Green Technologies, Innovations and Practice in the Agricultural Sector

UNITED NATIONS
الاسكوا
ESCWA

Shared Prosperity Dignified Life

GREEN TECHNOLOGIES, INNOVATIONS AND PRACTICES IN THE AGRICULTURAL SECTOR

E/ESCWA/SDPD/2019/INF.8

The Arab region faces many challenges including severe water scarcity, rising population, increasing land degradation, aridity, unsustainable energy consumption, food insecurity and deficiency in waste management. These challenges are expected to worsen with the negative impact of climate change, the protracted crises plaguing the region and the rapidly changing consumption patterns.

Some of these challenges, however, can still be mitigated with the judicious use of appropriate technologies, practices and innovative ideas so as to transform depleted, wasted or overlooked resources into new opportunities for revenue generation, livelihood improvement and resource sustainability. Innovation and technology are the main drivers of economic growth and societal transformation through enhanced efficiency, connectivity and access to resources and services. Yet, current growth models have led to environmental degradation and depletion of natural resources.

Such environmental technologies and innovations may result in what is often referred to as “green technologies or practices” or “clean technologies”. These technologies and innovations may help bridge the gap between growth and sustainability as they reduce unfavorable effects on the environment, improve productivity, efficiency and operational performance. It is high time the region brought this frontier thinking to the fore by building on existing Arab initiatives. Green technologies can be adopted at individual, company, community or national levels and they are a key tool for a green economy that improves livelihoods without jeopardizing the wellbeing of future generations.

Green technologies that increase resource efficiency, harness renewable resources and conserve non-renewable resources play an important role in supporting and enhancing economic growth, reducing production costs and increasing resilience while addressing environmental challenges. Their applications include renewable energy solutions, water and energy saving devices, air pollution control and sustainable agricultural practices. These technologies aim at improving the efficiency of resource use and the contribution to a reduction in greenhouse gas emissions.

Green technologies are advancing globally, and they are gradually spreading in the region. Adopting these technologies should be case-specific where trade-offs and synergies are taken into account. It is also important to remember that technology evolves rapidly, thus what is considered as green technology today might no longer be considered so in the future.

The main aim of this factsheet is to introduce a number of green technologies, innovations and practices that could be adopted and applied easily throughout the Arab region. The factsheet also encourages stakeholders and the public to further explore this area and further innovate in it. Ten different technologies, innovations and practices are presented in the factsheet, and they address some common issues and challenges. The information provided is not exhaustive but hopefully could spur further innovation and the adoption of similar initiatives.

The 10 green solutions were prepared by a team from ESCWA’s Food and Environment Policy Section (FEPS) with substantial research from Samar Morkos, ESCWA intern, under guidance and supervision of Reem Nejdawi, Fidele Byiringiro and Lara Geadah.

Throughout the drafting and editing phases, the fact sheets also benefited from Rita Wehbe’s editing and inputs from Hadi Jaafar, American University of Beirut; Lara Gemayel, Compost Baladi; Nada Ghanem, Douda Vermiculture Solutions; Atle Idland and Dionysia Angeliki Lyra, International Center for Biosaline Agriculture; Rawad Nasr and Rani al Achkar, Lebanese Center for Energy Conservation; Mariam al Sheikh Issa, Urban Farming; and Ali Amirlatifi, Evergreen Farms.

LIQUID NANOCLAY

Source: Mr. Atle Idland.

Liquid NanoClay (LNC) is a new technology whereby desert and dry land sandy soils are turned into fertile ones. LNC coats sand particles mechanically with a clay layer, thereby turning desert sands into a sponge like basin that better retains moisture and nutrients. Its impact lasts for around 5 years, and it could help save up to 50%-60% of irrigation water. LNC does not contain chemicals, only water, air and clay. However, one major restriction to the use of this technology is the lack of water-precipitation due to climate change. Nevertheless, this promising patented solution saves water, increases biomass efficiency and helps in combatting climate change and threats to food security.

