seem to find their way into every garden. They are small, soft-bodied insects that can survive in almost any zone. Aphids multiply quickly, so try to control them before reproduction starts. Many generations can occur in one season. The good news is that they tend to move rather slowly, and aphid control is relatively easy. For identification of aphid see the pictures in the image above.

How to control them?

- Stir together 1 quart of water, 1 tsp of liquid dish soap, and a pinch of cayenne pepper. Do not dilute before spraying on plants.
- Organic controls include soapy emulsion, horticultural oil (read the directions), and pyrethrum spray. Soapy water should be reapplied every 2-3 days for 2 weeks.
- Use homemade garlic, hot peppers and soup recipe.
- Preparation: chop and knead a head of garlic and two red hot peppers. Grate 25 grams of coconut soap and dissolve it in two litres of hot water, adding the garlic and the pepper. Let it rest until cool and then strain into a thin cloth and apply.

Garlic

Hot pepper

Soap

*Using "biorational" pesticides such as oils neem Oil**

*Neem *(Azadirachta indica)*

Neem oil is a vegetable oilpressed from the fruits and seeds of the neem (Azadirachta indica), an evergreentree and has been introduced to many other areas in the tropics. It is the most important of the commercially available products of neem for organic farming.

Biopesticides

Formulations made of neem oil, is used as a biopesticide for organic farming, as it repels a wide variety of pests including the mealy bug,beet armyworm,aphids, the cabbage worm, thrips, whiteflies, mites, fungus gnats, beetles, moth larvae, mushroom flies, leaf miners, caterpillars, locust, nematodesand the Japanese beetle.

Neem oil is not known to be harmful to mammals, birds, earthworms or some beneficial insects such as butterflies, honeybeesand ladybirdsif it is not concentrated directly into their area of habitat or on their food source.

Readymade Neem oil is available in the market. Commercial neem sprays smell better and are convenient, because ready to use.

To prepare the proper biopesticide solution it is very important to follow the indication reported in the label.

Spray plants thoroughly preferably early in the morning, in a dry and sunny day.

CERCOSPORA LEAF SPOT/ DOWNY MILDEW

Symptom of Cercospora leaf-spot of lettuce

PRACTICES FOR INTEGRATED PEST MANAGEMENT FOR FUNGAL DISEASES

- Plant adapted cultivars, less subject to environmental stresses;
- Reduction of humidity and leaf wetness duration to prevent spore germination, provide good air circulation and reduce humidity within the canopy (during the rainy season we could reduce the number of plants for square meters);
- Control weeds;
- Dispose of diseased plants and debris in plastic bags; keep bags closed to prevent the spread of spores to uni-infected plants during removal from the greenhouse.
- Avoid unnecessary handling of plant material;
- Pay attention during the nutrient solution preparation in order to avoid nitrogen excess;
- Disinfect the hydraulic system with bleach (concentra tion 10%) periodically ;
- Change all the substrate once a year;
- Begin treatments as soon as the first sign of infestation is noted;
- Include copper in the disease management program (e.g. Bordeaux mixture – see proper card);*

Bordeaux mixture

Bordeaux mixture (also called Bordo Mix) is a mixture of copper sulfateand slaked limeused as a fungicide.

- It is approved for organic use;
- Re-entry Statement: nil (after sprays must be dry or dusts must be settled);
- PHI: 7 days on tomatoes, peppers and cucumber, and 14 days on let tuce.
- Targeted disease: Many diseases incl. Cercospora Leaf spot, angular leaf spot, downy mildew, Alternaria blight, anthracnose, bacterial, blight, bacterial spot;

Materials needed to make a 10 liters mixture:

- 2 plastic bucket
- 10 liters of water
- Copper Sulfate - 60 g
- Quick lime - 40 g
- Wooden stick or ladle

How to prepare?

Dissolve 60 g of copper sulfate in 5 liters of water in a plastic bucket and stir well using a wooden sick or ladle;
Dissolve 40 gr of quick lime in 5 liters of water separately and stir well using a wooden sick or ladle;
Pour copper sulphate solution into lime water slowly with constant stirring using a wooden stick;
Protect self from direct contact with the solution.

How to use?

Spray plants thoroughly preferably early in the morning, in a dry and sunny day.
Constantly shake the sprayer while in the process of application to prevent the solution from clogging.
Crops grown in greenhouse may be more sensitive to copper injury so the user should determine plant sensitivity. Observe for 7–10 days for symptoms of injury.

Plant Nutrient Deficiencies symptoms

Not all plant problems are caused by insects or diseases. Sometimes an unhealthy plant is suffering from a nutrient deficiency or even too much of any one nutrient. Plant nutrient deficiencies often manifest as foliage discoloration or distortion. The following chart outlines some possible problems.

Macronutrients deficiency:

Nitrogen (N): N deficiency shows with green-yellow leave color (older leaves), and a slow and limited development. Extreme pH contributes to N deficiency;
Phosphorus (P): Purple color of the leaves, branches and trunk, rachitic aspect, low fruit count, and seeds productivity are all symptoms of P deficiency;
Potassium (K): Leaves show marginal necrosis (tip burn);
Calcium (Ca): The deficiency shows burn in the younger leaves confine and tip fruits show apical rot. The very low mobility of calcium is a major factor determining the expression of calcium deficiency symptoms in plants.
Magnesium: The Mg-deficient leaves show advanced interveinal chlorosis, with necrosis developing in the highly chlorotic tissue. In its advanced form;
Sulfur (S): Leaves show a general overall chlorosis while still retaining some green color. The veins and petioles show a very distinct reddish color. The visual symptoms of sulfur deficiency are very similar to the chlorosis found in nitrogen deficiency. However, in sulfur deficiency the yellowing is much more uniform over the entire plant including young leaves.

Macronutrients deficiency:

Iron (Fe): Leaves show strong chlorosis at the base of the leaves with some green netting. Interveinal chlorosis of the youngest leaves, evolves into an overall chlorosis, and ends as a totally bleached leaf. The bleached areas often develop necrotic spots. Iron deficiency symptoms appear first on the youngest leaves. Iron deficiency is strongly associated with anaerobic conditions;
Manganese (Mn): Leaves show a light interveinal chlorosis developed under a limited supply of Mn.

Plants nutrient deficiency simptoms

N deficiency symptoms in the oldest (lowest) leaves deficiency symptoms in gailan plant of lettuce.

P deficiency symptoms in gai-lam plant.

K deficiency symptoms in the oldest (lower) in lettuce.

Ca deficiency symptoms in the younger leaves of Lettuce

K deficiency symptoms in the oldest (lower) in lettuce.

Ca deficiency symptoms in the younger leaves of Lettuce

Signs of Nutrient Deficiency

Iron: Young leaves are yellow/white, with greenveins. Mature leaves are normal.

Calcium: New leaves misshapen or stunted. Existing leaves remain green.

Potassium: Yellowing at tips and edges, especially in young leaves. Dead or yellow patches or spots develop on leaves.

Nitrogen: Upper leaves light green. Lower leaves yellow. Bottom (older leaves) yellow and shrielled.

Magnese: Yellow spots and/or elongated holes between veins.

Carbon Dioxide: White deposit. Stunted growth. Plants die back.

Phosphate: Leaves darker than normal. Loss of leaves.

Magnesium: Lower leaves turn yellow from inwards. Veins remain green.

Monitoring Pest template

Date	Pest found	Crop	Number of insect for trap	Number of insect for plant

Monitoring Diseases template

Date	Disease found	Crop	Number of spot found/leaf

Monitoring Useful template

Date	Useful insect found

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