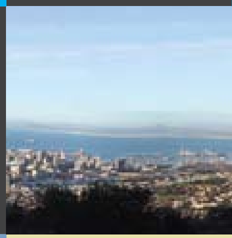
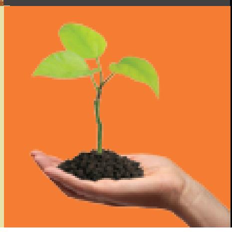
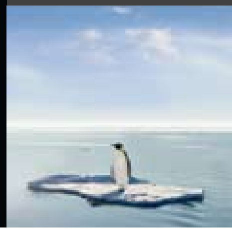



IZWA

Institute for Zero Waste in Africa

Designing pollution out, designing jobs in.

Zero Waste

Multiculture

September 2009

A Sustainable Response to:

- Food Production;
- Rising Food, Oil and Agricultural Input Prices; and
- Climate Change.

by the **Institute for Zero Waste in Africa**
(IZWA)

C O N T E X T

Food prices are rocketing, farming input costs soaring and increasing numbers of people are hungry. The effects of climate change are inducing fear of the impending chaos. Is it time to continue business as usual, or is it time for change?

Sixty nations, backed by the World Bank and most UN bodies, have called for radical changes in world farming to avert increasing regional food shortages, escalating prices and growing environmental problems. They endorse a 2500 page report by the International Assessment of Agricultural Science and Technology for Development (IAASTD) released in 2008.

Some extracts from the report:
"Genetic Modification (GM) technology was not a quick fix to feed the world's poor.[1]*"*
"Growing biofuel crops for automobiles threatened to increase worldwide malnutrition.[2]*"*

In response to the report, UNESCO advisor Guilheim Calvo said, "we must develop agriculture that is less dependent on fossil fuels, favours the use of locally available resources and explores the use of natural processes such as crop rotation and use of organic fertilisers"

[1]South African agricultural input costs have also risen sharply. According to Grain SA, the changes in prices from 2007 to 2008 were as follows:

- Fertiliser - 126.6%
- Fuel - 93%
- Soil preparation - 23%
- Herbicides - 45%

As these costs have risen, so too have food prices, locally and internationally.

[2]The increasing use of biofuel has been responsible for 75% of the price rise. Researchers estimate that current livestock production for meat consumption is responsible for between 18% and 40% of all greenhouse gases, the single highest source. Meat production is estimated to utilise up to 80% of all organic matter on the planet, which emphasizes how reducing meat in our diet is a key component in the fight against climate change, poverty and world hunger.

You will see below how IZWA's Zero Waste Multiculture system addresses all these concerns, and more. We are confident that the information contained in this booklet will be useful in promoting genuinely local sustainable development.

We acknowledge the support of the IWRM project within DWAF in the development of the content, and the support from CIDA for the publication of this document.

Muna Lakhani - National Co-ordinator, South Africa

1 (Source: M&G 11-17 July 2008)   2 (Source: Reuters UK: July 7, 2008 World Bank Report)

Canadian International Development Agency
Agence canadienne de développement international

MULTICULTURAL PROJECT DEVELOPMENT

The Institute for Zero Waste in Africa (IZWA), in consultation with other specialists, has designed a comprehensive and sustainable systems-based food production agricultural design model as an alternative to the dominant agro-industrial food production model.

WHAT IS ZERO WASTE MULTICULTURE?

Simply defined, Multiculture involves making sure that the benefits of all resources are maximised through improved products or processes that will enable as much of the resource flow to be used - and re-used - as locally as possible.

Multiculture includes using local and/or abandoned resources, designing low- to zero-input food production and sales and cultivation systems that create the least harm. This all gives substance and life to localised sustainable development.

Some Design Principles We Apply

- Zero Waste (as close to zero input costs, for example),
- Permaculture
- Organic farming
- Life cycle benefits
- Use of Traditional and appropriate modern agro-ecological information and systems
- Tapping into natural patterns and rhythms
- Human scale development
- Least carbon and pollution footprint
- Co-operative inputs and design
- Highest benefit to local area
- Sustainable technologies

An Example of a Zero Waste Multiculture Hub

In practice a Zero Waste Multiculture hub could be a situation where organic vegetables are grown, with certain vegetables grown for both food and secondary use, for example, feed for chickens or pigs. Some of the waste from the chickens (which act as mobile pest control units) can be fed directly into ponds, where it will provide nutrient for fish food for several species of fish, which will render the fish less vulnerable to diseases.

Excess pond water can be used directly in the garden, keeping as many of the nutrients within the system as possible and which will assist in growing a range of food and other crops.

Pig and human waste, should be fed into a bio-digester, which in turn produces methane gas, ideal for cooking or heating (of both homes and greenhouses, for example). The remaining wastewater provides an ideal nutrient rich base for food or algae production, which can be used to produce sustainable bio-diesel, aquaponics, food forests or in other integrated agro-ecological systems.

Through using local resources such as straw, water hyacinth and compostable materials, it is possible to produce high value gourmet and medicinal mushrooms as both a food and cash crop.

IZWA notes that a major constraint to maximising the highest levels of local benefit, a key design principle, is the lack of access to markets. Surplus production is ideally absorbed locally, reducing transport and energy inputs while benefiting the local economy.

Any single facet of Multiculture can be used as a "stand alone" component, or adopted in conjunction with other aspects of Multiculture. The scale and degree of adoption of each component can be altered to suit local conditions.

Initial Resource Assessment

The success of projects revolves around identifying available inputs and outputs close to the project. A brief assessment can help identify potential resources. Some key resources, which are often underutilised or abandoned, can include, almost any surplus or waste organic materials and almost any locally available water. These can all be used to grow a wide range of foods, both for personal consumption and for sale. Value can also be added to foods through further preparation.

Some often overlooked materials and resources of value include:

- kitchen waste
- garden waste
- suitably treated sewage resources
- domestic grey water re-routing
- harvesting rain water
- ash from fires

Organic waste material from people and animals can be used in a bio-digester, which breaks down the materials through bacterial action, providing methane bio gas, which is suitable for cooking, heating and drying. It is best to use the gas as a gas, and not lose efficiency by conversion to another energy carrier.

The outflow from the digester can be used as a fertiliser and nutrient enhancement for food production. In ponds it can also produce algae, which can in turn feed fish and animals, produce biofuels, while simultaneously purifying the water.

