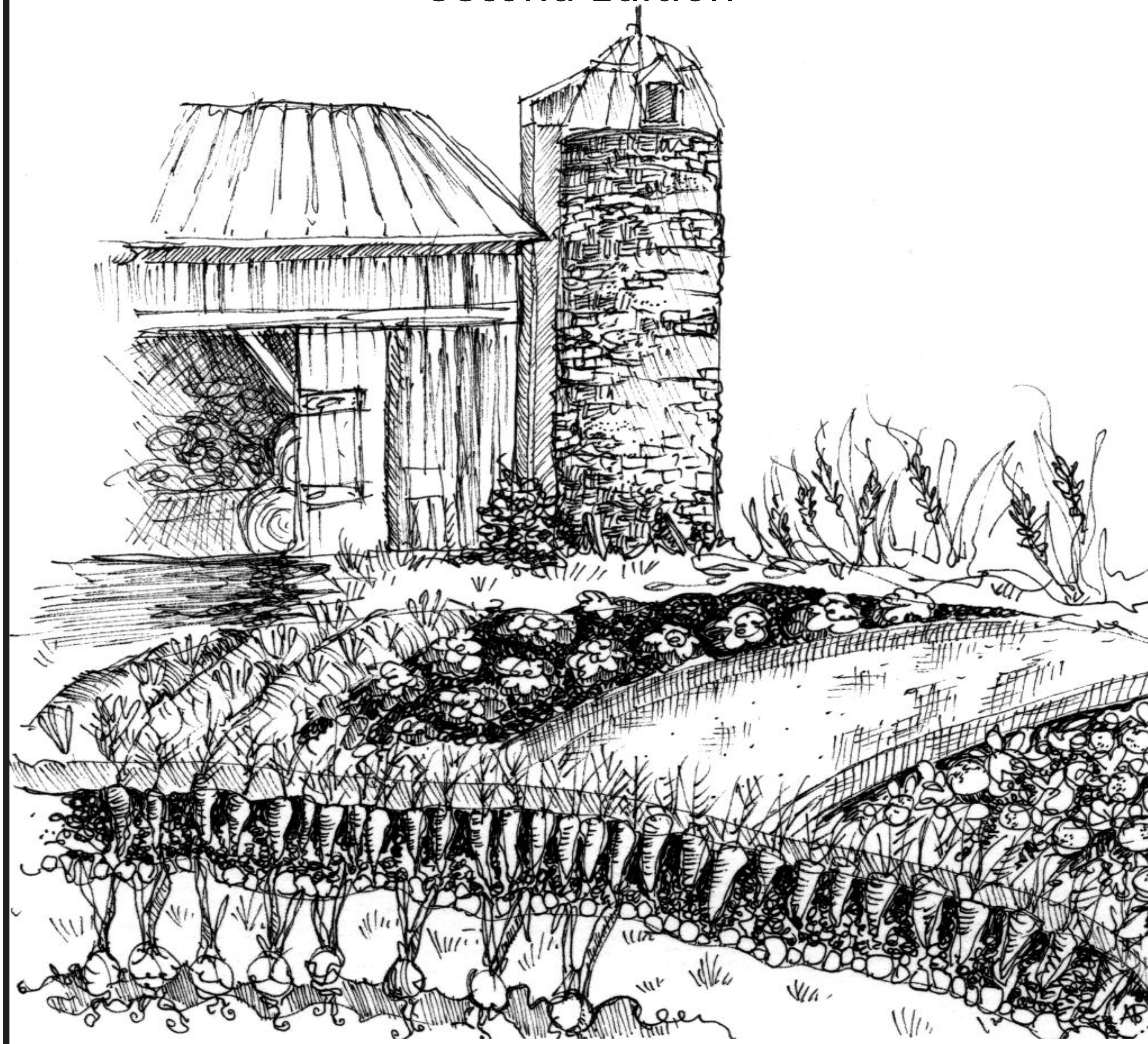
oh, to grow

An Educational Primer for New Farmers

Second Edition



by Jacinda Fairholm

Ignatius Jesuit Centre
A Place of Peace

Ignatius Farm • Community Shared Agriculture

A Publication of Ignatius Farm

Ignatius Farm is part of the Ignatius Jesuit Centre of Guelph – 600 acres of farmland, wetlands, woodlands, meditational landscapes and hiking trails. This land is home to the Loyola House Retreat & Training Centre, Ignatius Old-Growth Forest, and Orchard Park Office Centre.

Ignatius Farm has evolved to become a model for organic agriculture and the mentoring of organic growers. Located at the northern perimeter of Guelph, Ontario, Ignatius Farm bridges the urban with rural, and invites the surrounding community to visit and get involved with their local farm. Initiatives of Ignatius Farm since 2001 include:

- Ignatius Farm Community Shared Agriculture. Fresh, organic vegetables and fruits for CSA members as well as a local farmers market, restaurants, and social service agencies.
- Principles & Practices of Organic Agriculture – Ignatius farm internship program which led to the publication of Oh, to Grow! An Educational Primer for New Farmers and Nurturing New Farmers. A practical guide to hosting interns and mentoring the next generation of farmers.
- Collaborative Regional Alliance for Farmer Training (CRAFT) in Ontario– Founder. A network of organic farms working together to provide field day training to the interns working on member farms.
- Ignatius Farm Community Gardens. Sharing acres of beautiful farmland with local gardeners.
- Ignatius Farm Small Business Initiative. Rental of farmland and infrastructure for field crops, horticulture, and livestock enterprises.
- 2008 Great Lakes CSA conference. Initiated and partnered with regional farm organizations to offer this sold-out weekend conference.

Further information about the Ignatius Jesuit Centre and Ignatius Farm publications is available at www.ignatiusguelph.ca.

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Jacinda Fairholm
November 2003

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Introduction

This manual was originally written for aspiring growers taking part in CRAFT Ontario, the Collaborative Regional Alliance for Farmer Training program. It is designed for beginners--those who don't know much about the magical world of growing vegetables. For those who do, hopefully you'll be able to pick up a thing or two.

This book will help the newly minted or soon-to-be farmer make sense of organic food production, let you nod your head (at least vaguely) when someone says "cover crops" and give you a few tools so that you can look at a field of vegetables and grasp what is going on. You can read it in one-go, but it's probably best to read a bit at a time as you see and hear about different methods and principles of organic farming. In fact, the book may make the most sense to you at the end of the season. Most chapters have an introductory activity and discussion questions. A glossary of underlined words and a list of resources appears at the end. The blank pages following each chapter can be used for making notes. If you are considering a career in organic farming we encourage you to make notes about field design, seed sources (names and addresses of suppliers), equipment uses, and transplanting dates so that you have a good record when you make your first valiant attempt at farming solo.

As a summer intern I performed tasks without knowing why I was doing them. I spent hours sitting on my haunches weeding, keenly aware that I didn't understand the big picture. My desire to learn led me to write this book to help others out there who just want to be a bit more in the know. It's meant to be neither in-depth nor overly scientific. It's meant as an introduction--a primer--to bring you up to speed and satisfy some elements of your curiosity while whetting others.

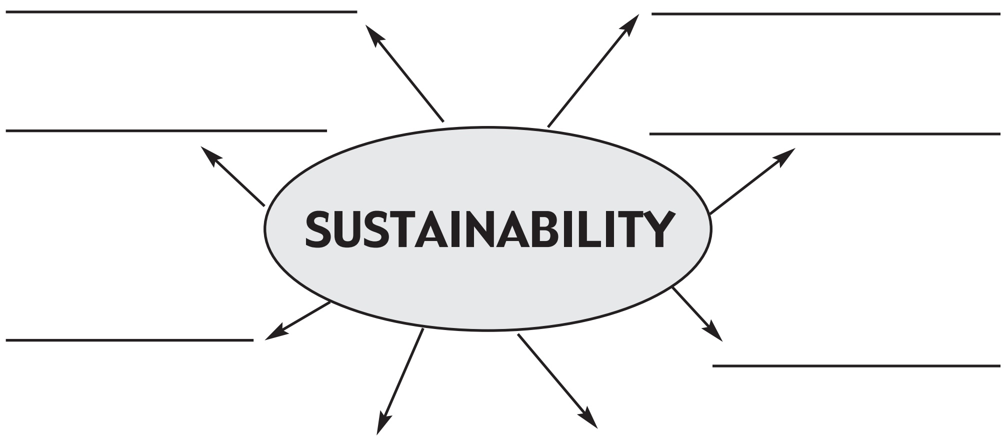
Happy reading!

Chapter 1

Defining Sustainable Agriculture and Organic Farming

Introductory Activity

In the space below, write down words that you associate with the term "sustainability". At the bottom, create your own definition of "sustainability". Consider both ecological and economic sustainability, and the link between the two. Which aspects of farming are sustainable, and which are not?



Sustainability: (Definition) ____

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____

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____

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Looking Back

Defining sustainable agriculture isn't easy. The banner term holds many different meanings and encompasses a wide variety of practices. These practices share one thing however: the effort to work with and within ecological systems instead of trying to dominate them.

There are between 500 and 600 certified organic farms in Ontario and approximately 100,000 acres in organic production (Martin, 2006)

To understand sustainable agriculture we need to look briefly at the history of agriculture over the last 300 years. In the wake of the Industrial Revolution, agriculture changed. Food production went from a farm-based system to a segregated piece of the industrial chain. During the 1800s, agriculture slowly shifted to a model in which companies supplied the farm inputs such as seed, equipment, and fertilizer, farmers provided the land and labour, and distributors and retailers took the product to the market. By the mid 20th century, these roles had become increasingly specialized, and food had become more of a commodity and less an integral part of rural life and culture. Consumption patterns changed from eating food grown locally to eating globally. Consumer satisfaction with spots on their apples dropped, and a new desire for blemish-free foods appeared.

INDUSTRIAL AGRICULTURE

Benefits

Highly productive

Economically efficient

Abundant, cheap, and convenient food

Neat, well-organized landscape

Drawbacks

Soil erosion

Depleted water supplies

Soil salinization

Decline of rural communities

Reduced animal welfare

Increased heath risks of antibiotics, GMOs, pesticides, and food borne illnesses such as E-coli and salmonella

Loss of biodiversity

Dependence on fossil fuels

Market failure caused by oversupply, fluctuating prices and increasing input costs

The Spread of Industrial Agriculture

The industrial system with its economies of scale encouraged farms to become bigger and more specialized. This gave birth to monoculture—land organized to produce one crop using a predetermined set of inputs and machinery. Intensive plant breeding produced varieties with greater yield, uniform plant and seed size, and improved response to fertilizer applications. Farmers were encouraged to rely on external expertise in breeding, and later on genetic engineering, rather than producing their own seed. As old varieties disappeared the range of crops diminished. The lack of seed diversity left fields vulnerable to attack by a single pest, and helped prompt the development of pesticides. Chemical research during WW II led to the introduction of synthetic fertilizers and pesticides. The Green Revolution of the 1960s marked the spread of industrial agriculture to other parts of the world.

