COMPOSTING
FROM A TO Z






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WHAT IS COMPOST?

The process of fermentation and decomposition of organic material took place in nature on an ongoing basis and easily without any human intervention. This is done since many of the worms and micro-organisms like bacteria and fungi decompose and transfer all organic material on the ground. Humans can benefit from this process in many ways to get rid of all the organic waste instead of burying or burning them.

The process of decomposition of organic materials (animal manure, human house waste and garden waste, etc.) is called "compost." So Composting is the process that carried out by human in order to decompose the organic materials in the presence of a oxygen and relatively in a fast way to convert contaminated waste into organic fertilizer (soil improver), free from plant diseases and weed seeds.

WHY COMPOSTING?

There are many benefits to composting. It is the most practical, simple and inexpensive way to dispose of and recycle food scraps and yard waste. The process of composting doesn't constitute only an alternative solution to get rid of waste, but can be also used to several purposes. The compost helps to improve the health and quality of soil that is added to and improves and maintains the environment.

FACTORS AFFECTING THE ORGANIC BREAKDOWN

Several factors have been identified as important for microorganisms in the compost pile to work at their best. It is helpful to keep these factors in mind as you build and maintain your compost pile. Each of these factors has the potential to significantly affect the composting process. Some of the important factors in the composting process are shown in the following Table with their acceptable ranges.

Table 1: Factors affecting the composting process and acceptable ranges

FACTOR	ACCEPTABLE RANGE
Carbon to Nitrogen ratio (C:N)	25:1 - 30:1
Moisture content	50 - 60%
Aeration, percent oxygen	> 5%
Temperature	54 - 60°C
Porosity	30 - 36
pH	6.5 - 7.5

However, it is up to the farmer to decide how much time he wants to put into pile maintenance as well as how fast he desires finished compost.

I - CARBON/NITROGEN (C/N) RATIO

Two types of material are needed for a compost pile: those high in carbon and those high in nitrogen. Microorganisms in the compost pile use carbon as an energy source and nitrogen for protein synthesis. A good C/N ratio to ensure efficient decomposition in 30 parts carbon to 1 part nitrogen by weight. When too little nitrogen is present, decomposition will occur more slowly; if too much nitrogen exists, it can be lost to atmosphere as ammonia gas (which can cause your pile to become smelly).
If you are a small-scale home composter, it is more difficult to achieve the ideal 30:1 carbon to nitrogen ratio with readily available materials. Therefore, use this rule of thumb: add 2 parts nitrogen-rich materials to 1 part carbon-rich material by volume.

Table 2: Carbon to Nitrogen Ratios in various materials

ORGANIC MATERIALS	C:N
Poultry manure (fresh)	10:1
Poultry manure (with litter)	13-18:1
Vegetable waste	13-20:1
Cow dairy manure	20:1
Horse manure	25:1
Horse manure (with litter)	30-60:1
Wood chips and sawdust	100-500:1
Paper	150-200:1
Straw	40-100:1
Foliage (green)	30-80:1

A. WHAT CAN BE COMPOSTED?

- Leaves, Twigs, Pine Needles, Wood Chips & Sawdust (Source of Carbon)
- Olive cake, Straw & Cornstalks (source of Carbon)
- Cardboard, Paper Towels, Napkins, & Tissues (source of Carbon)
- Tea bags and coffee grinds (source of Nitrogen)
- Any vegetables and fruits scraps, breads and grains, crushed egg shells (source of Nitrogen)
- Manure from Farm Animals (sources of Nitrogen)









B. WHAT CANNOT BE COMPOSTED?

- Meat, Fish, Poultry or Dairy Products
- Fats and oils
- Pesticide-Treated Grass Clippings
- Diseased Plants
- Animal droppings
- Plastic, Glass and metals

II - PILE MOISTURE

Moisture plays an essential role in the metabolism of microorganisms. The microorganisms work faster when thin liquid films are present on the surface area of the compost pile materials. Optimal decomposition occurs when moisture content is between 40 to 60%. If the pile's moisture content is below 40%, microorganisms will work more slowly or become dormant. If moisture content goes above 60%, nutrients are leached and the pile can become compacted. When compaction occurs, decomposition is slowed and anaerobic bacteria may become active in the pile, which can create unpleasant odor.