The use of aquaponics, crops grown on the water surface, also removes nutrients while providing food and fodder crops. Once water is suitably stabilised through these nutrient removal methods, fish can be grown, using established aquaculture methods. It is important to have a hierarchy of fish, with bottom feeders, like barbel / catfish preventing siltation, while aerating and stirring up the water column, being used along with fast growing mid-water fish like bream and tilapia, and carp at the surface to aerate the water, reducing the need for more energy inputs for aeration.

Aquatic poultry such as ducks are traditionally used in these systems, grazing nutrient absorbing plants, while their nutrients in turn provide fish food. Chickens are also integrated into these systems, being housed over ponds, their droppings providing fish food as they control pests by eating insects and parasites.

Any excess water from this closed loop system can be directed vegetables production, and then to constructed wetlands, which again remove excess nutrients before being reused. Plant material from the wetlands can be harvested and converted into products, or composted, returning the nutrients to the soil in a useful way.

Alongside the food gardens, biodigesters, ponds and wetland systems fruit, olive and other food trees can be grown, providing shade for poultry and ponds, creating an integrated biological system. Again poultry is ideally suited to this system, as chicken arks, which are enclosed, movable coops and runs, are excellent for clearing and fertilising ground before planting and moving on.

This document will address these and other aspects as well.

Crop Selection

Organic, open pollinated seed, together with organic fertilisers are acknowledged as providing the most superior and sought after products. It is preferable to select and produce crops specifically for local market demands, reducing food transport costs and emissions, while also creating other social and environmental benefits.

The potential for food producers to provide additional value and skills, for both enhanced incomes and the development of their communities, must be considered. Networking skills and encouraging innovative and sustainable equipment suited to local uses is also beneficial

Non-obvious Benefits of Zero Waste

By removing waste from the production stream, other, non-obvious benefits can accrue to this system. For instance, by putting a value on human sanitation nutrients, waste is transformed from a problem to a resource. Grey water, instead of creating mosquito and disease breeding ponds, is used to grow food, cleaning watersheds by nutrient removal.

By turning waste to food value is added. Food security is enhanced. Communities can become aware of the direct tangible effects of adopting conservation agriculture. Waste can be transformed, literally, from a problem to healthy foods, and value added products.

Other carefully selected plants, for example bamboo, could also be adapted as part of this production process, resulting in many potential benefits, including material for construction and additional cash income.

Renewable Energy Sources

There are additional opportunities to be gained regarding solar and other renewable energy sources. Simple solar energy by for example adding value to tomatoes by drying them, which also improves their storage life. Solar cookers can readily be made from recycled or reused materials, saving energy and processing food for free, as far as energy is concerned.

In cold seasons, ponds can be warmed using simple solar water heating systems, to keep fish growing optimally. Solar water heating systems for houses can also be made at reasonable cost.

The use of wind and solar photovoltaic (electrical) energy can be added to that of biogas, providing further value for the community.

Some Key Aspects of a Possible Zero Waste Multiculture System

- Re-using grey water from homes
- Removing alien invasive vegetation
- Growing organic high value food – vegetables herbs fruit mushrooms chicken and fish
- Growing high quality food products for sale and local food security
- Using natural and organic pest controls
- Production of superior quality animal feed
- Safe ecologically positive sanitation
- Water saving technology
- Natural flood control through swales, water harvesting and constructed wetlands
- Biogas production reducing energy impacts and costs
- Increased availability of nutrients for aqua- and agriculture
- Minimise disease vectors by fish, chickens and ducks eating the mosquito larvae
- Appropriate use of livestock, primarily poultry
- Aquaculture provides various fish for local consumption and sale
- Growing food on ponds providing food while cleaning water through aquaponics and algae production for animal feed and biodiesel
- Encouraging soil bacteria, thus making minerals and nutrients bio-available
- Macrophytes used to remove nutrients, clean water and provide compost material
- Snails can be beneficial as a food source for birds and humans
- Plant tonics, medicines and traditional medicine can be produced
- High value compost can be produced through harvesting excess nutrients
- Protein production through fish, poultry, legumes and others
- Vermicomposting – compost production through worms eating food scraps and green material
- Financial benefits through integrated production and ecosystem management as each resource is used many times, through economies of scale

The Minimum Specifications of a Zero Waste Multiculture System Could Include:

- The system is proposed to follow organic methods, as well as maximise multiple use from, and design principles such as Permaculture
- These methods and principles aim to halt soil erosion and maximise efficiency while remaining environmentally positive
- It must be water sensitive, to reduce water use and maximise re-use from biodigesters, ponds, harvested water, etc.
- The system must be energy sensitive – energy conservation, low energy inputs through on site generation through biodigesters, solar, etc.
- Waste must be integrated into the production system, creating closed loop, cradle to cradle production methods
- Input materials and costs to be minimised to as near zero as possible after initial setup
- Biodigestion
- Aquaculture / polyculture – diverse aquatic systems, with a minimum of three types of fish
- Aquaponics, using waste water as a nutrient source
- Planting a wide range of trees, that will provide a variety of crops and products
- Growing vegetables using companion planting and other organic principles
- A broad range of herbs for medicinal, culinary and crop protection
- Plants selected for the climate, geography and aspect of area
- Plants chosen for ease of growth and ability to add value and local acceptance
- Poultry should comprise of several species – geese, ducks, chicken, guinea fowl, etc housed at a minimum in mobile arks
- Add maximum value on site through solar dryers with biogas backup, air drying and food processing
- Provide processing and packaging areas, with potable water and shelter
- Meet security needs for the site to secure foods from rodent, insect and human damage
- Materials composted on-site
- Vermicomposting (using worms) for harvesting "black gold", vermicompost and protein
- Seek adjacent and local markets, tapping in to wealthy areas, through real WORLD research - not academic study
- Identify and map local resources
- Select and share and a host of recipes for value-adding
- Identify and exclude toxic packaging such as polystyrene, plastics and tetrapak
- Prioritise low energy, human and animal powered delivery services
- Relevant management and accounting requirements must be established and implemented

Training Across All Spheres

Agriculture - There has been a severe loss of agricultural skills in all communities, brought about by a lack of vision BY LEADERS and a lack of understanding of what is possible in this arena. This has occurred through historical circumstances a limited knowledge base of modern agro-ecological interventions, driven in turn by vested interests in conventional agriculture. The capacity constraints around appropriate training resources to can be best addressed through the networking of existing information through NGO's, CBO's and co-operatives. A list will be created for use, as the IZWA identifies them.

Why Organic Farming?