Silent Spring

The industrial model results in a set of deeply rooted environmental, social, and economic problems. Twenty-four billion tons of top soil are lost a year, one-third of the world's food is produced on artificially irrigated lands, and poor food distribution leaves 800 million people worldwide malnourished, for example. (Baskin, 1997; Shiva, 1999)

Moreover, the current food system does not reflect the true cost of production. The environmental and ecological costs of air and water pollution are externalized. They're not included in the cost of farming or in the price of food. If they were, it would be abundantly clear that the conventional food system poses huge problems.

The publication of Rachel Carson's book Silent Spring in 1962 was a searing indictment of pesticide use in industrial agriculture that galvanized the environmental movement and led to a widespread call for more sustainable farming methods. Over the years, different approaches have taken root. Organic agriculture is the most widely recognized.

Organic Agriculture

At the turn of the 20th century, Sir Albert Howard and Lady Eve Balfour called for organic practices and for recognition of the link between human health and the health of the soil. J.I. Rodale promoted these ideas, publishing *Organic Gardening* magazine and establishing the Rodale Institute in the 1940s as a centre for education and research. In the 1960s, organic farming became the face of a social movement dissenting against industrial agriculture, urbanization, and consumerism. (Vos, 2000) With sales growing at a rate of 15%-20% a year, the retail organic food market in Canada was estimated at $1.3 billion in 2005. (Martin, 2006)

> Organic agriculture is based on ecological principles and holistic design. As a process, it refers to on-farm management practices that displace the need to purchase manufactured inputs.

Biodynamic Agriculture

In the 1920s, Austrian educator and philosopher, Rudolf Steiner called attention to the relationship between soil degradation and the quality of farm produce. He believed a farm could be a self-contained entity in which all nutrients could be recycled, and the soil, the crops and the well-being of the animals could be maintained with on-farm resources. One characteristic of biodynamics is the use of eight specific preparations derived from cow manure, silica, and herbal extracts to treat compost, soils and crops. Steiner also emphasized the connection between the physical and non-physical (cosmic) realms; biodynamic growers pay close attention to the relative positions of the moon, planets and stars to determine the best times to plant different types of crops.

> The Demeter standard is an international agreement about the principles and practices of biodynamics. To obtain Demeter certification a farm must also meet the requirements for organic certification.
>
> (www.demeter.net)

Permaculture

Coined by Australian ecologist Bill Mollison, the word "permaculture" is a contraction of "permanent agriculture", and is concerned with designing ecological human habitats and food production systems. Any site-specific ecologically-based farming system can utilize permaculture design principles.

Agroecology

This approach, which emerged from the academic community, advocates low-input farming methods including integrated pest management (IPM), physical, cultural and biological weed and disease controls, and the use of on-farm resources. Purchased chemical inputs are reduced, but not necessarily eliminated. Agroecology is not a common food production system. Because it includes IPM, which uses pesticides (albeit in reduced and strategic applications), agroecology is still considered conventional, not sustainable, agriculture. What makes agroecology unique is that it places agriculture within the context of the larger food system, looking beyond just food production and its effect on the environment, to encompass the farm, the rural landscape, the community, and the human behaviour that drives the system.

SUSTAINABLE AGRICULTURE

Broadly speaking, sustainable agriculture means reducing purchased inputs in favor of managing on-farm resources. Any form of sustainable agriculture aims to be economically viable, socially acceptable and environmentally sound (Diver, 1996). The diversity of practices simply reflects the difference of opinion in how to achieve these goals. This workbook will focus primarily on organic agriculture. We hope that from this platform you will gain a broader understanding of how food can be grown sustainably.

CANADA'S NATIONAL ORGANIC STANDARD

The general principles of organic production from Canada's Organic Standards include:

- protect the environment, minimize soil degradation and erosion, decrease pollution, optimize biological productivity and promote a sound state of health
- maintain long term soil fertility by optimizing conditions for biological activity within the soil
- maintain biological diversity within the system
- recycle materials and resources to the greatest extent possible within the enterprise
- provide attentive care that promotes the health and meets the behavioural needs of livestock
- prepare organic products, emphasizing careful processing and handling methods in order to maintain the organic integrity and vital qualities of the products at all stages of production
- rely on renewable resources in locally organized agricultural systems

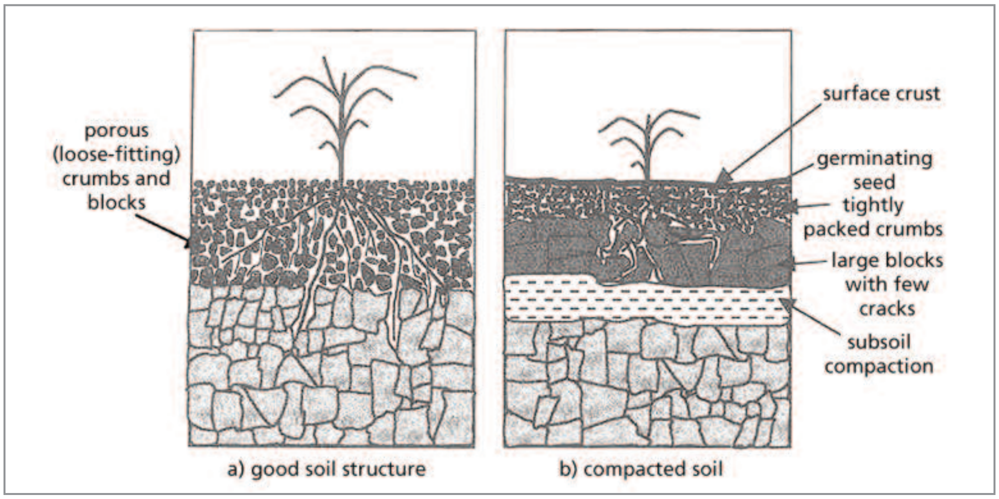
Organic farming encourages balanced predator/prey relationships; organic residues are recycled back into the soil; and cover crops and composted manure are used to maintain and enhance soil fertility. Soil conservation and integrated methods of weed, pest, and disease management are also used. Organic food production prohibits the use of synthetically compounded mineral fertilizers, pesticides, fungicides, herbicides, plant or animal growth regulators, antibiotics, hormones, preservatives, coloring or other artificial additives, ionizing radiation or genetically engineered plants or animals

(OMAFRA Factsheet: Introduction to Organic Farming, November, 2006)

NOTES

Chapter 2

Understanding Soil
Getting Down to Earth



Reprinted from Building Soils for Better Crops, 2nd Edition, with permission from the Sustainable Agriculture Network (SAN). www.sare.org

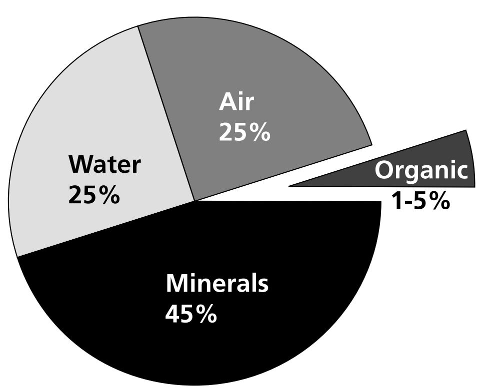
Soil is more than just the dirt beneath your feet. It's where all things connect, where our food comes from and where our waste goes. Soil is teeming with life. Look at it under a microscope and you'll see little creatures performing countless tasks of awesome proportion. Building the soil, rather than feeding plants directly with industrially fabricated nutrients, is one of the basic principles of organic agriculture and the best way to ensure healthy plants over the long run.

Healthy soil is the key to successful organic agriculture. The healthier the soil, the healthier the plants will be.

Soil consists of air, water, mineral particles, and organic matter.

Particle Size

Minerals take up about half the space in soil and consist of bits of rock of varying size. Clay particles are the smallest, sand particles the biggest, and silt particles fall somewhere in between.



COMPOSITION OF HEALTHY SOIL - BY VOLUME

Minerals about 45%

Air about 25%

Water about 25%

Organic matter and living organisms about 1 to 5%

Soil is usually classified according to the size of its particles. Soil texture refers to the relative amounts of different size mineral particles in the soil, i.e. the mix of sand, silt and clay. Soils with high proportions of clay are considered heavy, while sandy soils are considered light. Loam is the ideal mix of sand, silt, and clay.

The size of the particles affects how tightly they clump together and therefore how much room there is for plant roots to penetrate and Pore space also affects the soil's ability to retain water and nutrients and allows soil microorganisms to move.

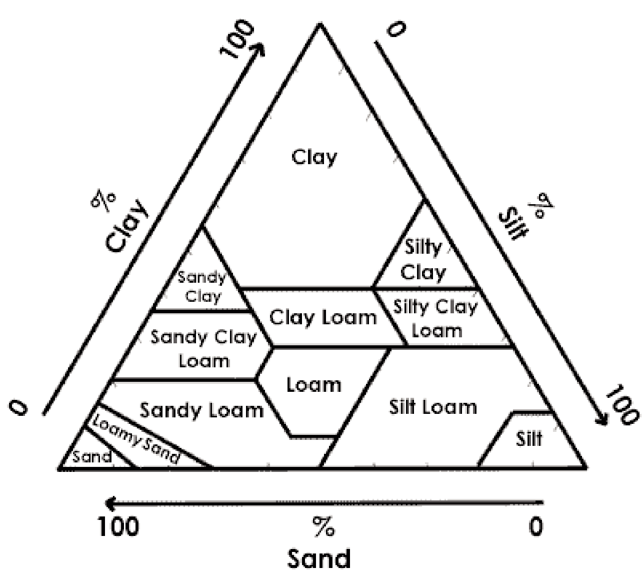
PARTICLE SIZE CHART

Particle		**Size in mm**
Sand	Coarse sand	0.2-2
	Fine Sand	0.02-0.2
Silt		0.002-0.02
Clay	Clay	0.0005-0.002
	Colloidal Clay	Below 0.0005

Water and nutrients stick to the surface of soil particles. Soil consisting of many small particles has more available surface area than one consisting of fewer large particles. Thus, clay soils hold water and nutrients better than sandy soils. Too much clay however, could mean that the soil becomes waterlogged in the spring, and is more prone to compaction. Sandy soils drain well in the spring, but may dry out in the summer. They are more easily penetrated by plant roots or tillage implements, but don't hold nutrients as well. The ability of the soil to hold nutrients is called the Cation Exchange Capacity.

[An excellent chart for determining soil texture by feel is found in chapter 8 of the *Canadian Organic Growers Organic Field Crop Handbook, Second Edition.* See Resources for details.]

SOIL TEXTURE TRIANGLE



Particle composition

Some minerals such as phosphorus, potassium, calcium and magnesium are essential for plant growth. Others are not. Weathering dissolves soil particles, making these minerals available to plants and soil organisms. Plant roots and soil organisms produce acids to accelerate the process. (The higher the proportion of useful minerals, the greater the soil fertility, provided there is organic matter to make nutrients available). Mineral type also affects the pH of the soil. For example, limestone particles tend to produce basic (alkaline) soils, while granite particles tend to produce acidic soils. The optimum pH for most plants ranges from 6.2 to 7.0. In this range, nutrients are most available for absorption by the plant's roots.