Description

LNC is prepared by mixing water with clay in a patented process. The mixing is done on site. LNC is spread on sandy soil using traditional irrigation equipment such as sprinklers. The soil is sprayed until the mixture saturates the soil down to root depth, a process which take up to 7 hours, after which seeding can be made as usual. This treatment gives sand particles a nanostructured clay coating, which improves the sand's physical qualities. However, fertilizers must be applied as normal. LNC increases the sandy soils water holding capacity significantly and decreases the topsoil salinity levels, while increasing the soil's available Potassium and organic matter content.

Cost

A study showed water savings ranging between 40% and 50% in a replication in a United Arab Emirates municipality park and a golf course which recorded better grass growth compared to traditional methods while using only half of the irrigation water. Returns on Investments are reported to be high.[1]

Benefits

- Improved water holding capacity in sandy soils;
- Saving water use with up to 50-60%;
- Increasing biomass efficiency;
- Turning deserts and dry lands into farmable lands; enhancing food security;
- Using a completely natural mineral and organic solution for treating existing agriculture lands and commercial greeneries;
- Halting the expansion of deserts and reducing sandstorms.

Case study

Liquid NanoClay was tested out on an 800 m2 area within the premises of an existing farm located in the desert of Al Ain, Abu Dhabi. The area was divided into two plots with one undergoing liquid NanoClay treatment and the other relying on traditional agriculture techniques. Results show that the average yield weight of cauliflower, okra, sweet pepper and carrot harvested from the area treated with LNC was higher by 109%, 18%, 64%, and 17%, respectively compared to the control group. Irrigation water saving was estimated at 40%. Result: Huge water savings, healthier and larger sized crops in an open field desert environment.[2]

1. https://www.thenational.ae/uae/environment/nordic-know-how-set-to-reap-rewards-for-uae-farmers-1.877647.
2. https://static1.squarespace.com/static/595955913a041144867e8268/t/5c7c0a53e2c4834c1a33aa68/1551633018267Desert+Control+Whitepaper+ORIGINAL.pdf.

SMART IRRIGATION

Source: Mr. Hadi Jaafar.

Smart irrigation is a technique used to decrease the water footprint through water efficiency using smart controllers. The sensor-based controllers use real-time measurements of several local factors to regulate irrigation timing. Controllers could be regulated using computerized systems, including the Internet of Things (IoT), to facilitate automation. The factors monitored include temperature, rainfall, humidity, solar radiation and soil moisture. Usually, sensor-based systems have historic weather information for sites programmed into them which is then used to adjust the amount of water delivered to the field.

Description

A sensor-based irrigation system usually consists of sensors to collect measurement from the soil, weather and crops; a software to analyze the data and issue recommendations; and an automated system linked to the water network to control irrigation scheduling.

There are 3 main sensor types: the largest are soil-based sensors, which detect plant stress by collecting soil moisture, salinity, conductivity, etc.; next are weather-based sensors that detect changes in the local environment by collecting evapotranspiration and weather data; and plant-mounted sensors that measure variations inside the plant but are still being developed.

A smart irrigation assesses whether water is flowing or not, and if the pipes are not clogged or leaking. It can be controlled through a smartphone application. The system determines the best time to irrigate, the duration of irrigation and the quantity of water needed.

Cost

Commercial controller systems for a 100,000 ft^2 cost between 7,000$ and 12,000$ per year. Drip irrigation systems cost approximately 15,000$ at the same scale.[1]

Water use efficiency and irrigation water use efficiency are higher in automated irrigation systems (AIS) than in conventional irrigation control systems (CIS). According to a study, the efficiency values were 1.64 and 1.37 $kg.m^3$ for wheat under AIS, while under CIS the values were 1.47 and 1.21 $kg.m^3$.[2]

1. https://www.facilitiesnet.com/green/article/Smart-Irrigation-Systems-Rainwater-Collection-Are-Cost-Effective---13436
2. http://www.scielo.org.za/pdf/wsa/v43n2/18.pdf.
3. https://services.google.com/fh/files/misc/accelerating_social_good_with_artificial_intelligence_google_ai_impact_challenge.pdf.