It has been proven that organic food provides superior quality food. Organic food generally has higher levels of important nutrients critical to the health and well-being of all. Children, the elderly, the ill or infirm all stand to greatly benefit from consuming foods grown in this manner. Healthy plants and people require well over 20 essential nutrients.

Reliance on artificial fertilizers that supply only a few of these while reducing the availability of others can never provide a successful and sustainable food production system. The fossil fuel sources of fertilisers, pesticides, herbicides and other chemicals emphasizes their unsustainability. The Zero Waste model considers all pollutants in the food chain, including pesticides, herbicides, artificial fossil fertilisers, food additives, preservatives, fossil fuel energy and other processes. Livestock production alone generates more than 50% greenhouse gases than global transport (livestock production: minimum 18% - global transport – 12%)

A flexible and resilient farming system has local markets as a key component. This maximises the value to the grower while reducing costs, footprint and food miles.

Organic farming delivers 32% more jobs[3]. Over 20 years of agricultural development has shown organic farming to provide was the most successful model for emerging farmers. Organic farming requires crop biodiversity to help prevent diseases[4]. Building biodiverse and resilient cropping systems enhances biological and economic security, as not all the eggs *(pardon the pun)* are in one basket. Organic farms are found to contain 85% more plant species, 33% more bats, 17% more spiders and 5% more birds[5].

Organic farming has been shown to create ten times the earnings per hectare of industrially farmed monocultures[6]. Agro-ecological interventions like Multiculture have increased production levels to four times that of monocultures[7].

Clearly a Zero Waste Multiculture design must be underpinned by sound and genuinely sustainable organic food production methods. An over-riding principle must be that the system delivers the highest local benefits possible.

3 World Bank
4 'Can Organic Farming "Feed the World"?' Christos Vasilikiotis, Ph.D. University of California, Berkeley
5 DEFRA-commissioned study by the University of Exeter, 2006
6 Oxford University, the British Trust for Ornithology, and the Centre for Ecology and Hydrology
7 ISIS Dream Farms, 2005

PRODUCTS AND PROCESSES

• Biodigestion

Using a currently abandoned resource, namely sewerage, biodigestion enables a high pathogen kill rate while providing waste, methane gas for local use. Methane can be used for cooking and food processing.

The nutrient rich water released enhances soil fertility and plant growth at zero cost over its lifetime.

• Algae Ponds and Raceways

These can be used to further cleanse the water that has passed through the biodigester (with a 99% pathogen kill rate). Wastewater can provide nutrients for algae for biodiesel production through extracting oil from algae. Even chlorella algae (spirulina) can provide 14 – 22% oil, with other strains composed of almost 50% oil.

The "waste" from this system is suitable for both fish and animal feed. Glycerine from the biodiesel production process can be used in health and beauty products. Where biofuel is impractical, algae can still provide a useful animal feed supplement, as it is high in oils, protein and carbohydrates. A 500m2 microalgae pond can produce up to 120 tons of wet algae, per annum.

Harvesting algae

Simple equipment required to make biodiesel from vegetable oils

Raceway for algae production

• Aquaponics

Growing food and other plants on floating beds is called Aquaponics. Nutrient rich water contains high levels of nutrients even after the biodigester and algae production systems have played their role. This provides a highly viable medium for growing of water based plants.

Growing food on floating platforms

Water can be scrubbed clean to almost drinking water quality by plants in intensive aquaponic systems, with plant growth providing excellent compost materials for soil enrichment and rehabilitation.

Aquaponics can deliver a system that is similar to hydroponics, with the nutrient rich medium feeding plants. This strips additional nutrients and conditions the water for further use such as fish production.

• Polyculture

Polyculture is a more completely integrated version of aquaculture. Aquaculture generally concentrates on raising single species of fish and molluscs, increasing vulnerability to disease.

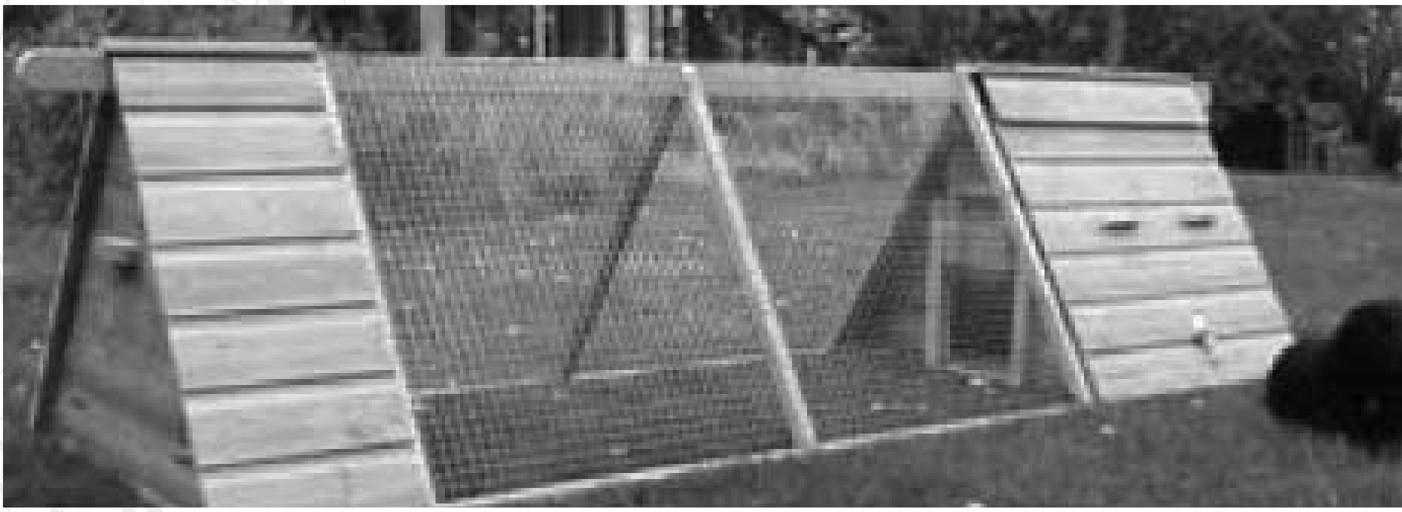
Many benefits are realised by raising different varieties of fish, including a higher uptake of food an nutrients. This lowers feeding costs and waste. It also provides a wider variety of marketable products.