Organic Matter

Organic matter is the portion of the soil derived directly from plants or animals. It includes roots, soil fauna and all the wiggly creatures, seen and unseen, that zip (or creep) around that soil. Many soil creatures secrete mucus that helps soil particles stick together. This is called aggregation. Soil texture, pore space and aggregation make up the soil structure. Friable (easily crumbled) cake-like soil has good structure. There isn't much you can do to change soil texture--each farmer deals with the challenges that his or her particular soil presents--but structure can be improved by building up organic matter levels.

Organic matter that is readily decomposing (recently dead) is known as active. It's at this stage that organic matter replenishes soil nutrients. Active organic matter is also food for the microorganisms that transform soil into humus. Humus is thoroughly decomposed organic material. It represents the final phase of decay and the stable part of organic matter. Humus gives the soil structure by helping soil particles stick together and increases the soil's nutrient holding capacity. Humus is dark brown or black, porous, spongy, and smells like moist earth (actually the smell of actinomycetes microbes). Darker soils indicate higher organic matter.

Cation Exchange Capacity (CEC)

When mineral compounds dissolve in water, they split into positively-charged (cation) and negatively-charged (anion) particles. For example, potassium chloride (KCl) splits into K^+ and Cl^-.

Clay and humus are negatively charged so positively charged particles bind to them. This prevents essential nutrients such as magnesium ($Mg2^+$) and potassium (K^+) from leaching away in the rain. Nutrients held in this way are slowly released over the growing season and feed the plants.

Nitrate (NO^{3-}), which is negatively charged, does not bind to clay or humus and is easily lost through leaching. (*Smillie & Gershuney*, 1999: p. 20-24)

Tilth describes the physical condition of the soil:
- the amount of sand or clay (texture)
- the space between the particles (structure)
- how tightly clumped the particles are (aggregation)
- the amount of space for water to drain

If these factors produce a good, loose, easy-to-work-with soil that allows roots to really dig in, holds water without becoming soggy, and has space for air, then the soil is said to have good tilth.

GOING FURTHER

1. Ask to see your farm's soil test report. What is the percent of organic matter in your soil?

2. How is the farmer working to increase organic matter? Are there any other nutrient deficiencies? If so, how would you rectify them?

Organic matter matters. It:
- **Feeds plants**
- **Captures nutrients**
- **Provides a home for microbes**
- **Creates space for air and water in the soil**

(Magdoff & Van Es, 2000)

Soil Test in a Jar

Shake up a jar filled half way with topsoil, and topped up with water. Gravel and sand will settle to the bottom almost immediately. Let the jar sit overnight, and the silt and clay will settle out, in that order. The smallest particles (colloidal clay and humus) will not settle out, but will remain in the water, making it look cloudy. The colloids are among the most important parts of the soil: exchangeable cations are held on them. Slow muddy rivers in agricultural areas suggest that valuable colloids are being washed away.

Hands-on Soil Sample

Take a moment to look, feel and smell the soil. Does it crumble in your hands? Is the soil soft to touch or hard? Does it smell clean? Record the information using the *Soil Field Assessment* sheet. Make 3 copies of this page and use it to assess the soil at different times in the season. Is the condition of the soil improving? How does the moisture level of the soil affect the results?

The Wonder of Worms

Charles Darwin was right: The more earthworms in the soil, the healthier it is.

There are over 200 species of worms, eating, digesting, and helping to build soil fertility. Some feed on the soil surface, some pull plant material down and mix it into the soil, and some digest the organic matter in the soil.

Worm castings contain high levels of nitrogen, calcium, magnesium, and phosphorous which feed the plants. Worms also burrow through the soil, creating channels for water and air flow, and for roots to grow.

(Smillie & Gershuney, 1999: p. 46-47)

Soil Field Assessment:

Which Field? _____ Date______ Weather Today_______

Weather last 2 days________

Indicator	Your Assessment
Earthworms How many are there? How deep are they? Can you identify earthworm holes? Birds flocking behind tilling tractors often indicate the presence of earthworms and other soil critters.	
Organic Matter What colour is the topsoil versus subsoil? Darker colour is indicative of higher organic matter.	
Organic Matter residues Are there plant residues on the surface? In the soil?	
Root Health How well are roots penetrating the soil? Are carrots long and straight (indicates good tilth) or short and twisted (indicates poor tilth)?	
Tilth / Compaction How easily can you cut through the soil? Do your feet sink in? How does it crumble in your hands?	
Erosion Are there gullies? Are crops planted on sloping fields? Are there signs of runoff and erosion?	
Water Holding Capacity How quickly does the soil dry after rain or irrigation?	
Water Filtration How well does water seep into the soil? Does it puddle (and evaporate) or run off?	
Crop condition How are the plants growing? Do the leaves look healthy? Is growth even across the field?	

NOTES

Chapter 3

Plant Nutrients
N, P, and K: What in earth are they?

Introductory Activity

Does your farmer do soil testing? If so, get a copy. In what areas is the soil deficient? According to this soil test, which nutrients does this soil lack? What are some possible sources of these nutrients?

AGRI-FOOD LABORATORIES

Unit 1, 503 Imperial Road North, Guelph, Ontario N1H 6T9 (519) 837-1600

AGTEST FARM SOIL REPORT

AgTest®

REPORT: 127561 Page: 1
Received: 01-nov-2000 Printed: 22-nov-2000

Sample ID	Lab #	pH	BpH	Total Salts mmhos/cm	Organic Matter %	Nitrogen NO_3-N ppm	Phosphorus-P ppm Sodium Bicarb.		Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm
100	215107	7.6			5.4		12 L		81 L	380 H	3049
200	215108	7.7			4.4		17 L		99 L	439 H	2755

Sample	Zinc Zn ppm	Zn Index	Manganese Mn ppm	Mn Index	Copper Cu ppm	Iron Fe ppm	Boron B ppm	Texture	Cation Exchange MEQ/100G	K%	Base Saturation Mg%	Base Saturation Ca%	Base Saturation H%	
100	2.4 H	20.9	36.8 H	22.6	1.8 H	37.5 H	.60 L	M	20	1.0	16	77	6	
200	2.7 H	22.2	35.2 H	23.5	1.4 H	23.7 H	.70	M	19	1.3	19	73	6	

Sample	Sodium Na ppm	Sulphate SO_4 ppm	Chloride Cl ppm	Aluminum Al ppm	K/Mg Ratio	Ex.Acid.				
100					.2					
200					.2					

AGRI-FOOD Sample	RECOMMENDATIONS Crop to be grown	yield goal	N	P_2O_5	K_2O	Magnesium	Calcium	Sulphur	Zinc	Manganese	Copper	Iron	Boron	Lime te/ha
						pounds per acre								
100	LETTUCE		95	75	180									
100	CABBAGE		130	80	230								1.0	
100	CARROTS		69	80	180									
200	TOMATOE		82	112	315								1.0	
200	SWEET CORN		110	75	180									
200	STRAWBERRIES (EST.)		35	60	140									

Feeding the Soil

An organic farmer "feeds the soil in order to feed the plants." The soil holds nutrients that the plants then take up and put into the crops we eat. These nutrients are essential for human health to build bones, transmit nerve signals, and produce energy, for example.

Plants build their bodies primarily out of oxygen (O), hydrogen (H) and carbon (C) found in air and water. To grow and live, plants also need 15 other elements that come from the soil. They are divided into two groups: macronutrients--including nitrogen (N), phosphorous (P), and potassium (K)--and micronutrients. Most of these nutrients are present in compost, rock dust, or kelp and are slowly released over time through the action of weathering. Nitrogen is the one exception.

Macronutrient	Role in Plant
Nitrogen (N)	Basic building block of all proteins
Phosphorous (P)	Encourages growth, helps to transfer energy, essential for photosynthesis
Potassium (K)	Helps to build protein and carbohydrates, aids in nutrient absorption, helps fight disease
Calcium (Ca)	Major component of plant's cell walls, essential for nitrogen absorption, improves the quality of fruits and grains
Magnesium (Mg)	Essential component of chlorophyll (which makes plants green)
Sulphur (S)	Essential for producing proteins and some vitamins, improves growth

Plants need these **micronutrients** in only small amounts, but they must be in balance. An excess of chlorine, for example, can poison the soil.

Iron (Fe)
Manganese (Mn)
Boron (B)
Zinc (Zn)
Molybdenum (Mo)
Nickel (Ni)
Copper (Cu)
Cobalt (Co)
Chlorine (Cl)

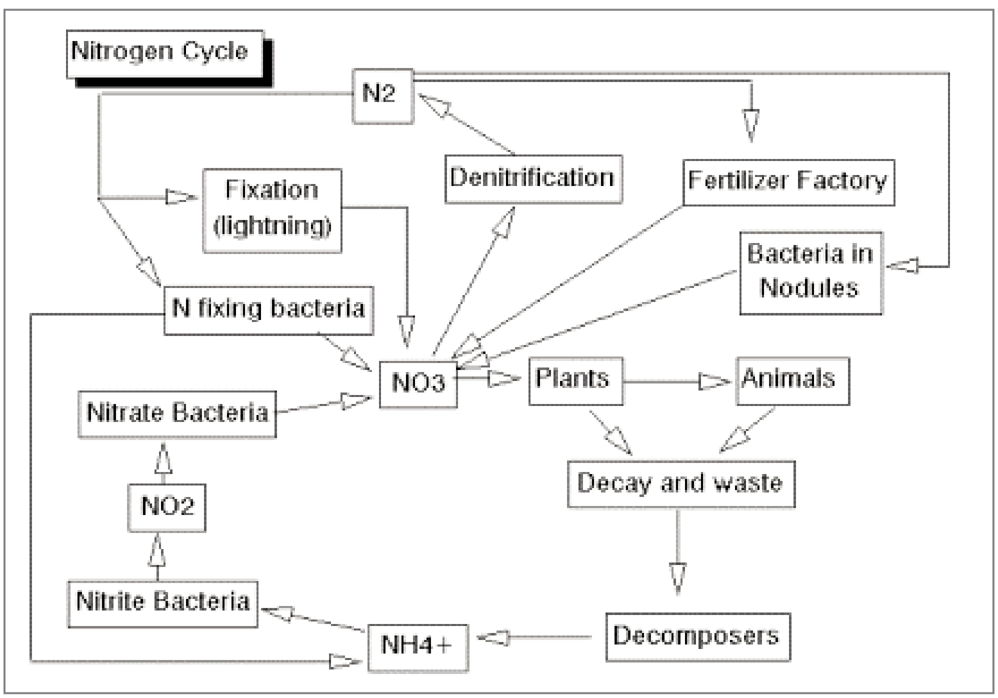
Nitrogen Fixation

Nitrogen is not produced by the weathering of soil particles. It is present in the atmosphere: 78% of the air we breathe is nitrogen gas. Plants need nitrogen more than any other nutrient, but they can't take it directly from the air. They can only use it when it's dissolved in water either as nitrate, which leaches away, or ammonium, which is converted into nitrate by soil bacteria. So, nitrogen has to be continually added to the soil. The process of converting nitrogen into usable forms is called nitrogen fixation. While nitrogen is present in compost in a stable, plant-usable form, organic farmers utilize naturally occurring nitrogen fixation to supplement compost.