Benefits

- Limited water usage since water is used efficiently and in the needed amounts;
- Saving money on unnecessary water costs because the system eliminates water loss and reduces water consumption;
- Limited human resources due to automation using IoT;
- Scheduled irrigation using moisture sensor irrigation, with time shortened or prolonged according to need;
- Decreased fertilizer leaching as water runoff is minimized.

Case study

The American University of Beirut received a grant funding from Google.org in a customized Google Developers Launchpad Accelerator program. The project consists of applying machine learning to weather and agricultural data to improve irrigation for resource strapped farmers in Africa and the Middle East.[3]

SOLAR ENERGY

Source: Mr. Rawad Nasr.

Renewable resources are virtually inexhaustible. In agriculture, renewable energy can be used for various purposes including power production, drying processes and many other farm related functions.

Renewable energy helps to combat climate change through a reduction of greenhouse gas emissions, while providing people, and especially those living in remote areas, with alternative opportunities to access energy. In addition, the rapid growth of renewable solar technologies has decreased their cost, making them more affordable to poorer countries. Solar energy is free, but its collection, conversion and storage remain expensive.

Description

Solar energy is obtained by converting sunlight into a usable form of energy through 3 main techniques: solar photovoltaic or PV (consisting of semiconductors within a PV cell that capture sunlight to produce electricity); concentrated solar power (using the sun to heat a fluid and then use the steam to generate electricity); or solar heating and cooling (collect thermal energy from the sun to heat water or to heat or cool spaces).

Solar energy can be used to:

- Dry crops and warm households, livestock buildings and greenhouses;
- Provide hot water for on-farm processing and other operations as well as household use;
- Power farm equipment and water pumps;
- Provide lighting and used for electric fences.

Cost

Current Power Purchase Agreement (PPA) and auction price data suggested that by 2020, the price of electricity from solar PVs will fall to around 0.048$/kWh.[1]

Benefits

- Producing energy free of greenhouse gas emissions from fossil fuels and reducing certain types of air pollution;
- Can save money on the farm;
- Diversifying energy supply;
- Reducing the dependence on imported fuels;
- Generating economic development and jobs in manufacturing and installation among other things.

Case study

In 2018, 11 solar PV pumping systems were installed in the area under the Union of the Municipalities of Baalbeck, Bekaa, Lebanon. The system has a total capacity of 1.43MWp. It powers 11 submersible water pumps in different wells that supply potable water to the population living across the project area.

1. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/May/IRENA_Renewable-Power-Generations-Costs-in-2018.pdf.

VERTICAL FARMING

Source: Mr. Ali Amirlatifi.

Vertical farming is a system of food production in layers stacked vertically. It usually consists of indoor farming in a controlled environment to optimize plant growth, often in a soilless environment. These include hydroponics (on water), Aquaponics (in combination with aquaculture) and aeroponics (without any medium). Vertical farming is also found in greenhouses but most often in buildings, containers, underground tunnels or old mines. Vertical farming combined with other advanced technologies such as lighting can produce up to 10 times more than traditional farming. It is more suited to the farming of vegetables, i.e., tomatoes, peppers, cucumbers or lettuces.

Description

The following shall emphasize on hydroponics, which consist of growing plants in liquid substrate without soil. Mineral nutrients are usually dissolved in a water solvent for terrestrial plants, with only the roots being submerged.

Active hydroponic systems use a pump to actively move around the nutrient solution, whereas passive systems depend on the capillary function of the plant.

In the hydroponic solution culture, plant roots are not supported by a solid medium, whereas in the hydroponic medium culture an inert solid medium is provided.

There are many hydroponic systems which are distinguished by the technique used (static, continuous-flow, deep water, flood and drain, drip method, rotary, etc.); the substrate used (clay, growstones, rice husks, perlite, vermiculite, sand gravel, sheep wool, polystyrene packing peanuts, etc.); and nutrients (inorganic, organic, additives, mixed, etc.).