You can test your pile's moisture content by doing a squeeze test.

- The best moisture content could be felt when pile material is squeezed tightly in hand, and you feel the compost like a wet sponge with only one or two drops of liquid expelling.
- If the compost is too dry it will crumble in your hand, the pile should be also turned with addition slowly of water during the process.
- If it is too wet it will drip, the pile should be turned and/or add absorbent dry material

CASE STUDY

Problem: A surplus of water has been faced with one of the Bekaa Farmers. This problem has been occurred because of a heavy rain while the pile hasn't been covered.

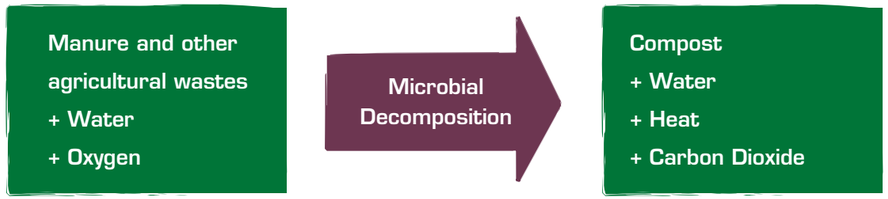
Results: Slow rate of aerobic decomposition, compact pile and some unpleasant odor

Solution: The pile has been turned with addition of some dry materials

III - AERATION

Like most living creatures, the decomposer organisms need oxygen to survive. Aeration, or air movement through the pile, is necessary for efficient decomposition.
The minimum desirable oxygen concentration in the composting material is 5%. Greater than 10% is ideal to avoid anaerobic conditions and high odor potential. Rapid aerobic decomposition can only occur in the presence of sufficient oxygen. Good aeration during composting will encourage complete decomposition of carbon (C) to carbon dioxide (CO2) rather than releasing carbon as methane (CH4). Too much aeration, however, can actually reduce the rate of decomposition by cooling the composting material.

Figure 1: The Basic Composting Process



Excessive air flow can remove a lot of moisture. Another consequence of excessive aeration is ammonia loss, especially with high nitrogen (low C:N ratio) mixes. As the material dries out, more ammonia volatilizes and consequently, more nitrogen is lost.
If the supply of oxygen is limited, the composting process slows and the temperature begins to fall. In this case the composting materials should be turned.

IV - TEMPERATURE

The temperature is a very good indicator of the process occurring within the composting material. The temperature increases due to the microbial activity and is noticeable within a few hours of forming a pile as easily degradable compounds are consumed. The temperature usually increases rapidly to 50 - 60°C where it is maintained for several weeks. Temperatures gradually drop to 38°C and finally drop to ambient air temperature when the composting process finish.

The highest rates of decomposition occur when temperatures are in the range of 43 - 66°C. There is a direct relation between temperature and rate of oxygen consumption. The higher the temperature is, the greater the oxygen uptake and the faster the rate of decomposition. During the active composting stage, the temperature may start to fall because of a lack of oxygen. Turning the material introduces new oxygen and the active composting stage continues. The temperatures can exceed 70°C but many microorganisms begin to die, which stops the active composting stage. By turning the pile may help to keep the temperature from reaching these damaging levels. If the moisture content falls too low it increases the chance of obtaining damaging high temperatures.

The temperature should be maintained at 55°C or higher for a minimum of 14 days to destroy the viability of many pathogens and weed seeds. Remember, the edges of the windrow are cool; therefore they must be turned into the center to kill the weed seeds.

The temperature can be measured with a 1 meter long dial temperature probe.

HOW 70°C HOT IS YOUR 55°C 60°C COMPOST?

CASE STUDY

Problem: Farmers reported that their pile's temperature is dropping

Results: The farmers thought that the decomposition phase is over.

Solution: After site visit by Afield engineer, it was clear that farmers were mistaken and all what the piles need is to be turned. Once this has been done, the temperature climbs again to continue its process.