Nitrogen fixation occurs in three ways:

1. Atmospheric nitrogen may be combined with hydrogen extracted from natural gas to produce ammonium. This is the basis of the synthetic fertilizer industry.   Organic standards prohibit the use of synthetic fertilizers.
2. Air, heated through combustion or in lightning during a thunderstorm converts some atmospheric nitrogen into nitrates, which then fall, in limited amounts to the ground. (Nitrate is also present in snow and is a component of compost.)
3. Certain soil bacteria are able to convert atmospheric nitrogen into nitrate. Free-living bacteria that fix nitrogen, such as *Azotobacter*, are found in higher concentrations close to plant roots, where they consume the sugary, vitamin-rich exudates from plant roots. The plant receives the free nitrate in exchange. *Rhizobia* bacteria enter into a symbiotic relationship with plants of the legume family (beans, peas, clover, etc). They fix nitrogen in nodules that form on the plant roots, which appear moist and pink on the inside. The plants provide sugars that feed the bacteria, and the bacteria provide nitrates that nourish the plant.

NITROGEN CYCLE



Bacteria are the source of virtually all the nitrogen in an organic operation. The nitrogen in manure is fixed by soil bacteria, taken up by plants, and eaten and excreted by the animals. In this way, nitrogen continually moves through the farm in a complex cycle.

Fertilizers

Except for nitrogen, all other nutrients are held by soil particles and tend not to run off unless the topsoil itself is washed away. When produce is sold, however, these nutrients don't return to the farm. The only way to get them is through weathering of soil particles. Otherwise, they have to be brought in from off the farm in one of two ways.

- Add the needed nutrients using **mineral fertilizers**. Rock phosphate, greensand, granite dust, gypsum, calcitic or dolomitic lime, and "Spanish River Carbonatite ™" are some examples. Rock powders release their nutrients very slowly: one application may be sufficient to correct micronutrient deficiencies for decades to come.
- **Organic materials** release nutrients quickly. These soil amendments may come from other farms (manure, compost, straw, hay, etc.), forests (sawdust or wood chips), the food industry (brewery or cannery wastes), or even the ocean (crushed shells, seaweed or kelp products, fish emulsion). Fully prepared organic fertilizers are also available, but may be too costly for large applications.

Farmers often purchase potting soil containing nutrient-rich materials such as peat moss or worm castings, to start seedlings in the greenhouse. Other nutrient-rich amendments such as kelp, seaweed, fish emulsion and some bio-dynamic preparations can be applied as a foliar spray, in some cases, when plants show signs of stress.

Purchased nutrients are not always added directly; the farmer may buy animal feed and indirectly spread some of those nutrients on the field in the resulting manure. Even farmers that grow their own feed often purchase mineral supplements for their animals, and some of these minerals end up in the soil. Before making any purchases, farmers need to check with their certifier to be sure the product is approved.

Foliar Sprays

Sometimes it is necessary to feed plants directly. Foliar fertilizers are a short-term fertility measure you can take until the soil is ready to provide nutrients.

Timing should coincide with the stage of plant growth when nutrients are in high demand but root intake is low. The best time to spray is early in the morning on a cloudy day. The finer the spray drops the more effective the absorption; the leaves absorb the dissolved nutrients and move them to where they're needed.

(Similie & Gershuny, 1999, p 134)

How does a farmer determine what the soil needs?

A soil test is a good place to start. Test the soil in different locations across the fields, and keep the results separate to see which areas need more help.

Close observation of the plants will show nutrient deficiencies in the colour and conditions of the leaves, stemming from the veins. Purpling on the underside of leaves can indicate phosphorous deficiency. (Phosphorous deficiency in the spring is often the result of cool temperatures slowing the development of microbes that are needed for phosphorous availability.) Yellowing of leaves, beginning with the lower leaves, indicates nitrogen deficiency. If the whole plant yellows, it may be due to the lack of sulfur. Scorched-like leaves mean that potassium is in short supply. Splotchy marks on the leaves usually indicate disease, not nutrient deficiency.

GOING FURTHER

Compare this year's soil test to those from the last two years. Are any deficiencies getting worse? What measures have been taken to address this? If your farmer does not use tests, find out his or her opinion on soil nutrient levels. If there are any concerns, how is your farmer planning to address them?

The Chilean Nitrate Controversy

Naturally-occurring mineral nitrates are found in few places worldwide.

Sodium nitrate or saltpeter forms when plant and animal remains oxidize under certain rare conditions. All of the world's sodium nitrate is mined from a narrow strip of land in the Atacama Desert in Chile.

Chilean nitrate is a limited non-renewable resource. It is a quick-release nitrogen fertilizer that acts much like chemical fertilizers and is prohibited under Canadian and other organic standards. The American standard--the National Organic Program (NOP)--however, allows "limited" applications. Some Canadian growers feel that this gives the Americans an unfair advantage. This was one of the more controversial inclusions in the NOP.

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Chapter 4

Organic Matter
The Fertility God

Introductory Activity

Your farm almost certainly has a compost pile somewhere. Farm compost piles range from the little heap behind the house for kitchen scraps, to barnyard-sized concrete pads for animal manure, complete with runoff catchbasins. Pay a visit to your local compost heap. Take a shovel and dig around. The interior may be quite hot: it has to reach 50°C for certification purposes (very hot to scalding), and it may get hotter, although it's not good if it does. People have lost garden trowels in compost piles and found them weeks later with their plastic handles melted. Is your pile hot inside? Can you make out the original materials (straw, corn cobs, etc.)? When finished, it should just look like soil. Does the compost look ready?

SOIL BUILDING SECRETS

Farmers often talk about organic matter with reverence, and for good reason.

- Organic matter is the food for soil life and the start of the food chain.
- Organic matter is associated with good soil tilth and helps the soil particles aggregate together
- Organic matter holds onto soil nutrients released by weathering
- Organic matter contains proteins that are broken down, providing a steady supply of nitrogen.

Building soil is a long-term project. It takes many seasons to increase the amount of organic matter in the soil. But farmers also have to replace nutrients (primarily nitrogen) and provide for the needs of the current and upcoming crops. They do this in three ways:

- by adding animal manure or compost
- by growing cover crops (green manures)
- by rotating the soil into perennial, soil-building crops like hay, pasture, or clover.

1. Manures and Composts

Manure

Late fall and early spring are not the best times to spread manure. More than 50% of the nitrogen may be lost through nitrogen leaching or denitrification if manure is applied when it's rainy.

Farmers often apply composted manure in early fall and seed a winter crop to hold the nutrients until they are incorporated in the soil in the spring. That way the nutrients will be available for next year's crop. Organic vegetable growers might spread approximately 10 tons of composted manure per acre. Larger amounts may be applied before heavy-feeding crops. (Nutrients cannot be held by microorganisms if applications exceed 10 to 15 tons/acre.)

Manure Risks

Since the Walkerton tainted water crisis--when e-coli from manure got into the groundwater, killing several people--the management of manure has come under greater scrutiny by the Ontario government. Organic standards are designed to prevent environmental contamination and the loss of valuable nutrients.

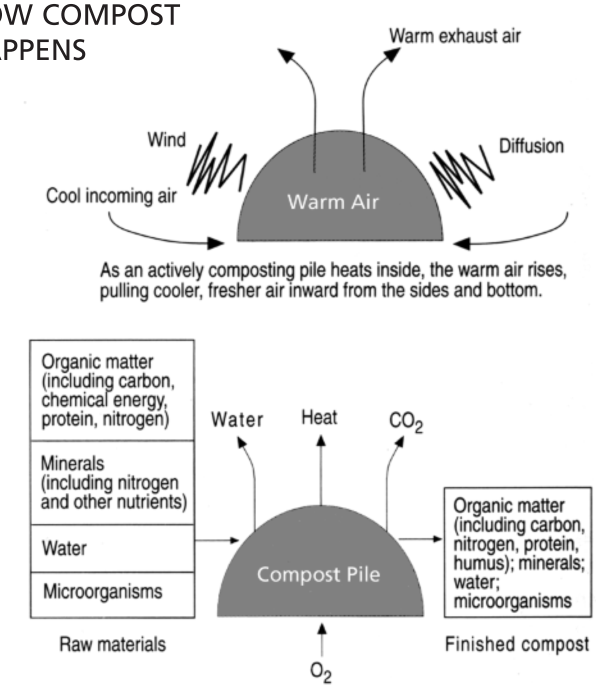
Most organic standards encourage the use of manure produced on the farm, and either recommend or require that it be composted. (In biodynamic farming, manure must be composted in a specific manner; microbes present in the bovine digestive tract are thought to be highly beneficial.) Manure from conventional farms is subject to specific restrictions, and manure from intensive animal operations (factory farms) is prohibited under the Canadian Organic Standard. Nutrient levels depend on the animal species, the bedding, the feed, and on how the manure is stored and composted. **Proper composting is essential.**

Compost

Composting is a fine art. It involves creating the right conditions for microbial life to flourish. Microorganisms do most of the work in a compost pile and require lots of oxygen and moisture.

The microbial life in compost is one of its most beneficial qualities. Some microbes may suppress plant pathogens, for example. In addition, scientific trials have shown that compost produces higher crop yields than either raw manure or synthetic fertilizer, even though each treatment contains the same amount of nutrients (Gov. of Canada, 2002). (Spreading compost inoculates the soil with beneficial microbes that convert

HOW COMPOST HAPPENS



Reprinted with permission from Sustainable Vegetable Production from Start-Up to Market, NRAES-104. Natural Resource, Agriculture, and Engineering Service. www.nraes.org crop residues and take up minerals.)

Materials such as manures, crop residues, grass clippings, leaves, sawdust and most kitchen wastes can all be composted. Proper composting encourages organic wastes to decompose in a uniform and stable manner. Here are a few things to remember about making a compost pile:

A carbon to nitrogen ratio of 30:1 is ideal. This is achieved by mixing carbon-rich materials with materials high in nitrogen. Carbon-rich materials include straw, leaves, and sawdust. Nitrogen-rich ingredients include chicken manure, kitchen waste and fresh green residues. During the composting process, microorganisms consume carbon, so the finished product will have a C:N ratio closer to 10:1, and will weigh less (some of the organic matter is consumed).

Large particles break down slowly. Hay should be chopped and wood chipped.

Size matters. The pile needs to be large enough so that materials will heat up and decompose but not too large and compacted as to prevent airflow. Proper composting requires oxygen.

Material	C:N
Hay, legume	16:1
Hay, grass	32:1
Straw, oat	60:1
Straw, wheat	125:1
Cattle manure	19:1
Chicken manure	6:1
Horse manure	30:1
Softwood shavings	640:1
Grass clippings	17:1
Leaves	54:1
Food waste	15:1

(Attra On-Farm Composting Handbook, NRAES-54)

The pile needs to be turned. This moves the materials on the outside to the inside (to be heated up) and vice versa. For farm-scale composting, the pile might be turned two or three times. If turning the pile isn't feasible, compost will sit longer and decompose more slowly.

Compost is often piled in long rows, usually 5' wide and 4' high, called windrows.