Cost

It is 3-5 times more costly to grow in a greenhouse or vertical farm compared to conventional farming. A greenhouse or vertical farm grown product can be priced at 2$ to 3$ a unit at retail, a conventionally grown lettuce can be priced below 1$.[1]

Benefits

- Decreased labor costs and space due to the stacked nature of such systems;
- Improved crop yields because of the efficiency of the system;
- Increased water-use efficiency: evaporated water can be recovered through condensation and recirculated into the irrigation system;
- Increased production per unit area;
- Production in areas where weather and soil are not favorable since it is mostly indoors;
- No need for pesticide and herbicide applications.

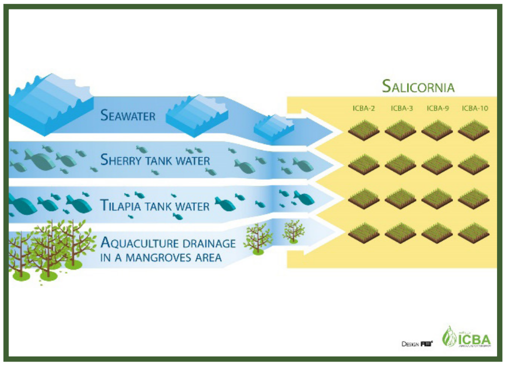
Case study

Grow360 system contains units 30 m long and consisting of 10 levels. The 10 levels contain 1,000 units. The annual yield in each level is 972,000 kg. The system can produce around 9,720,000 kg per year.[2]

Grow360 can be used to produce a wide variety of fruits and vegetables such as strawberries, lettuce, etc.

1. https://agfundernews.com/the-economics-of-local-vertical-and-greenhouse-farming-are-getting-competitive.html.
2. https://www.unescwa.org/sites/www.unescwa.org/files/events/files/s4-5.pdf.

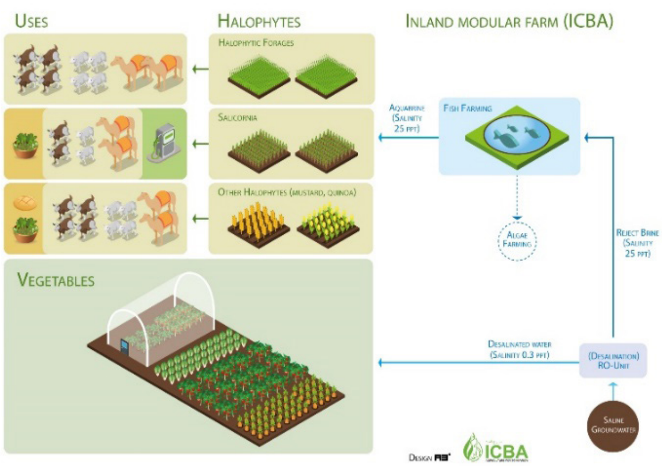
INTEGRATED AGRI-AQUACULTURE FARMS



Source: Ms. Dionysia Angeliki Lyra.

Integrated production systems are among the very few sustainable agriculture models suitable for marginal lands. They can generate multiple products and several sources of income in rural communities. The schemes involve combination of crops, domesticated animals and aquatic species. They utilize low quality land and water resources including, for example, saline groundwater, drainage water or salt-affected lands. The system produces positive interactions as: (i) animal manure is used to fertilize crops and ponds; (ii) crop by-products are used to feed animals and fish (iii) pond sediments are used as fertilizers and (iv) aquaculture water is used for irrigation.

Description



Benefits

- Improved farmer's income through multiple production;
- Improved on-farm productivity at a low cost;
- Use of desalinated and marginal quality water;
- Optimized farm production;
- Growing aquatic species;
- Improved nutrition for small-scale farmers.

Cost

The fish can have two growing cycles within a year, providing a great economic opportunity for local farmers and agripreneurs.

Reduction in the cost of fish feed by decreasing the fish feed requirement from 2 kg of feed/1 kg of fish to 1.1 kg of feed/1 kg of fish.[1]

Case study

The International Center for Biosaline Agriculture has achieved one of the highest fish biomass densities for Tilapia using reject brine from desalination; 30kg/m^3 compared to 10kg/m^3 using waste water.

1. https://www.biosaline.org/news/2018-06-07-6506.