V - PARTICLE SIZE

Particle size affects the composting process by influencing aeration and continuity of the interstitial air spaces. Microbial activity generally occurs on the surface of the organic particles. Therefore, the surface area should be maximized by shredding and chipping all clippings and waste into small pieces with a chipper/shredder (see annex 1). The more surface area you expose for microorganisms to attack, the faster the decomposition.

Too large a particle size will cause large air pockets and the pile might not heat up. On the other hand, when particles are too small and compact, air circulation through the pile is inhibited. This may risk of anaerobism due to inadequate aeration and clogging the small air spaces with water.

CASE STUDY

Problem: Shredder failure at one of the south farmers (Mrs. Amina Eid in Maarakeh)

Solution: Constructing a compost pile with no shredded materia

Results: Composting time was extended from 90 days as an average to 120 days.

VI - POROSITY

Porosity refers to the spaces between particles in the compost material. These spaces are partially filled with air that can supply oxygen to the organisms and provide a path for air circulation. Compacting materials reduce the porosity. Excessive shredding can also impede air circulation by creating smaller particles and pores. Turning fluffs up the material and increases its porosity. Adding coarse materials such as straw or woodchips can increase the overall porosity, although some coarse materials will be slow to decompose.

VII - PH OF MATERIALS

Composting may proceed effectively over a range of pHs without seriously limiting the process. The optimum pH for microorganisms involved in composting lies between 6.5 and 7.5. The pH of most animal manures is approximately 6.8 to 7.4.

VIII - NUTRIENTS AND TOXICS

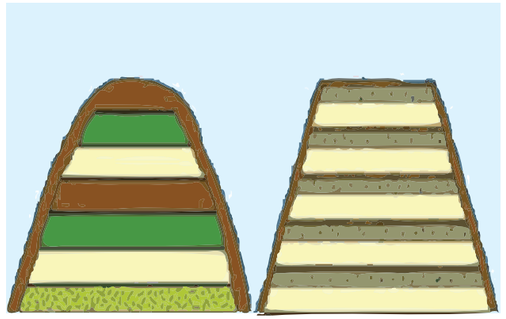
Adequate levels of phosphorus (P), potassium (K), carbon (C), nitrogen (N), etc. are normally present in farm organic materials such as manure, and other vegetative debris. Composting converts all nutrients into stable forms which have a low ability to be lost by volatilization and leaching when applied. In addition, under this form the nutrients are easily taken and used by plants.

Heavy metals such as manganese, copper, zinc, nickel, chromium and lead could be present and may be immobilized chemically prior to composting.

BUILDING A COMPOST PILE

A - SITE CHARACTERISTICS

- The best location for the pile is out of direct sunlight, which would dry it out, and out of direct exposure to high winds, which would dry and cool the pile.
- The site must be sloped between 2 to 4%.
- The pile must be done on a moderate to well drained soil surface which will help to avoid excessive moisture of the pile.
- The pile would be to place it near available water, and where there is enough room for temporary storage of organic wastes.

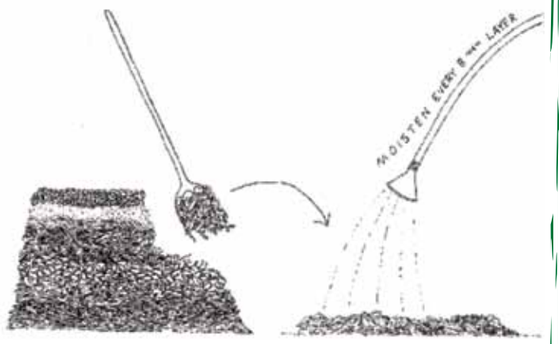


B - BUILD THE PILE

- Wet the ground of the pile
- Put twigs or other un-shredded carbon source on the bottom of the pile to provide some aeration at the base (not obligatory)
- Mix your shredded (5-15 mm) raw material, and add water while mixing
- Cover your pile with a semi-impermeable no thermal plastic cover, or with 5 to 10 cm of soil for a better isolation from external aggression.