It takes anywhere from 6 weeks to a year to

Manure into Compost

The Canadian Organic Standard has strict requirements for turning manure into compost, designed to prevent e-coli contamination of organic crops.

- The optimum C:N ratio should be between 25:1 and 30:1.
- The pile should maintain a core temperature of 55ºC for 15 days and be turned at least 5 times.
- Records should be kept for temperatures, C:N ratio, moisture and the date and time of turnings.
- The new regulations require animal manure to be composted if it is to be applied less than 90 days (crops with no soil contact) /120 days (crops with soil contact) to harvest of crops. Manure must be composted for at least 6 months, and heated to 50°-70° C for a 2-week period.

produce good compost. After compost has gone through its high temperature stage, some farmers feel it needs 1-3 months to cure. Once it has cured the compost can be spread on the surface of the soil as a top dressing, or incorporated into the soil. You can also use compost as part of a recipe for potting soil mix for seedlings.

2. Green Manures

A green manure is any crop that is turned under in order to feed the soil. The plant residues rot and release nutrients, hence the name green manure. Green manures are also known as cover crops.

For short-term purposes, 'fresh' green manure gives the soil lots of nitrogen (particularly if it is a legume crop) and significant amounts of other nutrients, as well as biomass, which translates into organic matter as it decomposes. The longer the crop is allowed to grow, the greater the benefit. Ideally, it should be left for a full year, so it can develop an extensive root system and give the soil plenty of organic matter to chew on. Cover crops are often an integral part of crop rotations.

3. Soil Building Crops

Soil tillage tends to reduce organic matter. Tillage removes plant cover (the source of organic matter) and oxygenates the soil, accelerating the rate at which soil fauna consume organic matter. Putting the land into perennial crops such as hay or pasture for a few seasons eliminates tillage and therefore helps increase soil organic matter. These crops generally include legumes, so they build soil nitrogen. This also improves soil structure. Organic farmers are encouraged to incorporate livestock into their farming operations to capitalize on the benefits of hay and pasture fields. Feeding hay to livestock over the winter provides income from the haylands and allows farmers to move nutrients from hayfields and concentrate them onto crop fields by spreading composted manure.

Hayfields benefit the soil even if the hay is sold off the farm (although potassium is lost and difficult to replace), due to the extensive root systems and the elimination of tillage. Some farmers without animals put fields into clover for a few years (an excellent soil builder), and harvest the seed for sale. Recent research suggests another option for a perennial soil-building crop: perennial grasses like switchgrass can be harvested like hay, pressed into pellets and used as a heating fuel.

SOIL- BUILDER BENEFITS AND CONSTRAINTS

	Compost (plant and manure)	Green Manures
Benefits	Turns waste into valuable resources Stable nitrogen in finished product Available potassium and phosphorus High quality compost; mostly humus, which increases CEC Heat kills weed seeds and pathogens Readily available nutrients; good for feeding current crops	Great for organic matter Can be high in nitrogen Moderates soil temperature Suppresses weeds Controls erosion Can interrupt weed and pest cycles
Constraints	Takes time, energy, and money to manage May require a front-end-loader and manure spreader Materials may be difficult to source Takes land out of crop production	Seed (hairy vetch, for example) can be costly Can become weeds in the following year Can temporarily tie-up soil nitrogen as it decomposes

Farmers give considerable thought to long and short-term fertility, weigh the pros and cons of each method, and experiment with new methods. Often, a combination of compost and green manures provides nutrients as well as weed control.

GOING FURTHER

1. Which of the three main sources of organic matter--manure/compost, green manure, or perennial crops -- does your farmer use?

2. How does your farm prepare compost? What goes into it? What does the compost look like at 6, 4, 2, and 0 months before field application?

3. How could the composting process be improved?

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Chapter 5

Crop Rotations and Cover Crops
Going Around in Circles

Introductory Activity

In the space below, map your field and write in the location of the different crops. Find out what crops were planted in each block last year and write them in a different colour.

LOCATION, LOCATION, LOCATION

Organic farming is about producing food in a way that prevents problems. Nothing demonstrates this better than crop rotation. Crop rotation means planting crops in different locations from one year to the next. Eliot Coleman--the granddaddy of organic vegetable production, claims that this is the single most important practice in a multi-cropping system, like a Community Shared Agriculture farm.

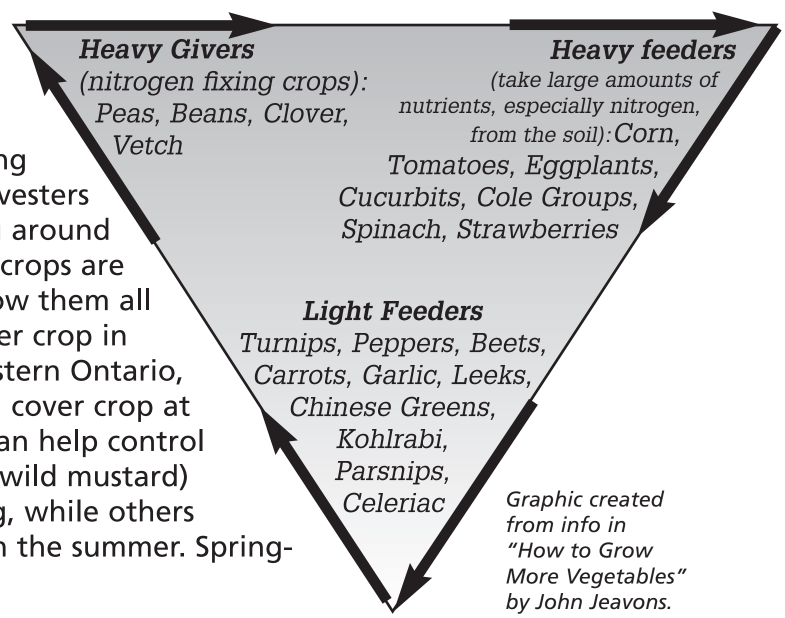
Crop rotation is an integral part of organic farming. It's based on the principle of ecological diversity. Changing the crops on the same piece of land mimics a diverse system. A given block of land may grow carrots one year, onions the next, and tomatoes after that. To plan a rotation, the farmer divides the land into roughly the same size blocks. Each block may contain a single species, or groups of species based on botanical family, nutrient demand, timing of planting, or cultivation techniques.

Botanical family Vegetables in the same family usually attract the same pests. In these rotations, they shouldn't follow each other. For example, if eggplants are planted in the same field that grew potatoes in the previous season (both are members of the nightshade family), the disastrous Colorado potato beetle gets two years worth of goodies to feast on, and feast they will. By changing the location, farmers can interrupt the buildup of these bright orange critters in one area. Planting the nightshades in different fields every year delays infestation as the insects search for the crop.

Nutrient demand These rotations allow farmers to make better use of farm-produced nutrients. Different plants need varying amounts of nutrients to grow. Some crops are heavy feeders and some are light feeders. Cover crops and perennial sod crops like hay are givers; they contribute more than they consume. For example, a cover crop of field peas (a nitrogen giver) planted before corn (a heavy feeder) provides a natural source of nitrogen.

Planting and harvesting times These rotations can make harvest more concentrated and effective. If all the spring crops are together, harvesters spend less time moving around the fields. When these crops are finished, it's easy to plow them all under and plant another crop in that space. In southwestern Ontario, it is common to plant a cover crop at this time. This system can help control weeds. Certain weeds (wild mustard) germinate in the spring, while others (ragweed) germinate in the summer. Spring-

ROTATION BY NUTRIENT DEMAND



Graphic created from info in "How to Grow More Vegetables" by John Jeavons.

planted crops require tilling the soil in the spring, killing those weeds, while summer-planted crops require summer tillage, which kills the later weeds. If long-season, spring-planted crops are grown in the same field year after year, the summer weeds may get out of hand.

Harvesting techniques (all root crops together) or **cultivation practices** (all hilled crops together) might also be part of the planning. Your farmer has probably designed a rotation that combines some or all of these elements.

Allelopathy: What's that?

Allelopathy is the ability of plants to produce chemicals that harm other plants. These chemicals may wash off the leaves, come from the roots or be released when the plant decomposes.

Black walnuts are the most notable example: the toxin juglone leaches from fallen leaves and is exuded from the roots, strongly inhibiting the growth of broadleaf plants, including walnut seedlings!

Winter rye is known to suppress weeds (or other crops) as it grows and after it is tilled in. To a lesser extent, crops such as beets, corn, peas, and cucumbers produce chemicals that inhibit the growth of nearby weeds (but don't count on it).

Allelopathy have been observed since Greek and Roman times--historian Theophrastus suggested that the "odours of the cabbage caused vine plants to wilt and retreat"—but was not widely accepted until the 1930's when allelopathy was coined.

(Gliessman, 2000)

COVER CROPS AND EROSION CONTROL

As you know, farmers also need to think about building the soil and preventing erosion. One way to do that is to include cover crops in the design of the rotation.

A good rotation includes cover crops left on the soil over the winter. The plants hold the soil in place and prevent it from being blown or washed away in the spring melt. Annual cover crops that are winter-killed are the best choice for fields that are to be planted early, since their residues are easily worked in. Winter grains can be planted in the fall to provide a living cover crop through the winter, but are not easily worked in until they have gone to head (produced seed/grain) later in the spring. Perennial cover crops continue growing in the spring. They provide better erosion control and more organic matter, but take time to kill and incorporate in the spring.

Other Benefits of Cover Crops

Cover crops have different uses.

- As a <u>fallow</u> to build organic matter by growing a cover for the entire season and into the next. Some species have long taproots that bring up nutrients from the subsoil as well as break and open up the soil.
- As a winter crop to capture nutrients that are in excess in the soil or that might wash away with the fall or winter precipitation.
- As a <u>smother crop</u> to compete against weeds and prevent them from gaining ground (requires thick, fast-growing species like buckwheat).

- As underseeded crops to cover the soil in and between the rows of food crops like corn, grain or squash (Grubinger, 1999).

On the downside, cover crops can provide habitat for pests and soil pathogens. Some farmers leave the soil bare over the winter to control pests but it is not an accepted organic practice because of enormous nutrient losses. In addition, some cover crops produce chemicals that have a negative allelopathic effect on future crops although they delay the germination of weed seeds.

Cover crops are usually legumes or grains (including cereals) and can be used singularly or combined. When choosing a species, farmers consider the cost of the seed, when it will be planted, what nutrients the soil lacks, and which crop will follow. (Grubinger, 1999)

CHOOSE THE BEST COVER CROP

Cover Crop	**Uses**
Buckwheat	• quick-growing annual • suppresses weeds • believed to extract phosphorus from the soil • decomposes quickly and makes nutrients available to the next crop • contributes little organic matter • winter kills Note: if allowed to seed, may become a weed in the next year
Clovers	• fix nitrogen • deep tap roots (sweet clover) loosen compacted soils and bring up nutrients • Low-growing, creeping perennial, white clover often used in alleys or paths
Field Peas	• annual legumes • fix nitrogen • thrive in cool areas and often planted in the fall or spring • mixed with oats, produce lots of biomass and may smother spring weeds
Oats	• quick growing in cool weather (ideal as a fall cover) • die over winter; provides a protective dead mulch that suppresses spring weeds and controls erosion
Vetch	• fixes nitrogen if allowed to grow till flowering stage • cold tolerant legume • grows well on a wide range of soils
Winter Rye	• planted after harvest in the fall • produces a mat-like cover that suppresses weeds • allelopathic effect • can be difficult to turn under in the spring • does not winter-kill *(adapted from Sarrantonio, 1994)*

GOING FURTHER

1. What determines the crop rotation on your farm-nutrient demand, botanical groupings, planting and harvesting timing, or cultivation practices? What are the benefits and drawbacks of this system?