WASTEWATER TREATMENT AND REUSE

Source: Ms. Samar Morkos.

Wastewater treatment and reuse, also known as reclaimed water, requires different kinds of treatment depending on its origin, destination and associated costs. Wastewater may contain nutrients that may benefit the agricultural sector. For the proper use of wastewater, certain considerations should take place such as future availability, re-use safety, storage facilities and much more. Wastewater reuse is one solution to the effects of climate change since it provides a new water resource that could be used in agriculture, urban watering, industrial processes, replenishing groundwater basins.

Description[1]

- Wastewater collection: transportation process done under hygienic conditions. People have to wear protective clothing. Pipes should be leak proof;
- Odor control: odor sources should be placed and treated to neutralize the smell;
- Screening: removal of large objects that may damage the equipment. Solid wastes removed from the wastewater are disposed of in landfills;
- Primary treatment: separates the macrobiotic solid matter from wastewater. The solid waste settling at the surface of the tank is removed and pushed for further treatment. The remaining water is pumped for secondary treatment;
- Secondary treatment: the active sludge process that involves adding seed sludge;
- Bio-solids handling: solid matter settling from primary and secondary treatment stages are diverted into digesters. The wastes are treated for a month under anaerobic digestion;
- Tertiary treatment: removes up to 99% of impurities;
- Disinfection: the process is done for at least 20-25 minutes with chlorine and sodium hypochlorite;
- Sludge treatment: sludge produced requires concentration and thickening. This process can take up to 24 hrs. The remaining water is collected and the sludge is treated and sent back to the environment.

Cost

The estimated total cost per m^3 of treated water is 0.35 $/$m^3$. This value can vary depending on the type of installation used, the size of the wastewater treatment plant and the age of the facilities.[2]

Benefits

- Saving water;
- Enhancing food production;
- Reducing environmental pollution;
- Disease prevention;
- Energy production

Case study

In a village in South Lebanon, Deirmimas, a waste water treatment plant was established in 2004 and rehabilitated in 2016 through funds from the UNIFIL's Spanish battalion. The wastewater emitted to the Litani River from the treatment plant is acceptable in terms of specifications.

1. https://www.conserve-energy-future.com/process-of-wastewater-treatment.php.
2. https://www.mdpi.com/2073-4441/11/3/423.

IMPROVED VARIETIES

Source: Ms. Dionysia Angeliki Lyra.

Scientists are developing high yielding varieties, more nutritious, drought and climate resilient seeds to withstand environmental challenges. There are different types of improved seeds: open pollinated, hybrid and genetically modified seeds.

Open pollinated seeds are naturally produced through random pollination.

Hybrid seeds result from the crossbreeding of two parent plants with desirable traits. However, they maintain their high yielding potential for the first year only and lose effectiveness in the second generation. Therefore, farmers need to buy new ones each year.

Genetically modified (GMOs) seeds are created when one to two genes with the needed traits from living plants are transferred directly into a plant's genome. However, GMOs seeds are usually not well accepted as they are thought to have heightened health risks.

Description

Genetically modified plants or seeds involve adding a specific segment of a DNA into the genome of a plant, which gives it new characteristics such as making it resistant to a particular disease.

The first stage requires a DNA transfer into the plant cell using one of two methods. First, coating the surface of small metal particle with the needed DNA fragment and inject it into the plant cells.

Second, using a bacterium or virus as most are capable of transferring their DNA into a host cell though the most often used ones are Agrobacterium tumefaciens.

Once the gene of interest has been transferred into the plant cells then, the transfer of the new DNA into the genome of the plant cells should take place.

The plant cells that successfully took up the DNA are grown to create a new plant.

Cost

In preliminary field trials conducted at ICBA's experimental station:

- The total revenue of Salicornia production is 36,894$/ha having a cost of 10,597$/ha;[1]
- The price of one kilogram is 4.73$.[2]

Benefits

- Clean seed;
- Varietal purity;
- Guaranteed quality assurance;
- New genetics;
- Productive use of discharges to generate value-added by-products increasing farmer's income.