• Poultry

To reduce feed costs (which comprise a key input cost) high protein worms from vermicomposting processes, and waste vegetables, can be fed to poultry. Combined with other crops such as duckweed grown on aquaponic systems, reduced production costs can be achieved, improving competitiveness. Algae cake can also be fed.

Poultry waste is utilised for fish feed and to enhance soil quality through composting, compost teas, and effective microorganism (EM) mixes.

Housing Poultry in arks or tractors (below) provides mobile pest control, clearing of grass and weeds, improved security for poultry as well as making egg collection easier.



• Mushroom Production

Mushrooms are acknowledged as a valuable crop medicinally, nutritionally and financially.

Mushroom preparation

Production is surrounded by myths and misinformation but they are not that difficult to grow. While some varieties of mushrooms like shiitake, miitake and reishi may require laboratory preparation, other valuable crops such as oyster mushrooms can be grown more easily.

Conventional growing mediums, the substrate, needs to be steam sterilised and then colonised with mushroom spawn but mushrooms can also grow on logs and under bushes on straw.

Oyster mushrooms can be safely and relatively easily grown in simple systems, where substrate is produced through boiling in a drum. Others require a supply of (usually) bags for fruiting.

Oyster, miitake, shiitake and reishi are worthwhile considering for production, with reishi holding significant potential community health benefit, with recognised cancer curing benefits. Other mushrooms also have culinary as well as medicinal properties. A value-added income stream is making and selling ready-to-grow bags to wealthier households.

Mushrooms have the key advantage being able to be safely and easily dried. While mushrooms lose 90% of their weight in the drying process, the dried product is 10 times more valuable than the fresh, resulting in no income loss whatsoever. This removes concerns around perishability of the product and removes the need for expensive and energy hungry refrigeration and transportation.

Mushrooms bag prepared in laboratory

The substrates for mushrooms can be produced from a wide variety of raw materials, including certain grasses, straw, sawdust from many types of wood and other organic materials.

The primary advantages of mushroom production lie in the high value of the crop and the fact that they are able to be safely stored and cheaply transported through drying.

• Food Forests

Food forests are an ancient Southern African and Southern Indian agricultural design practice, perfectly suited to both sustainable crop production, even when using marginal land. The over arching idea is simple; a range of food trees - fruit, nut and indigenous species such as Morenga, Kei apple, wild plum) are interplanted with other crops. There is minimal ongoing maintenance once the trees become established.

A food forest creates not only a viable eco-system but once production begins – usually from three to seven years - but also provides a regular food source for local consumption or for sale, with minimal ongoing inputs.

• Effective Microorganisms

Beneficial microorganisms exist everywhere in nature. Each handful healthy of soil can contain billions of microorganisms that unlock nutrients from the soil, making them bio-available to plants.

Effective microorganisms (EM) are cultures of beneficial microorganisms found and gathered from nature and natural processes. While EM is biotechnology, it is not a product of genetic engineering. EMs exist in any healthy natural environment – the use of cultures simply enhances natural processes. Research has shown how these can be specifically designed for applications in forestry, agriculture, aquaculture, environmental ecology as well as for industrial and medical purposes.

Many of the current problems around agricultural production are caused by insufficient knowledge and research around the role of soil microorganisms. The abuse of soil in industrial farming practices through chemical fumigation, and sterilization is designed to kill soil microorganisms, good and bad alike. The use of chemical fertilizers further destabilises the delicate balances in soil life. Add herbicides, pesticides and other concoctions and soil becomes nothing more than a sterile medium in which to grow food, after adding yet more chemicals.

As an example of beneficial use of EM, commercial livestock is regularly confined inside to raise productivity and efficiency. The lack of contact with beneficial microorganisms results in frequent occurrences of disease. These are routinely treated with antibiotics which again are devised to kill microorganisms, creating a further vicious cycle. The inevitable result is a decline in the quality of the produce.

Adding EM mixtures directly to soil, or indirectly to animal feeds restores the microbial system, assisting it to reach equilibrium and to establish effective resilience to harmful pathogens and bacteria.

Microorganisms have also been used from ancient times for making bread, yoghurt, wine, beer and cheese.

Microorganisms are naturally incorporated into the entire ecosystem, including us humans. Without paying attention to the microbial systems it is not possible to attain balance in macro systems such as plants and mammals, which are reliant one upon the other.

1) Rhizosphere (Root-Zone) Micro-Organisms

Microorganisms gather and aggregate around plant roots. Plants have hundreds of roots, some many meters long, each with multiple millions of root hairs. Roots provide hundreds of square meters of surface area per plant.

Roots secrete carbohydrates, amino acids, organic acids and enzymes. They also secrete substances that can promote or inhibit the growth of fungi, bacteria and nematodes (eelworms). The substance and quantity of the root secretion differs according to the kinds of plants and their growth stage. In turn the quantity and variety of microorganisms differ according to root secretions from different plants.

There are 2 main kinds of microorganisms promoted by root secretions in the rhizosphere. Root nodule bacteria live in the root cells themselves while, and mycorryza live around and on the surface of the roots. The secretions in turn unlock the supply of nutrients to the roots, vitalizing the plant. Root secretions of 300-400 kg/ha can support up to a billion microorganisms per 1g of soil.

Beneficial microorganisms protect roots by eliminating or competing with dangerous pathogenic germs. An adequate community of beneficial microorganisms in the soil provides a balanced growing environment.

2) Soil Improvement

EM can improve the chemical, physical and biological aspects, as well as microbial aspects of the soil.

- Chemical aspect: pH balance, nutrients electrical conductivity, BC, etc.

- Physical aspect: water permeability, water retention, breaking down minerals etc.

- Biological aspect: up to a billion microorganisms per gram, including millions of yeast and actinomycetes, thousands of photosynthetic bacteria, as well as protozoa, nematodes, earthworms, insects, etc.

3) Changing the Micro-biosphere

After conventional chemical farming, fields are mainly populated by putrefying bacteria. Natural forest, mountain, grassland and savannah soils are dominated by fermenting bacteria with sterilizing qualities. Adding natural concentrates of EM helps to balance fermenting and photosynthetic bacteria.

Soil microorganisms are symbiotic and opportunistic. If pathogenic germs multiply more rapidly than the beneficial microorganisms, the biosphere rapidly becomes disease prone. By assisting beneficial microorganisms to dominate the soil biosphere suppresses disease and can regenerate.

It is possible to improve the soil micro-biosphere simply by inoculating it with cultured microorganisms, just like sowing the seeds of plants.