2. Find out which cover crops preceded this season. Why were they chosen? Did they meet their expectations? Considering this year's rotation, what is your recommendation for cover crops for the late summer and fall? Why? Consider the following: nitrogen supply, soil organic matter, erosion control, nutrient availability, reducing compaction and weed suppression.

Making Plans

Go back to your field map. In a third colour, write down where you think each crop should go next year, including cover crops. Explain your reasoning and long-term plan. You have just developed your first crop rotation!

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Chapter 6

Knowing the Crops
Is it a Fruit or a Vegetable?

Introductory Activity

Which crop is which? Draw a line to the answer.

a. This plant originates in the Andean Mountains. When it was brought to Europe people would not eat it because it was thought to be toxic.

b. There are drawings of this plant on Egyptian tombs dated at 4500 BC.

c. You can steam and eat the greens; the roots provided sugar in Eastern European diets for centuries.

d. Beans, squash and this crop are known as the Three Sisters. These plants are native to Mexico. They were brought to what is now Canada by the native people who grew them together because they provided each other with significant growing advantages.

e. At the end of the 19th century, there were over 642 varieties recorded in North America. Now only 9 varieties are widely available.

f. There are orange, yellow and purple varieties of this vegetable. The wild variety is white, and is a common weed in old hayfields.

1. Corn
2. Apple
3. Romaine
4. Tomato
5. Carrot
6. Beets
7. Radish

Answers to Introductory Activity:

a. tomato b. romaine c. beet d. corn e. apple f. carrot

Plants in the same family often attract the same pests and have similar growing requirements, so it helps to become familiar with them. Here are some of the main crop families you are likely to work with. The weeds that are listed are in the same family as the plants that are described above them. Weeds that affect each family of plants vary from place to place.

Nightshade family (Solanaceae)

peppers, tomatoes, eggplants, potatoes

These plants produce toxic alkaloids and, with the exception of potatoes, only the fruits are edible. Solanaceae crops prefer temperatures of 25-30ºC. In northern climates, they are started in greenhouses in April and are not planted until the soil is warm. They are easily killed by frost.

Weeds: deadly nightshade, wild tomato, jimsonweed

Pests/diseases: tomato hornworm, Colorado potato beetle, blight, fusarium rot

Crucifer/Mustard family (Cruciferae or Brassicaceae)

cabbage, turnip, radish, arugula, rutabaga, collards, broccoli, cauliflower, mustard, canola, kale, Brussels sprouts

Crucifers are distinguished by bitter chemicals called gluconsinolates that give this family its tanginess and zing. The many varieties of Brassica oleracea are collectively known as cole crops. Pak choy, mizuna, arugula, and rapini are known as mustard greens. Crucifers prefer cooler temperatures: 15-20ºC. They are very frost-tolerant, and some can be successfully harvested in the snow.

Weeds: wild mustard, wild radish, shepherd's purse, stinkweed

Pests/diseases: flea beetle, aphid, cabbage looper, cabbage maggot, black rot

Determinate and Indeterminate Plants

Tomatoes originally grew as a sprawling vine. This vine is indeterminate. That is, the tip of each branch produces a series of 3 leaves and a group of flowers, followed by another three leaves and more flowers. The tip just keeps on growing.

The determinate tomato (bred in the early 20th century) stops growing after it reaches a certain distance from the centre of the plant and forms a final flower cluster. These plants never get too large and all their flowers bloom within a limited time, so that the fruits ripen over a short period.

A farmer may choose to grow determinate tomatoes because one can time the harvest more specifically. Determinate tomatoes also work well in northern climates with short growing seasons

(Patent and Bilderback, 1997: p. 279)

Onion family (Alliaceae)

onions, garlic, leeks, shallots, chives

These are known as alliums because of the presence of alliinase, the enzyme which causes tears, and also gives these vegetables their tangy flavour. Alliums prefer cooler temperatures: 13-24ºC.

Weeds: none

Pests/diseases: onion maggot, fusarium basal rot

Goosefoot family (Chenopodiaceae)

spinach, beets, and chard

These hardy crops grow best at 16-20ºC. Beets and chard (Beta vulgaris) can tolerate hot summer temperatures, but spinach (Spinacia oleracea) cannot. Spinach can tolerate freezing down to –10ºC.

Weeds: lamb's quarters, goosefoot

Pests/diseases: leaf miners, tarnished plant bug, mice

Botanically, any plant is a vegetable (not animal or mineral). A fruit is a mature ovary of a flowering plant. Many vegetables are also fruits, including tomatoes, eggplants, zucchini, and whole beans.

Legume family (Fabaceae or Leguminosae)

beans and peas

These plants develop a symbiotic relationship with Rhizobium bacteria, which fix nitrogen inside root nodules of legumes. Peas grow best at 13-18ºC and are frost sensitive. Beans grow well in climates up to 25ºC. They are sensitive to drought and air pollution.

Weeds: black medic, clover, alfalfa

Pests/diseases: leaf hoppers, blight, mosaic virus, mildew, bacterial brown spot

Aster or Daisy family (Asteraceae or Compositae)

lettuce, endive, radicchio, chicory

Most of these crops are grown as leafy greens. Chicory root has long been used medicinally and to make a hot drink similar to coffee. The characteristic milky latex contained in the stems gives these greens a bitter taste, and is more pronounced when conditions are hot and dry. They prefer cooler temperatures: 10- 20ºC.

Weeds: dandelion, thistle, burdock, chamomile, fleabane

Pests/diseases: tarnished plant bug, cutworms, bottom rot, brown rib, mosaic virus

Gourd family (Cucurbitaceae)

cucumbers, zucchini, squash, pumpkins, melons

Cucurbits grow as trailing vines, either climbing or prostrate. They are warm season crops (25–30°C) that are easily killed by frost.

Weeds: wild cucumber

Pests/diseases: cucumber beetle, fusarium wilt, powdery mildew, mosaic virus, black rot

Carrot family (Apiaceae or Umbelliferaceae)

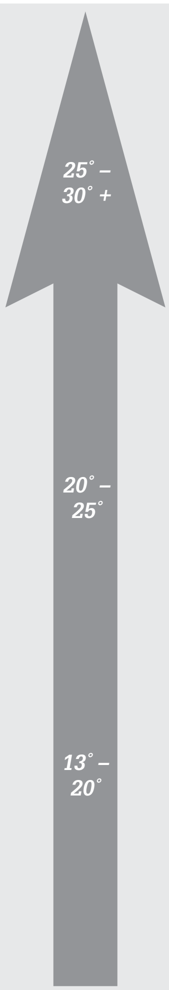
carrot, celery, fennel, cilantro, dill, parsnip, parsley, parsley root

Most of these vegetables produce flowers in their second year of growth (biennial), so they are rarely seen by farmers (you may recognize the characteristic umbrella flower of wild carrot, or Queen Anne's lace). They are cool season plants: 16-21°C. Frost makes the roots sweeter.

Weeds: wild carrot

Pests/diseases: carrot fly, celeryworm/parsleyworm, wireworm, alternaria, blight

NAMING NAMES



Summary of Planting Temperatures

Hot Season Crops 25˚– 30˚+

Sweet Peppers, Tomato

Eggplant, Hot Peppers, Okra, Watermelon

Warm Season Crops 20˚ - 25˚C

Bean

Corn

Pumpkin, Squash

Cucumber, Cantaloupe

Cool Season Crops 13˚ – 20˚

Asparagus, Rhubarb

Broccoli, Brussel Sprouts, Cabbage,

Collard, Kale, Kohlrabi, Parsnip, Radish, Rutabaga, Spinach, Turnip

Carrot, Cauliflower, Celeriac, Celery, Fennel, Lettuce, Pea, Potato,

Beet, Chard

Garlic, Leek, Chive, Onion

(Adapted from Jeavons, 2006:79)

All plants have a two-part scientific name such as Brassica oleracea (common cabbage) for example. The first part of the name, "Brassica" designates the genus to which the plant belongs. The second part "oleracea" gives the species.

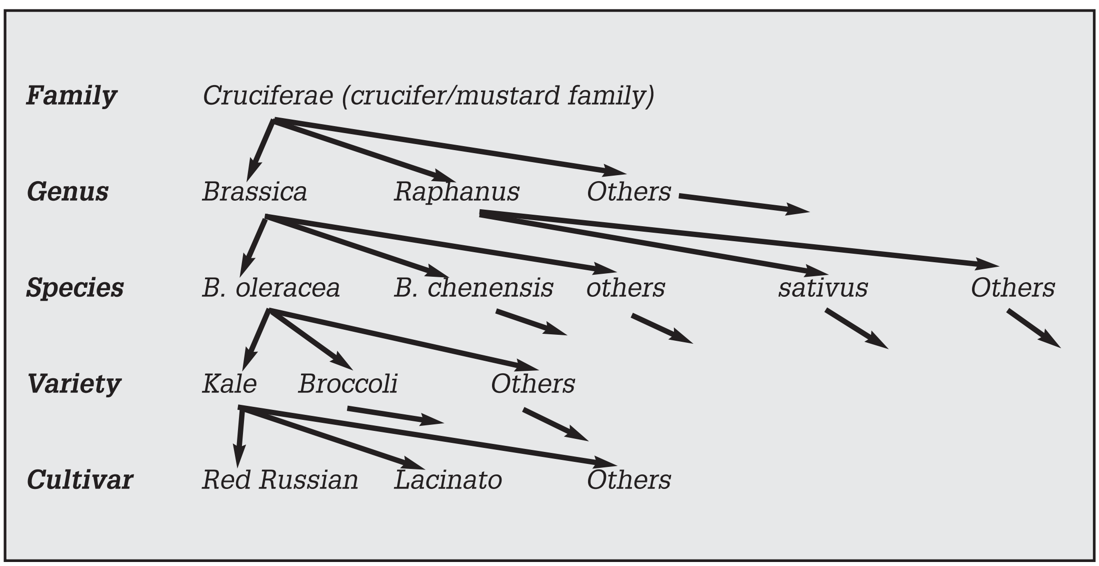
Plant names may also indicate varieties and cultivars. All the varieties within a species can potentially cross-pollinate, but different species cannot. Kale and broccoli for example – different varieties, same species and genus - could cross pollinate. But kale and Chinese cabbage—different species, same genus—could not.

Related species are grouped together into families. Kale, broccoli and cauliflower for example, are all in the crucifer or mustard family, "Cruciferae". The radish is in a different genus (Raphanus), but this genus is also in the crucifer / mustard family.

Why can't they all agree?