C - SIZE OF THE PILE

The compost pile should reach a size of at least 1m3 to allow for the correct composting process and so as to allow sufficient aeration; it should not be more than 2.5 m wide and 1.5 m high. This is large enough to retain heat and moisture.



D - TURN THE PILE

Turning frequency depends on the rate of composting reaction.
Temperature, oxygen content and odor are good indicators for turning.

During the active composting stage, the temperature may start to fall because of a lack of oxygen. Turning the material introduces new oxygen and the active composting stage continues. The temperatures inside the compost pile can exceed 70°C, but at this point many of the beneficial composting microorganisms cannot survive and the reaction slows down or ceases. To prevent this from happening, cooling the material by turning the compost pile is necessary.

E - MONITOR THE PILE

The monitoring of the pile is very important in order to ensure the optimum pile decomposition. The monitored factors are: pile temperature, moisture and odor.

Table 3: Troubleshooting Composting Problems

PROBLEMS	POSSIBLE CAUSES	SOLUTION
Damp and warm only in the middle of the pile.	Pile could be too small, or cold weather might have slowed composting	If you are only composting in piles, make sure your pile is at least 1.2 high and 2 m wide.
Nothing is happening. Pile doesn't seem to be heating up at all.	1.Not enough nitrogen 2.Not enough oxygen 3.Not enough moisture 4.Cold weather? 5.Compost is finished.	1.Make sure you have enough nitrogen rich sources like manure, grass clippings or food scraps. 2.Mix up the pile so it can breathe. 3.Mix up the pile and water it with the hose so that there is some moisture in the pile. A completely dry pile doesn't compost. 4. Wait for spring, cover the pile
Matted leaves or grass clippings aren't decomposing.	Poor aeration or lack of moisture.	Avoid thick layers of just one material. Too much of something like leaves, paper or grass clippings don't break down well. Break up the layers and mix up the pile so that there is a good mix of materials. Shred any big material that isn't breaking down well.
Stinks like rancid butter, vinegar or rotten eggs.	Not enough oxygen or the pile is too wet, or compacted.	Mix up the pile so that it gets some aeration and can breathe. Add course dry materials like straw, hay or leaves to soak up excess moisture. If smell is too bad, add dry materials on top and wait until it dries out a bit before you mix the pile.
Odor like ammonia.	Not enough carbon.	Add brown materials (rich in Carbon) like leaves, straw, hay, etc.

E - WHEN THE COMPOST IS FINISHED?

Finished compost takes only 25 - 40% of the space occupied by the original pile.

When the individual materials can no longer be identified and the pile resembles dark rich soil, the compost is completed. It will smell sweet, woodsy, dark and earthy. It will crumble through your fingers.

Composting process can take from 12 weeks to 2 years depending on how often the pile is turned, what materials are used, the conditions, moisture, adequate air, presence of insulation around the pile, size of the pile, etc.

To know if the compost is mature, some seeds could be sown in the final compost material:

- If the compost is mature, the seeds will germinate 2-3 days after and the young seedling will show healthy growth in the days after

- If the compost is fresh or immature, only few seeds will germinate, the seedlings will grow slowly with short and stunted roots.

When the compost is finished, a screening could be done to have a homogeneous product ready for selling, if the quantity is big. In addition, at this stage, some analysis could be done from time to time to know the quality of the compost done in comparison to the international standards.

WHEN TO APPLY THE COMPOST?

It is advised to put the compost in the end of February in order to take profit from the rain, thus the release of nutrients will be easier and available in spring time when needed by plants.

Table 4: Recommended use for compost from organic waste

AREA OF USE	VEGETATION	PURPOSE	AMOUNT Kg FRESH SUBSTANCE/m²	FREQUENCY	METHOD
Horticulture	Vegetables with medium nutrient needs	Fertilizing, soil improvement, supply of humus	2 - 4	Annually	Incorporate it in the superficial soil
Fruit growing	Stone and soft fruit	Supply of humus, fertilizing	3 - 5	Annually	Incorporate it in the superficial soil
Viticulture	Fertilizing of existing vineyards	Supply of humus	3 - 5	Annually	Incorporate it in the superficial soil
Nursery	Nutrient poor soil	Soil improvement	8 - 10	Once	Component for mixing with soil

WHAT ARE THE BENEFITS OF THE COMPOST?