4) A good soil environment for the micro-organisms

4.1 Temperature: Most microorganisms increase activity when the temperature rises. EM works best in the 20-30 0C temperature range.

4.2 Food: The quantity of the roots and quality of the crop residue is important. By mixing raw organic materials to improve the chemical and/or physical aspects of the soil we can also affect the micro-biosphere, sometimes positively, sometimes negatively.

5) Using EM (Effective Micro-Organisms)

5.1 It is important to activate microorganisms through EM before pathogenic or opportunistic germs are able to start multiplying. EM should therefore be applied in autumn, before the temperature falls, so that some of the micro-organisms stay activated during winter and begin to multiply in spring as the temperature starts rising. Before applying organic materials, ferment them using EM. (EM Compost/ Bokashi). It is best to apply EM before rain or after flooding.

5.2 The standard for EM Bokashi application is 1-2 tons per hectare but more may be needed (about 10 ton) for the complete improvement of the soil micro-biosphere.

• Composting

Western composting has been traced to a farmer and scientist named Marcus Cato, who lived in Rome 2,000 years ago. He stated that "all food and animal wastes should be composted before being added to the soil" and believed that compost was essential to maintain a productive agricultural land[8].

Composting is the "controlled biological decomposition of organic material to form a humus-like material"[9], generally via microorganism activity, a natural reminder of the importance of Effective Microorganisms. The benefits of composting have been acknowledged for centuries, when humans realized that they could transform organic material into valuable humus and available plant food.

From before Roman times compost was recognized as a transitional force in the life cycle. People have depended on compost since the dawn of formalised agriculture, until chemical fertilizers became widespread after World War II.

Today, composting is a key method to divert and utilise waste from homes, restaurants, farms and landfills and utilise it. The immediate benefit is to eliminate water and soil pollution produced by the anaerobic rotting and decomposition of organic material in dump sites. About 50% of all material in landfill sites is organic material.

Composting can take various forms, from simple piles of organic material, to rotating drums, to armies of worms and even to sustainable technologies that rapidly digest waste materials.

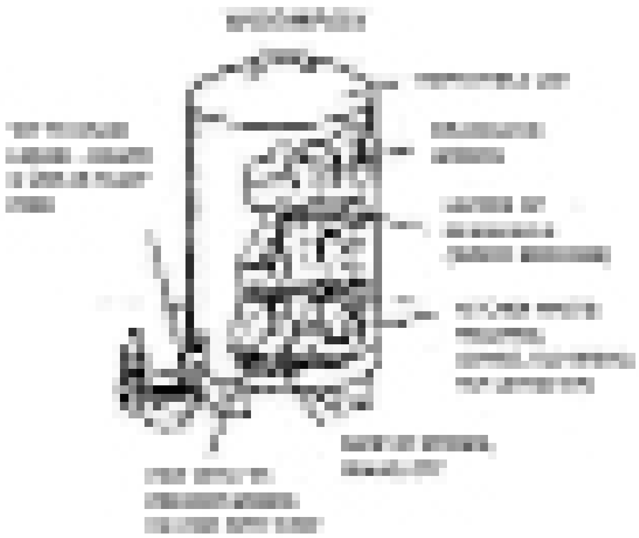
• General Description of Composting Types

: : Vermiculture

The use of worms to produce both a high value organic liquid plant tonic, together with a highly concentrated organic fertiliser is well known. As mentioned elsewhere, the worms can be harvested as a protein source for fish and poultry.

This type of composting requires a large box containing vermiculture worms (usually Eisenia fetida) and bedding made from hay, leaves or news paper. Under optimum conditions, one kilo of worms can digest half a kilo of organic waste every day, depending on variables. Optimum conditions include a large surface area and shallow depth (150mm - 250mm) for aeration. A 70-80% moisture level, a temperature of approximately 24C and a carbon: nitrogen ratio of 5:1, which is favourable for both microflora and worm biomass growth. Vertical systems work best, as worms prefer to move upwards towards food.

8 The Compost Resource Page, 2003.
9 The Business and Industry Resource Venture, 2003



Conversion of organic waste into worm castings produces a richer, more pathogen and odour free humus at greater rates of efficiency than any other type of composting. Efficiency can be markedly reduced through unfavourable conditions such as low temperatures, excessive dry or wetness, use of poor or toxic materials like metal or cedar chips. Calcium deficiency can halt reproduction so eggshells or other calcium feed is important.

The only real cost of this system is the initial outlay. Home made options can be pursued but at the most the worms may have to be paid for. Labour and maintenance costs are very low because the worms do all the work, such as aerating and mixing the materials.

Vermicomposting provides a safe and quick method to break down and concentrate valuable nutrients in solid and liquid form, while also multiplying the worms themselves.

: : In-Vessel Composting

This composting process is carried out inside containers of varying capacity. They are generally in the shape of closed silos or lengthwise cylinders. Silos are generally aerated by a turbine to aerate and mix the waste. This may be mechanically, solar or human-powered.

The lengthwise cylinders usually revolve mechanically to aerate and mix the compost. There is a considerable variation in technology, some with computerised monitoring systems for noxious gasses, moisture and temperature levels, others that require such measurements be taken by hand. In-vessel composters are more efficient if waste is shredded. This also helps prolong the life of the vessel.

The major costs involved in this type of composting lie in high capital and maintenance costs.

The biodigester with no moving parts is a preferred technology, for obvious reasons.

: : Anaerobic Digesters

Anaerobic digesters are used mainly to composting wet wastes like animal and human manure. They are not always suitable for composting food wastes. They are completely closed systems that rely on anaerobic bacteria like methanogens and methanotrophs – which produce methane - to decompose and stabilize organic wastes. The collected methane can be used as a source of energy.

Construction costs are lower than one would think. They can, with correct quality controls, be built using simple skills, such as bricklaying. The ability to produce methane, coupled to zero maintenance, while adding value to agri-business, ensures that investment in anaerobic digesters performs well over time.