Case study

Salicornia bigelovii, a multi-purpose species such as mustard and quinoa known to be salt-tolerant are being evaluated for their growth performance under high salinity levels.

Distichlis spicata, Sporobolus virginicus and NyPa showed to be salt-tolerant forages.

1. https://www.biosaline.org/sites/default/files/project_brief_integrated_aqua-agriculture_for_enhanced_v4-eng-web.pdf.
2. Robertson S.M., Lyra D.A., Mateo-Sagasta J., Ismail S., Akhtar M.J.U. (2019) Financial Analysis of Halophyte Cultivation in a Desert Environment Using Different Saline Water Resources for Irrigation. In: Hasanuzzaman M., Nahar K., Öztürk M. (eds) Ecophysiology, Abiotic Stress Responses and Utilization of Halophytes. Springer, Singapore.

ORGANIC WASTE REUSE

Source: Ms. Lara Gemayel.

Organic waste constitutes a valuable pool of organic matter and nutrients, making it suitable for reuse and recycling in agriculture. Organic waste includes food waste, green waste from landscaping and pruning trees, food-soiled paper or wood waste. Left alone, this waste decomposes in anaerobic conditions leading to the production of methane that is 20 times more potent as a greenhouse gas than carbon dioxide. The reuse or recycling of such waste reduces emitted gases and it is commonly used in rural communities to save on animal fodder, on energy sources in solid form (briquetting) or gaseous form (biogas) or on soil implements through composting for improved land productivity. Other techniques to reuse organic waste could include gasification, fiberboards, pyrolysis, etc. the mentioned techniques could be combined to allow a 100% recycling of agricultural waste.

Composting Process

1. Collect organic food waste and scraps.
2. Select a composting container (either construct your own or buy a composting container).
3. Layer the browning material inside the container (begin in late spring/summer when the weather is hot) – place brown waste (twigs, straws) on the bottom to encourage drainage.
4. Add alternating layers of moist and dry green and brown waste (thin layers).
5. Maintain a moist, covered, and well-turned compost pile.
6. Add green manure and green waste to add nitrogen (grass clippings, buckwheat, clover…) ten inches below the top of the pile.
7. Once the material at the bottom of the pile is rich dark brown, the compost is ready to use.

Cost

According to the study of the Institute of Local Government, a city provides the garbage collection service and bills the customers for all services. The itemized cost per household per month for recycling is 6.74$, green waste 9.88$/month and refuse 44.48$ for a 48 gallon bin collection on the customers' bill.[1]

The cost of the produced compost ranges from 95.98-766.56/ton, depending on operating modes and capacities.[2]

Benefits

- Organic waste reuse is an eco-friendly and sustainable way to manage waste;
- Compost helps retain moisture and suppresses plant diseases and pests;
- Compost improves the soil physical, chemical and biological characteristics that benefit plants and lead to increased productivity;
- Briquettes replace the usage of conventional types of fuels;
- Considered as best renewable source of fuel and energy;
- Best option for agricultural waste disposal;
- No sulfur or unsafe gas emissions.

Case study

Earth cube composter is a composting system designed for urban organic waste management needs. It is a completely enclosed system that eliminates the risk of pest attraction and infestation. The input capacity is up to 20 kg of total feedstock/day. The machines accept vegetable scrap, cooked food, meat, dairy and paper products.[3]

1. https://www.ca-ilg.org/sites/main/files/file-attachments/case_story_snapshot_compilation_final_0.pdf.
2. https://www.ecomena.org/solid-waste-middle-east/.
3. https://www.compostbaladi.com/project.

URBAN FARMING/GARDENING

Source: Ms. Mariam al Sheikh Issa.

Urban farming is the growing of plants and the raising of animals within and around cities. It is integrated into the urban ecosystem and is part of an urban food system influenced by urban policies and plans.

Production units can be established inside the city or in the surrounding semi-urban areas. Urban farming may involve crop production (grains, root crops and especially fruits and vegetables) and animal husbandry (poultry, sheep, pigs, fish, and beekeeping) and non-food products (aromatic herbs, ornamental plants, etc.).