1- Improves the soil structure, porosity, and density, thus creating a better plant root environment.

2- Increases moisture infiltration and permeability of heavy soils, thus reducing erosion and runoff.

3- Improves water-holding capacity, thus reducing water loss and leaching in sandy soils.

4- Supplies beneficial micro-organisms to soils, a variety of macro and micronutrients in addition to significant quantities of organic matter.

5- May control or suppress certain soil-borne plant pathogens.

6- Improves cation exchange capacity (CEC) of soils and growing media, thus improving their ability to hold nutrients for plant use.

7- Improves and stabilizes soil pH.

8- On practical agricultural level, the compost is an easy process, It saves money on disposal costs, in addition that reduces the need of the farmer for chemical fertilizers.

9- On environmental level, the compost reduces the volume of garbage.

SUCCESS STORIES OF THE PROJECT

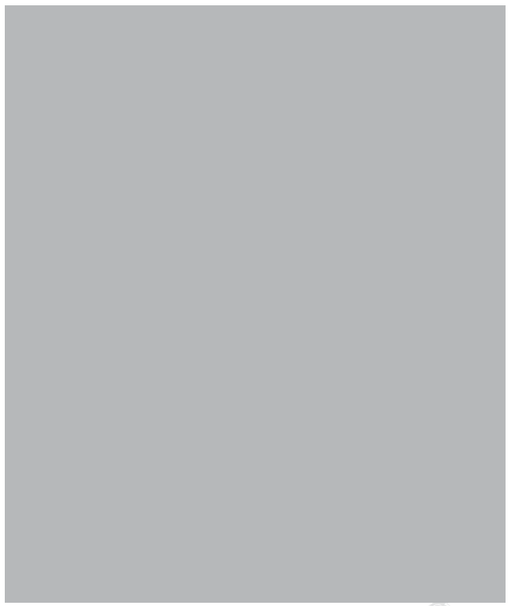
STORY No 1:

Mohammad Nehme known by Abu Kassem. He is 46 years old, from Zawtar, south region. He started growing thyme years ago but his farm has been certified organic since 2007.

He has 2 ha certified organic in compliance with the EU regulation EC 834/2007 by LibanCert, one of the Lebanese Organic Certification Body.

He is married and has 4 children. Abu kassem is a very motivated person. He was convinced to do an experiment on his compost; Mohammad wanted to test the successfully of his compost, so he made a trial, which consists on germinating the seeds of zaatar (origanum syriacum) on different sowing beds which were: compost, animal manure and only soil.

As a result, the compost gave a better germination in comparison to the other two types of bed.



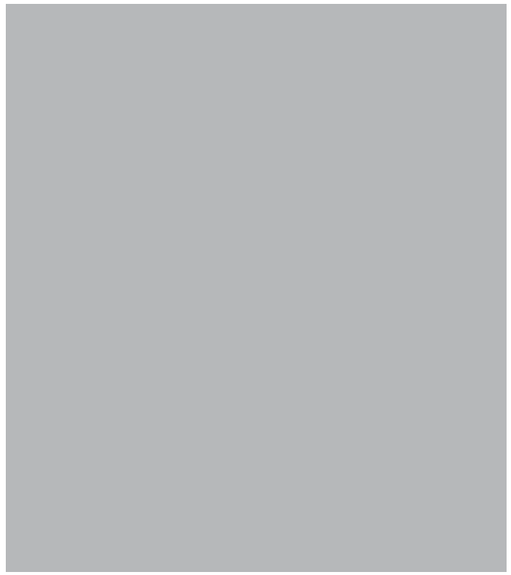
STORY No 2:

Ahmad Khodor Hossain known by Abu Rabii. Abu Rabii is 48 years old, from the north of Lebanon. He has two wives with 15 children. Abu Rabii is also a very motivated and active person. He has a farm of 3.3 ha which has been certified Organic since 2004.