• Ploughing

Convention has led people to believe that ploughing is necessary and must happen with a tractor. This is untrue. If you have to plough, animals can do the work for you in unexpected ways.
For example:

- Goats, cattle, horses and sheep eat plants and grass, while loosening soil under the correct conditions
- Pigs dig and plough the soil
- Chickens fertilise the soil, remove grass and weeds, and act as mobile pest controls
- While moles are seen as pests by farmers, they aerate and turn soil and allow moisture to penetrate soil
- Earthworms aerate soil, provide nutrients and rotate soil up to a meter deep

: : Zero Tillage: The No-Till System

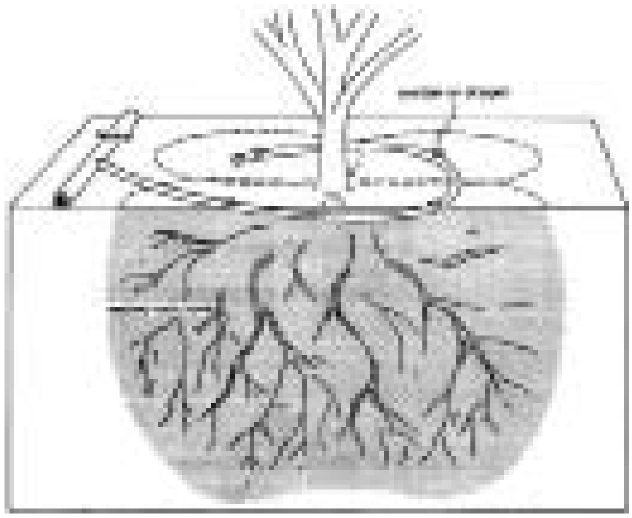
The No-Till system is a labour saving method of farming that simultaneously builds up soil fertility. By not ploughing, the carbon remains locked up within the soil, reducing climate change gas emissions. Other advantages include:

- Reduces erosion
- Conserves moisture
- Reduces the size of tractor power and the need for tillage equipment
- Uses less labour
- Requires less time for planting
- Uses less liquid fuel
- Increases the organic matter in the soil and tilth
- Reduces crusting by salts, through evaporation
- Provides firmer soil conditions at harvest
- Reduces soil temperatures

A simple no till system involves using a mulch. This can simply be flattened plain brown cardboard packing boxes, old carpet or underlay (be careful of toxic glues), or newspaper and hay. Avoid glossy cardboards and paper.

Cover the areas where you wish to grow plants with 3 or 4 layers of cardboard or 8 sheets of newspaper covered with hay or partially composted plant mulch. This kills off all the grass or weeds that are covered by the material. Seedlings can be planted in small holes in the material.

• Water and Irrigation



Water availability to plants is a critical component of productive farming. It is preferable get the highest production from the available water. Conventional spray irrigation is inefficient. Water loss can exceed 80% through spraying and evaporation and is also energy intensive, using large pumps. Finally most of the water that does reach the ground is lost to the topsoil, not reaching the roots.

The most efficient way to get water to plant roots of a plant is through drip irrigation. This system uses pipes to slowly drip water onto the root ball in a controlled manner.

Underground irrigation for raised bed row crops can also be made using similar principles. Old leaky pipes can be wrapped in carpet underfelt, rags or hessian and then buried beneath the ground. Waste water is then fed through these pipes, directly wetting the root zones with no evaporation.

: : Pumping Water

Diesel and electrically driven pumps are expensive to buy, run, maintain and replace. There are many other options available, including:

Ram Pumps

Ram pumps require no fuel, but need water pressure, usually gained from using flowing streams. They use a combination of water flow and hydraulic pressure and are very reliable. They pump about 10% of the flow of a stream, using the other 90% as energy source.

Plans for these pumps, which have only two working parts, are freely available. They are easy to build and maintain. Many are in local use. They can be built using locally recovered materials. Each meter of fall in river level can lift water approximately ten meters uphill.

Treadle Pumps

Treadle pumps are in widespread use, with almost half million units in Asia and at least 35 000 in East Africa. They can operate to 6 meters deep, and yield up to 6 cubic metres per hour, to a maximum head of 13m.

Costs vary widely for reasons that remain unclear. In Bangladesh they cost about US$20 while in Africa this rises to between US$50 top US$80. In South Africa, current locally manufactured units sell for around the R3500 mark.

Treadle pumps are better than the rotary 'play pump', a roundabout that drives a pump. Play pumps are designed for children to pump water, which can be equated to child labour, something IZWA is against.

Treadle pumps require adult operation.

: : Flowforms

What are Flowforms?

Besides being works of art, Flowforms are used around the world to treat water. They are extremely effective oxygenators of water and are also able to purify and polish water. The rhythmic intensification has been scientifically shown to increase water's capacity to support life.

They are used internationally in agricultural and effluent treatment. Flowforms are able to use the natural energy in water to regenerate and reactivate its biological properties.

What does a Flowform do?

Water flowing down a mountain stream becomes highly aerated through natural means. With flowforms, cascades are designed to reproduce this process in a concentrated and controlled way, but they do more than just aerate the water.

Where did this work begin?

Water quality can not only be considered in terms of its chemical constituents, but more broadly on its ability to support life. This suggests that there are inherent properties of water which are not readily measured by conventional means but which remain important to its overall health. It was with this aim in mind that John Wilkes of the "Flow Research Institute", following on work by Theodor Schwenck and Viktor Schauberger, undertook intensive studies of archetypal flow patterns in living systems in order to treat and purify water.

The culmination of this work has been the development of the "Flowform" principle of enhancing water movement. Water, flowing through specially shaped vessels is encouraged follow a figure of eight pattern in the form, which also provides a rhythmic pulse.

All forms of life show waterborne rhythmic patterns. Tests carried out in Holland have demonstrated that rhythmically treated water is more able to support the organisms necessary for biological water cleaning. The potential of "Flowforms" is increasingly being recognised and they are now being incorporated in a wide variety of different treatment projects all over the world.

• Seedling Production

There are many practical methods to reduce the costs of seedling production while improving their productivity.

: : Seedling Orientation

Maintaining the orientation of your seedling is important. The way this is done is as follows:
• Plant your seed for germination,
• Note and mark where north is,
• When you plant the seedling, keep it facing the same direction.

This improves chances of success as the young plant need not expend energy to re-orientate to the natural cycles of light and dark, sun and wind, as well to local geomagnetic forces.

: : Soil Blocks

Soil blocks are an ancient technology, part of a 2000 year old Mexican farming system called chinampas, that remove the need for toxic polystyrene or plastic seedling trays. Originally called chapines and developed by the Aztec, these soil blocks improve the survival rate of seedlings by greatly reducing root disturbance, making more nutrients available and allowing earlier sowing. They also reduce input costs, while maintaining a zero-waste organic approach, replacing plastic pots, trays and inserts.