The scientific classification system is supposed to be universal but biologists disagree about how to classify species. Some put onions (Allium sepa) in the lily family (liliaceae). Some give them their own family (alliaceae). Others lump lilies and onions together in the hyacinth family (amaryllidaceae). Your choice!

CLASSIFICATION OF PLANTS



GOING FURTHER

1. How many crops does your farm grow?

2. How does the farmer choose cultivars?

3. Where are the seeds ordered from? Are the seeds organic?

4. What are the last frost dates in your area?

Nitrogen-fixing Nodules

Gently dig up a leguminous plant (a clover, vetch or pea) and look for nodules. Cut one in half. If it is pink inside the bacteria are actively fixing nitrogen. If there are no nodules, the soil may contain excess nitrogen and the plants do not need the symbiotic relationship. The plants will not form nodules if there is sufficient nitrogen in the soil. They may also be too small to notice on some plants. They are easy to see on soybeans: if you know an organic soybean farmer ask to dig one up.

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Chapter 7

Dealing with Pests (Buzz Off)

Introductory Activity

Brainstorm: What elements of your field design contribute to pest management? Choose a field. In the space below, map the habitat areas such as hedgerows, field boundaries, trees and bodies of water. How do you think these areas influence pest management on your farm?

The Plant's Natural Defenses

Understanding pests is all about perspective. Veteran farmer Eliot Coleman thinks that pest pressure is a good indicator of plant health. If a plant doesn't get enough water or the right nutrients it will be stressed and its natural defenses may fail. In this light, killing the pest is like shooting the messenger. Addressing the plant's needs instead, helps it resist pests and disease on its own.

For strong, healthy plants, plan to:

- use crop rotations that build the soil
- use green manures and compost
- use bio-dynamic preparations
- select cultivars suited to the climate
- give seedlings the water and nutrients they need in the greenhouse, and in the field

Why Stressed Plants Attract Pests
Stressed plants don't synthesize protein well, leading to a build-up of free nitrogen in the plant tissue. (Nitrogen is a main component of protein.) Since pests are constrained by the availability of nitrogen, its abundance causes the pest population to explode.

(Coleman, 1995; p.176)

The Farm Ecosystem

Natural systems tend toward balance. An explosion in the pest population indicates that the balance between predator and prey has been disrupted. To restore balance, mimic the natural system. One way is to plant shrubs or flowers that attract beneficial insects. The farmer might also add perching sites and nesting boxes for birds, or install ponds for frogs and toads. Healthy, biologically active soil is a good habitat for soil-based predators such as nematodes; 75 percent of all insect pests spend part of their life cycle in the soil. If a farmer has identified a particular pest, they can also purchase and release natural predators (such as ladybugs to control aphids, for example). This is known as applied biological control.

Crop Rotations and Companion Planting

As discussed earlier, rotating crops prevents the buildup of pests in one area. Many plant diseases are transmitted through the soil, so rotation can also help prevent disease from infecting the same crop two years in a row and increasing to the point where it affects crop quality.

Within each rotation, pests can be controlled through companion planting. This works in two ways:

- Decoy plants or trap crops attract pests and lure them away from crops. Since flea beetles prefer mustard greens to kale for example, planting them together keeps the pests off the kale.
- Plants that repel pests help protect crops. In some cases, both plants will be valuable crops such as onions that repel the carrot fly whose maggots eat young carrot roots. Also, tomatoes are said to repel the asparagus beetle. (Riotte, 1975)

Proper Timing

Plantings can be timed to avoid peak pest pressure. For example, late potato plantings can avoid the early season colonization of potato beetles. Field activities can be timed, too. For example, the spread of mildew, blight, rot and many viruses can be reduced if susceptible crops such as beans, squash, and tomatoes are harvested when the leaves are dry.

Physical Control

Physical barriers can protect crops on vegetable farms. Floating row covers made of light fabric prevent flea and cucumbers beetles from landing on the brassicas and the cucurbits. A plastic trench sprinkled with dust built around a field keeps out the Colorado potato beetle, which over-winters in field edges. A slurry made of newspaper and water poured at the base of plants stops cutworms from eating the stems. Some farmers simply remove the bugs by hand. Critters can also be vacuumed up (especially if they are concentrated in a trap crop), and fencing or electric fencing may be used to keep out deer or raccoons.

Why pesticides don't work

Pesticides put selection pressure on the genetic make-up of pest populations. Resistant pests survive and pass this trait along to their offspring. In the last decade, herbicide resistant weed species increased nearly four-fold, and the number of pathogens resistant to fungicides grew from 100 to 150. Broad-spectrum pesticides kill pests along with their natural enemies leaving little to prevent recovered pest populations from exploding. Also, pesticide residues make their way into water, wind, and soil harming birds and amphibians.

(Dufour, 2001)

Traps

Insect traps are common on organic orchards, especially pheromone traps. Insects and other animals secrete pheromones to attract members of the same species. Traps soaked with synthetic versions of these chemicals lure insects to a sticky doom. Pheromone traps have been successful in preventing infestations of the European corn borer in sweet corn plantings.

Organic Insecticides

As a last resort, organic farmers can use plant-derived botanicals or biocides to kill or repel insects. Neem, pyrethrum, and rotenone are natural poisons that kill all insects (*broad spectrum*); garlic sprays simply repel them. Biocides such as Bt contain a toxin made by the Bacillius thuringiensis bacterium that the pest must ingest to die. Bt loses its effectiveness after 2 days in the sun, and there are different strains for different pest families. Organic standards restrict the use of most botanicals and biocides, which require specific permission from the certifier.

PESTS AND BENEFICIALS

Insect Pest	Plant at Risk	Damage	Protection	Natural Predator
Cucumber Beetle	Cucurbits	Leaves	Trap crop, row covers	Tachnid fly
Cabbage worms/looper	Brassicas	Leaves	Row covers	Parasitic wasp Ground beetles
Colorado Potato Beetle	Nightshades	Leaves	Row covers, trench, trap crop, timed plantings, intercrop with clover, chickens	Ladybug. Tachnid fly Spined soldier bug
Cutworms	Many	Cuts off stems	Newspaper slurry, spring tillage	Ground beetle, Tachnid fly
Flea beetle	Brassicas and leafy greens	Fine shot holes in leaves	Transplanting, row covers, trap crops of mustard, sticky traps	Flower beetles

(Grubinger; Foster and Flood, 1995)

GOING FURTHER

How have insect problems changed over the years? What strategies has your farm used?

Meet and Greet

Go out to the field and collect as many insects as possible. Take time to identify them. Get to know your local insects.

Bug Patrol

Assess field for pest prevention design. Which of the 7 general control methods described in this chapter are used on your farm?

- Boosting the plant's natural immune system
- Encouraging beneficial organisms
- Crop rotations and/or companion planting
- Timing plantings to avoid peak pest pressure
- Physical barriers
- Traps
- Approved organic insecticides

Does your farm use pest control methods not listed here?

Tracking Pests

Use this table to keep a record of the pests that are common on your farm, and how your farmer deals with them.

Pest	Crop Affected	Control Method	Your Assessment

NOTES

Chapter 8

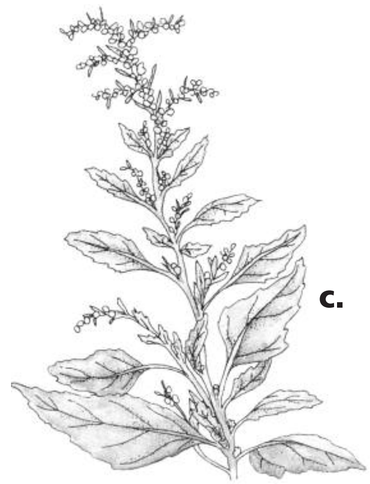
Weed Management
Growing Like a Weed

Introductory Activity

Can you name these common weeds?

b.

a.



c.

d.

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e.

a. BbroadleafPplantain   b. Canada Thistle
c. Lamb's Quarters   d. Quack Grass   e. Wild Mustard

Worthwhile Weeds

Many weeds are edible, or have medicinal uses. People in northern Africa eat the seeds of a pigweed cultivar--amaranth--as a grain. Another cultivar is steamed and eaten as a green in the Caribbean. Even stinging nettle can be steamed or added to soups. If you crush plantain into a poultice, it works wonders on cuts and bruises.

TELL-TALE WEEDS

Ralph Waldo Emerson once defined a weed as "a plant whose virtues have not yet been discovered". Technically, weeds are plants that are adapted to human-made habitats (such as cultivated fields) and interfere with human activity (Lampkin, 1990). In reality, the word weed applies to any plant that is growing where it is not wanted.

Like pests, weeds are excellent indicators of soil health. Chickweed and lamb's quarters for example, indicate soil with high fertility. Dandelions indicate acidic soil. And red rooted pigweed indicates excess soil nitrogen (Canadian Farm Business Management. Council, 2002: 56)

Weed Basics

Farmers typically identify weed control as the single biggest challenge in organic growing. While conventional farmers use herbicides to control weeds, organic farmers need to be more creative. That includes learning about common weeds and how they live and reproduce. Annuals are plants that live for only one season. Perennials are plants that live for more than one season. Both have adopted different survival strategies.

Annual weeds put much of their energy into seed production. The seeds tend to fall to the ground around the parent plant, producing a carpet of weed seedlings the following spring. If caught early, they are easily killed by tillage. Long-term weed control focuses on preventing these weeds from going to seed, and depleting the soil seed bank.

Wild mustard, lamb's quarters, pigweed, ragweed, and chickweed are annuals

Twitch grass, Johnson grass, thistle, milkweed, and dandelion are perennials

Perennial weeds can live for many seasons and produce far fewer seeds. The seeds are often carried away by the wind, so the seedlings will not compete with the parent plant. Perennials put more of their energy into their roots and re-grow after tillage. Weed control focuses on depleting energy reserves of the roots through repeated tillage (thistles), or removing the root mass from the field altogether with a harrow or rake (twitch grass).

WEED CONTROL

A weed control plan should be developed before the rush of spring. A good program starts before the crop is planted and continues after it is harvested.

Seedbed Preparation Cultivating fields in the spring as soon as the soil is dry kills the weeds that germinated in the early spring, but cultivation also brings new weed seeds to the surface, causing them to germinate in a weed flush. The soil may then be tilled again; each successive shallow cultivation reduces the seed bank and brings fewer weeds to the surface. Organic farmers often cultivate the soil three times before planting. This is called stale bedding or the stale seedbed technique.

What to do with Canada Thistle

Canada thistle is a perennial nightmare. It is best left undisturbed until it reaches the green bud or early flower stage, when it is most vulnerable to tillage. Continue tilling or mowing each time the plant reaches 8 cm tall, until freeze up. This starves the roots and prevents the build-up of food reserves so that the plant enters winter weakened and is less likely to survive.