Abou Rabii has a mix farm of plant production (fruits and vegetables) and animal production which make the composting process easier since most of the raw materials are from his own farm.

Before Cosv gave Abou Rabii the materials for doing compost especially the shredder machine, most of the woods were burned and the dust coming from was been used as organic fertilizer.

Now a day, Abou Rabii is not obliged to burn these materials; in contrary he is using them as a source of carbon in his compost pile. And the quantity of the end compost is now higher which help him not to buy any more an off-farm organic fertilizer.



ANNEX 1
THE BIO-SHREDDER

ANNEX 1

THE BIO-SHREDDER

The bio-shredder function is to finely shred organic residues such as leaves, grass, branches, organic waste, pruning waste and pieces of wood. The reduction of this waste to a minimum, helps to accelerate the composting process.
Besides composting, these shredded residues obtained using the bio-shredder can also be used for mulching.

The majority of bio-shredders use a carrier plate that chips wood. This cutting action, therefore, is developed by a series of blades (and counter-blades) that practically shred the material. Some of the latest bio-shredders use roll cutters instead.

The bio-shredders are often also called chippers (from the term chips=reduce to small pieces).

The chippers are used by forestry companies and companies that fell trees for centralized heating industries or for the production of isolating panels or for the use of chipped material in paper making.

MAIN FEATURES TO CHECK

The shredders can be fuel engine, electrical and tractor powered. The three types give different features to the shredding process and depends on the material and the use you need for. Families of for hobbyist use, small electric shredder cheap and strong, are available in the market. Farmers with branches (ex. olive oil pruning) need a stronger machine powered by a fuel engine or tractor which give more cutting power and can treat more material par hour.

One important feature at a motor level for farmers is the reliability through time.

The bio-shredder is used to shred leaves and grass, small branches (from 30 to 60 mm in diameter). Some shredders have two hoppers, one wide for the 30 to 60 mm size material, and another for the branches with a diameter until around 50 to 60 mm (it differs for each shredder, read the instruction manual) On every level, households or farmers it is an optimum instrument which helps composting process with contained costs.

Engine and power (HP) and brand

Electric small

Gasoline small

Tractor powered small

Double hopper shredder

TYPE OF CUTTING

There are many different type of system to shred the material; here there are the main types.

- **BLADES**

+ common and easy to find spear parts
+ difficult to clog
+ cuts also fresh material like leaves

- does not cut in a very small size maximum 30 mm
- the blades need to be change often

- **HAMMERS**

+ chops in very small size
+ very strong cuts also bug branches

- do not use with fresh material, you will end up with a cream (no good for composting)
- more expensive

- **J BLADES**

Similar to normal blades but with the J shape which pull the material into the shredder, you do not need to push it.

* Safety (grids, rubber protections, auto stop in case of material too hard, etc…)

BASIC SAFETY RULES

During the setting in motion, the use and the maintenance of the bio-shredder we recommend to follow these safety regulations:

- During the starting of the bio-shredder carefully check that all parts of the machine be correctly assembled like described in the instruction manual of the machine.

- The machine has to be set on a level and steady ground.

- During the shredding it's absolutely necessary to wear gloves and goggles and as the allowed sound level is exceeded during an uninterrupted use, you have to wear an ear-protection too.

- Before leaving the shredder unattended, it's necessary to switch off the motor following the relative instructions manual. If the bio-shredder is equipped by electric motor it's necessary to put the switch in O (OFF) position and to disconnect the plug from the network.

- During the change of the Blades and of the Hammers and during the cleaning-works you have to take care not to cut yourself. The cutting-tools are very dangerous!

- Use the bio-shredder only when its protection devices are correctly assembled.

- Shredding-machines can be connected to the electric-net only through a protected plug equipped with an automatic security switch.

- It's very important to underline that the couplings of the electric-lines could be used only for machines which are protected against water-sprays.

- During shredding always wear strong shoes and long trousers.

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