Also known as potting blocks, soil blocks are free-standing compressed cubes comprising of a mixture of potting soil and fibrous matter, enabling them to hold their shape without any container. They can be made from many materials and provide a practical base for seed germination, and transplanting. They have an amazing success rate due to the volume of soil compressed in the cube. The roots are naturally "air pruned" due to the air barrier of the "container-less" cube. The blocks become both the growing medium and the container! They are used for everything; herbs, flowers, vegetables, cuttings, and plant transplantation.

Soil Blocks provide many advantages over traditional potting methods. First, they eliminate transplant shock by keeping the root ball intact and undisturbed. Blocks do not become "root-bound", eliminating root circling that can stunt growth. Blocks also contain a greater volume of soil than conventional tapered pots. Soil is healthier as it has better air circulation. The utilisation of space is also improved. European studies have demonstrated that potting block transplants have a superior performance to conventional transplantation methods.

PLEASE REFER TO THE SOIL BLOCK PUBLICATION BY IZWA FOR FULL DETAILS

: : Paper Pots

Another way to avoid using expensive and toxic polystyrene seedling trays is by using paper pots. These provide similar advantages to soil blocks, such as improved performance and reduced transplant shock, while not polluting. Many alternative options of making paper pots are available, the following being one of the simplest.

How to make paper pots:

- Lay a full sheet of black and white newspaper flat. Don't use shiny, coloured paper as it may contain heavy metals.

- Fold the paper in half lengthwise twice to form a long, narrow strip of folded newspaper.

- Lay the glass on its side and place it on one end of the strip of paper. Roll the newspaper around the glass. The glass is used only as a form to roll the paper. About 1/2 of the strip of paper should overlap the open end of the glass.

- Push the ends of the paper into the open end of the glass. This step doesn't have to be neat and tidy; just stuff the overlapping newspaper into the glass.

- Pull the glass out of the newspaper pocket so you have the newspaper pot in your hand.

- Push the bottom of the glass into the newspaper cup, squashing the folded bottom to flatten. This step will seal the bottom of your pot. Once the pot has been filled with soil, the bottom will be secure. You can also moisten the paper to make it stick together better.

- Pull the glass out and you have a finished paper pot

- Place the finished pot in suitable rectangular boxes like a nursery flat

- Fill it with good-quality potting soil

- Continue to stack the pots side-by-side to support each other preventing the sides from collapsing

- Plant your chosen seeds

- When seeds have developed two sets of leaves, gently tear the bottom half off the pot and plant it

- The pot will break down quickly once in the soil. Most newspapers these days use soy ink for colour printing, which is not harmful to plants. Other paper varieties may use toxic, petroleum-based coloured ink, which should be avoided.

: : Planting and Growing by Phases of the Moon

While some may regard linking to our natural cycles a bit "new age" or "alternative", this overlooks the fact that this system has been scientifically and practically demonstrated to improve plant production. Logic dictates that planting and growing in harmony with natural forces produces better quality crops. Given that all life contains water, the influence of the moon plays a most powerful role.

Some basic lunar growing guidelines include:

- New moon to full moon - sow, transplant, bud and graft
- Full moon to new moon - plow, cultivate, weed and reap
- New moon to first quarter - good for planting above-ground crops with external seeds and flowering annuals
- First quarter to full moon - good for planting above ground crops with internal seeds
- Full moon to last quarter - good for planting root crops, bulbs, biennials, and perennials
- Last quarter to new moon - *do not plant*

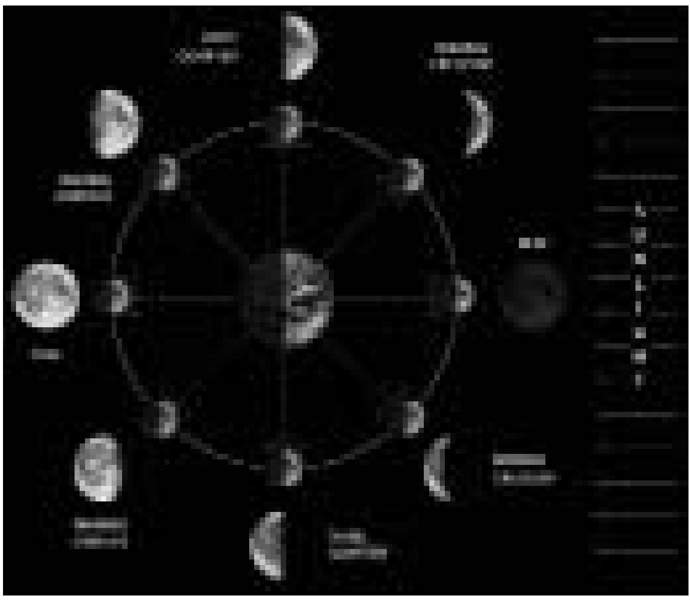
° *First quarter planting (waxing moon)* - from new moon until the first half moon is visible: Plant annuals with above-ground harvest, particularly leafy plants which produce their seed outside the fruit, such as asparagus cabbage, celery, endive and spinach.

° *Second quarter planting (waxing moon)* - from the first half moon until the full moon: Plant climbing and vining annuals with above-ground yields, which produce seeds inside the fruit, such as beans, peas, peppers, squash, eggplant, tomatoes, cucumbers.

° *Third quarter planting* - from the full moon to the half moon, (waning moon):
Plant biennials, perennials, bulb and root crops. These will include plants that only yield the next year, trees, shrubs, vines, such as onions, potatoes, rhubarb, grapes, winter wheat, and berries.

° *Fourth quarter planting* - from half-full to new (dark) moon (waning moon).
Pull weeds, cultivate, destroy pests and turn sod.

Free software for calculating the phases of the moon is available at www.filebuzz.com

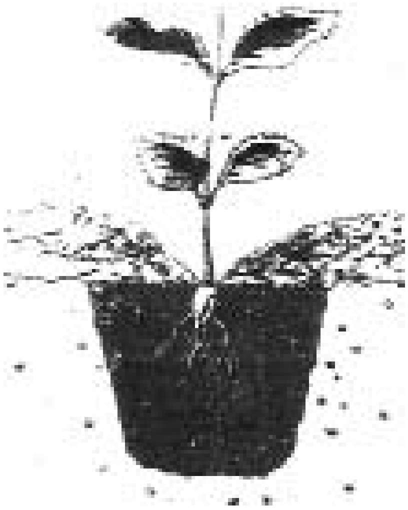


• Mulch

Mulch provides a guaranteed way to reduce water use and maintain a balanced soil temperature while encouraging plant growth. Mulch consists of various material spread over the soil surface in order to protect plant roots and soil from the effects of hard rainfall, evaporation, freezing, and crusting (hardening) of the soil. Good mulch materials must not blow away, they must be free of weeds, diseases and toxic chemicals while allowing water and air to readily enter the soil.