Urban farming has positive impacts due to the greening of the city as it turns into green zones that could positively affect the microclimate or embellishing rooftops.

Description

Urban farming is facilitated by the city which sets aside space such as vacant plots or greening areas. The system is usually set up as a community-based project with many farming participants and where each person is provided with or rents a plot within the larger field. Plot owners often share tools and resources including compost, mulch, stakes, seeds as well as capacity building. However, gardens could also be established on individual yards or rooftops. Urban farming is often associated with farmers' markets that allow producers to sell their products directly to consumers thereby removing the costs and risks associated with a regular food supply chain.

Cost

The urban sustainable rooftop garden implemented in Burj al-Barajneh camp direct cost is around 21,000$, granted from the Norwegian Embassy.[1] however the human resources' costs were not factored in.

Benefits

- Improves food security through production for direct consumption or income;
- Creates a sense of belonging by allowing urban residents to participate in agricultural activities;
- Produces healthy food since urban gardening can be achieved by any person and he/she controls the inputs of the agricultural production process;
- Provides learning opportunities by granting those interested that do not have the experience to practice such activities;
- Makes efficient use of land by occupying empty plots while improving the urban environment.

Case study

A group of female Palestinian refugees are running a catering business, Soufra, in the Burj al-Barajneh camp, Lebanon, where they are cultivating an organic rooftop garden to produce fresh products needed by the company, which encourages sustainable urban agriculture. The company is sponsored by the Women's Program Association (WPA). The garden holds up to 2,600 plants and 15 different types of vegetables where 75% of the produce fulfill Soufra's requirement. Vegetables are grown in recycled plastic boards and irrigated through the AC water collected from the building's ten air conditioners. In addition, WPA installed a composting unit to dispose food waste for future use as natural fertilizers in the eco-boards.[2]

1. https://medium.com/land-and-ladle/7-steps-to-an-easy-urban-garden-4b1d25b5c2b1.
2. https://www.dailystar.com.lb/News/Lebanon-News/2018/Oct-26/467539-eco-rooftop-garden-sprouts-in-palestinian-refugee-camp.ashx.

VERMICOMPOSTING

Source: Ms. Nada Ghanem.

Another name for vermicomposting is worm composting. It transforms kitchen scraps and green wastes into rich dark soil with an earthy aroma. The technique is made of mainly pure worm castings and known to be very beneficial. It is rich in nutrients and is loaded with microorganisms that compose and maintain healthy soil.

It is used as top or side dressing for demanding plants. When the vermi-compost is mixed with regular compost, it adds a boost to the garden's soil.

Worms feed on carbon emitting microbes in the soil, thus decreasing the amount of emissions to the atmosphere.

Process

1. Place tray under the bin.
2. Add water to the compacted substrate until it breaks and becomes similar to soil in texture.
3. Add the worms to the bin.
4. Spray water if needed.
5. Add food waste to one of the sides, do not over feed – waste level should not exceed 5 cm.
6. Cover the bin with the towel.
7. The upper lid should be opened when the temperature exceeds 30 degrees Celsius to allow proper ventilation.
8. Close the bin.
9. Do not feed the worms: oil, meat, chicken, fish, onion, garlic, vinegar, citrus, cooked meals.

Cost

Vermicomposting is not expensive. The cost consists of the cost of the worms and bin.

A bin is ready for harvesting in 8-12 weeks of time.

Benefits

- Worm compost contains higher percentage of both macro and micronutrients than the garden compost;
- Enhances plant growth;
- Increases porosity and microbial activity in soil;
- Suppresses disease in plants;
- Reduces the need for chemical fertilizers;
- Improves water retention and aeration;
- Decreases the amount of waste going to landfills.

Case study

Douda Vermiculture Solutions in Lebanon is a central resource for vermicomposting. It offers a sustainable solution for an odorless, fast and simple way to treat organic waste at the source. Douda aims at achieving environmental and agricultural sustainability through the promotion of vermicomposting as a regenerative agriculture practice to restore soil quality and increase food security in the region.[1]

1. https://www.doudavermiculture.com/

19-01333