The following materials can be used as mulch:

- Plants
- Leaves
- Straw
- Grass (dried)
- Seaweed
- Compost
- Cardboard



: : Use of Mulch

Mulch is an overlooked wonder material in the garden. It is inexpensive, easy to apply and very effective.

If one examines the soil surface in natural habitats, like a forest or woodland, the amount of organic matter covering the soil surface is immediately obvious. Leaves, stems, rotting branches, whole tree trunks, dead plants are all part of natural mulch systems. The living canopy provides a steady rain of organic material. This surface layer teems with living organisms - bugs, beetles, ants, spiders, worms, fungi, grubs and bacteria. This rich vegetable matter is used and broken down and provides plant nutrients for the soil and plants below.

You should always try to emulate these conditions in your garden beds. You can use compost, lawn clippings, leaves, bark chippings, twigs, straw, depleted mushroom compost and whatever else is available. You can even cover several sheets of newspaper with organic material to secure it but this is not as permeable to water as natural mulch.

Mulch has 5 main properties which makes it essential in the garden and reduces water use:

1) Insulates the Soil
   Mulch acts like a blanket over garden beds. It maintains soil warmth in winter and keeps it cool in summer. Because mulch is loosely packed and filled with air gaps it has good insulation properties. This reduces evaporation, and saves water. Plants grow better because of the more stable temperatures.

2) Absorbs Water
   Water soaks into the mulch where it can be retained for quite long periods. Water is gradually released to the soil where it can be taken up by the nearby plants, with the mulch acting as a reservoir.

3) Improves Soil Quality
   As the organic matter in the mulch gets taken down into the topsoil, it renders the topsoil more porous, loamy and moisture retentive. This improves the structure of the soil, increasing fibre and nutrients levels to the plants.

4) Stops Erosion
   Bare earth is vulnerable to heavy rain. If the soil is incapable of directly absorbing water, runoff erodes the soil surface, carrying off nutrients and topsoil. In contrast, a thick layer of mulch absorbs excess water and prevents the soil from being disturbed.

5) Slows Down Weeds and Pests
   A thick layer of mulch on garden beds greatly reduces weed infestation. Weed seeds are lodged in the surface of the mulch where conditions do not favour germination, allowing properly bedded plants to out-compete the weeds. The same applies to garden pests. High levels of mulch encourage beneficial insects and organisms, lowering the risk of attack.

Besides saving water, mulch can reduce the amount of work in maintaining a healthy garden.

Start a compost heap and spread it liberally around the garden beds. Use chipped material from your local council or garden services. Locate and use pea straw, tanning bark, pine bark, mushroom straw or any commercial composts or fibre based mulches.

There is a golden rule for garden beds: - mulch, mulch and more mulch.

• Value Adding

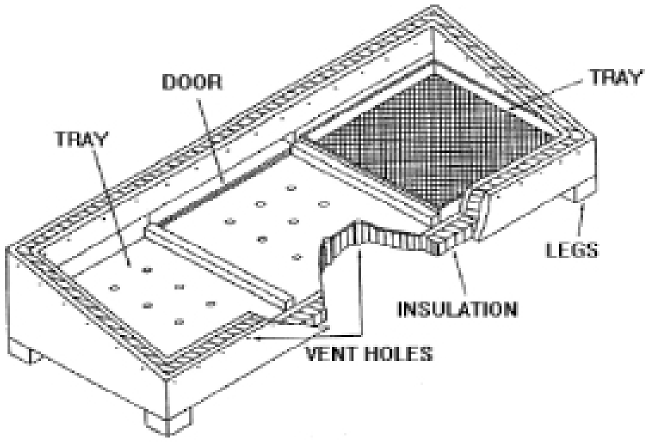
A critical failure of many organic and other food production projects is the lack of generation of adequate cash income. There are several reasons for this. A major one appears to be the belief that it is only financially worthwhile to market in volumes that can be sold to supermarkets or retailers. This is not true, as produce sold directly to consumers generates the highest income.

It is also possible to increase both income and access to markets, by adding value to crops through basic processing. Value can be added through innovative systems such as:

- Direct home deliveries of organic produce to wealthier suburbs enable growers to both receive higher prices while incentivising the growing of a wider range of produce in order that competition is reduced for by preventing oversupply of single crops.
- Food processing through drying, packing, sauces and jams are well established ways to both preserve produce without refrigeration, while also selling crops at a premium. This can also encourage growers to travel to markets where higher prices can be realised.
- Increasing the range of produce creates niche markets, reducing the competition while attracting higher prices.

• Solar Drying

Drying produce is a good way in which to both safely store excess production while potentially increasing income. Sundried tomatoes and dried fruit are examples of directly dried products. Direct or indirect solar drying can also be used for conventional crops like onions, carrots, peas, beans, seeds and many other products.



Making a solar powered drier is neither complicated nor difficult. This drawing indicates an example of the different types that can be manufactured at low cost.

• Markets

It has become clear that markets and marketing are key limitations to successful agribusiness. Simply selling high quality organic produce to local stores creates minimal value to the farmer and can perpetuate a cycle of poverty. A key component of localised, independent farming systems is the ability of the farmer to directly supply consumers, through processing, manufacturing and distributing value-added products.

A key outcomes of marketing plans should be their identification of products that can be directly sold to consumers. Potential areas for growth must be constantly analysed and assessed.

• Sustainably Re-usable Packaging

A key and ongoing input cost is packaging, for presentation, transport and sale. It is counter productive to sell organic produce in toxic and unsustainable packaging. The concept of locally produced, sustainable packaging, such as that from recycled paper pulp, plant materials must form part of the process. The use of recyclable materials like glass bottles must also be a key component of this area.

• Low Energy / Energy Efficient Transport

The best option for low energy transport is the use of a tricycle or a cart for deliveries within limited areas. Other ideas may be considered, with preference given to vehicles powered by locally manufactured biofuels that are not dependent on food crops or by co-operatively run and shared transport.

Zero Waste Multiculture provides responses to the various crises facing people and planet today through the adaptation of tested and proven methodology.

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Institute for Zero Waste in Africa

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not-for-profit-number: 2005/028558/08

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