(Canadian Farm Business Management Council, 2002: p. 65)

Hoeing, Weeding, and Mechanical Weed Control all refer to killing weeds by uprooting them and either removing them from the field or leaving them to dry out on the surface. This is the most common method of short-term weed control on organic farms. Timing is essential; it's best to get weeds when they are small. Between the rows, a wheel hoe is useful: a sharp blade is pushed along just under the soil surface, uprooting weed seedlings. If the crop has been transplanted, hand hoeing does the same thing between the plants. For direct-seeded crops, hand weeding may be necessary within the row, since the individual plants may be too close together for hoeing. The stirrup and wheel hoe sever the root from the plant without disturbing the soil. This prevents new weed seeds from being exposed. Implements for mechanical weed control may be mounted on a tractor.

Flame Weeding involves heating weed seedlings just enough to rupture the cell walls, causing them to dry out. The common flamer consists of a torch, hose and tank, which is sometimes mounted on a cart. Flame weeding is especially useful for direct-seeded crops that are slow to germinate, such as carrots, parsnips, and green onions. Weed seeds germinate first, so flaming is done after the weeds have sprouted, but before the crop has sprouted, killing the weeds and sparing the crop. Unlike mechanical weeding, flame weeding doesn't bring new weed seeds to the surface. To save time and fuel, only the rows are flamed, leaving the space between the rows for mechanical weeding. Larger farms have tractor-mounted flamers that cover each row or the whole bed.

Weeds…

- **Use up nutrients**
- **Crowd out root crops**
- **Shade other plants**
- **Provide habitats to pests**
- **Make it more difficult to harvest crops**

Mulching blocks sunlight or provides a physical barrier that keeps weeds from growing. Mulches often consist of leaves, straw, grass clippings or other organic material. All mulches hold moisture and reduce erosion. Organic mulches keep the soil cool, which can be either an advantage or disadvantage depending on the crop. Plastic or corn-based film mulches, usually black, not only prevent weeds, they also heat up the soil. Removing plastic mulch at the end of the season is time-consuming, and the plastic cannot be recycled in most areas. It is however, permitted under certification. Straw usually contains grain seed, which will sprout after rain and take root. Hay may contain grass and weed seeds. (Second cut hay has fewer weed seeds than first cut hay.)

Long-term control

To prevent weed seeds from getting to your soil in the first place:

- Mow the field perimeter to keep weed seeds from blowing into the field
- Make sure the compost pile reaches 50ºC to kill weed seeds
- Make sure mulches are free of weed seeds
- Cultivate crop residues promptly after harvesting so that remaining weeds are killed
- Plant a smother crop—a fast growing cover crop that will outgrow weeds, thereby reducing the light, nutrients, moisture, and space available to them.

After a few seasons, with careful attention to field design, crop rotations, tillage, and vigilant removal (by hand or machine), perennial weeds will be removed, and the soil seed bank will be depleted. This will make the task of weed control less daunting.

GOING FURTHER

1. Identify the weeds growing in your fields.

2. Name the 5 most problematic weeds on your farm. Are annual or perennial weeds a bigger problem?

Weed Watch

Fill in the chart below as a record of the weed situation on your farm, and the methods used to control them.

Weed	Annual or Perennial?	Control Method

NOTES

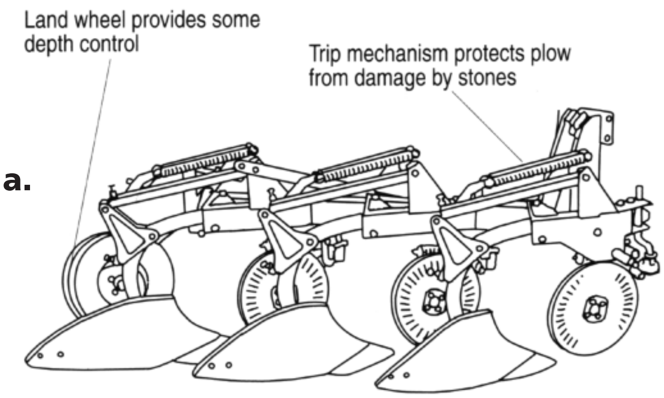
Chapter 9

Farm Implements and You
Riding the Wagon

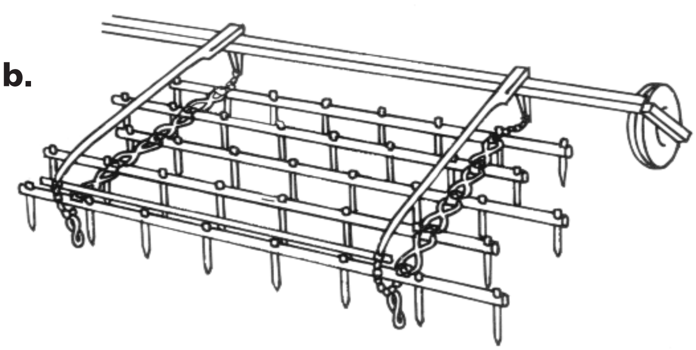
Introductory Activity

Three common soil cultivation implements are pictured below. Match the picture to the implement name.

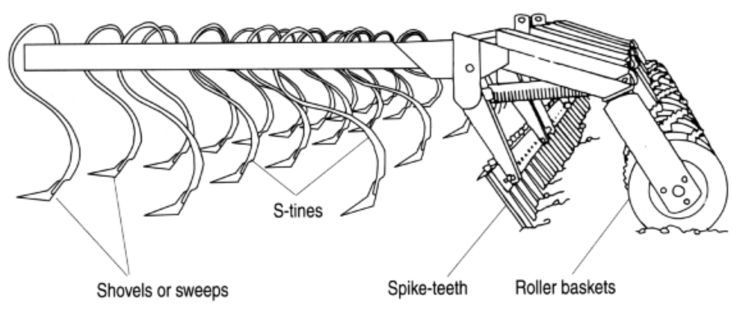
a.



b.



c.



Which is which?

Spike-tooth Harrow

Field Cultivator

Mouldboard Plough

Illustration b. Reprinted from *Steel in the Field: A Farmer's Guide to Weed Management Tools*, with permission from the Sustainable Agriculture Network (SAN). www.sare.org

Illustration a and c. Reprinted from *Sustainable Vegetable Production from Start-Up to Market*, NRAES-104, with permission from Natural Resource, Agriculture, and Engineering Service. www.nraes.org

a. Mouldboard Plough b. Spike-tooth Harrow c. Field Cultivator

TOOLS OF THE TRADE

Imagine that you are an aspiring farmer and have just acquired a piece of land. You are looking at an abandoned hay field and wondering what to do with it. How will you turn over the earth? What can you do to start? You can get familiar with tractors (or horses), and the implements they pull behind them that will turn your old field into a productive vegetable patch.

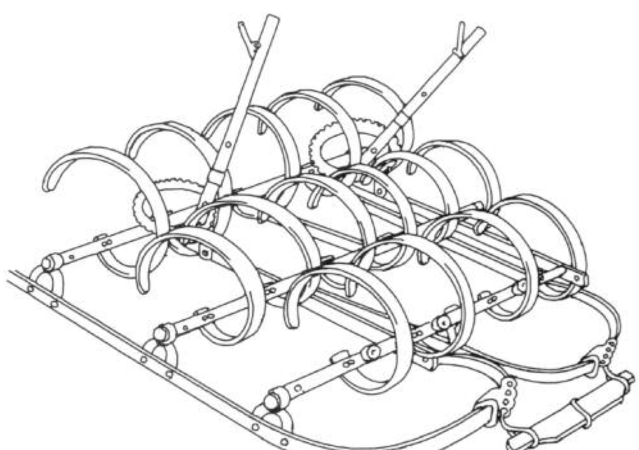
SOIL PREPARATION

Old hay fields or pastures tend to grow up in perennial weeds such as goldenrod, daisies, and thistles. Big mowers called **bush hogs**, cut and chop the weeds so they dry and begin to decompose.

A **moldboard plow** cuts and turns over the sod killing the weeds and accelerating their decomposition. Ideally, you wouldn't invert the sod totally because proper decomposition of the green material requires oxygen. You also don't want to plow any deeper than 8 inches or you will bury all the topsoil and organic matter while bringing up heavy and nutrient-deficient subsoil. This deep initial soil preparation is called primary tillage. Secondary tillage refers to the work done to the top 3-5 inches of soil.

Plowing leaves big furrows in the soil. **Disks** smooth and break up the surface. They consist of freely rotating rows of sharp disks that are pulled over the soil, chopping, cutting, and mixing as they go. The disk is also used to incorporate crop residues, cover crops, and weeds. In addition, various types of **harrows** are used to break up any surface pan that may have formed, break up big soil clots, and smooth the surface.

Spring-tooth harrow



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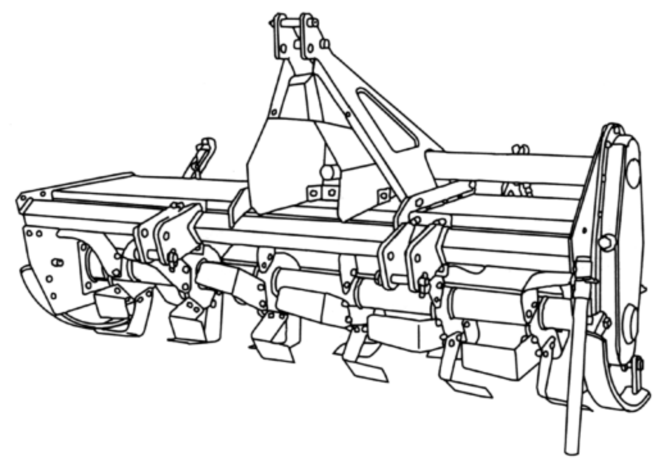
Many harrows look like large rakes that are dragged behind the tractor. On larger farms, a **field cultivator** combines tines and rollers to break up and smooth the soil.

For large-seeded crops such as grain and soybeans, ploughing and disking / harrowing may be all that is needed to prepare the seedbed for planting. On vegetable farms, a fluffier, smoother bed is often desired for small seeded crops.

A **spader** consists of slowly rotating spades that loosen and mix the soil without compacting or inverting it. Spaders can also be used to incorporate residues.

A **rotovator** is a tractor-mounted rototiller consisting of a series of quickly rotating metal blades that aggressively mix the soil. It produces a light and even seedbed but destroys any soil structure in the tilled layer. It is best to till shallowly. Both the spading machine and the rotavator are powered by the tractor motor through the PTO (power take-off).

Rotovator



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Some farmers choose to form the soil into raised beds. This helps the soil dry out and warm up more quickly in the spring.

A **bed former** mounds the soil up and flattens the surface. Some also have a **mulch layer** that covers the bed with a strip of plastic mulch and buries the edges to keep it in place.

PLANTING EQUIPMENT

Now you are ready to plant! Your local equipment dealer will happily sell you any of a number of implements to speed up the process.

Many vegetable farmers use hand-pushed **precision seeders**, which use rotating plates to pick seeds from a hopper and deposit them as evenly as possible in a row, covering them up as they go. A tractor-mounted **seed drill** has a similar function. For cover crops that do not need to be in rows, a **spin seeder** broadcasts seed evenly.

A **transplanter** gets seedlings that were started in a greenhouse into the ground more quickly. It has low-slung seats for workers and racks for holding the seedling trays. Workers remove each seedling and either feed it in to the machine, or press it into a water-filled hole made by the machine.

WEEDING EQUIPMENT

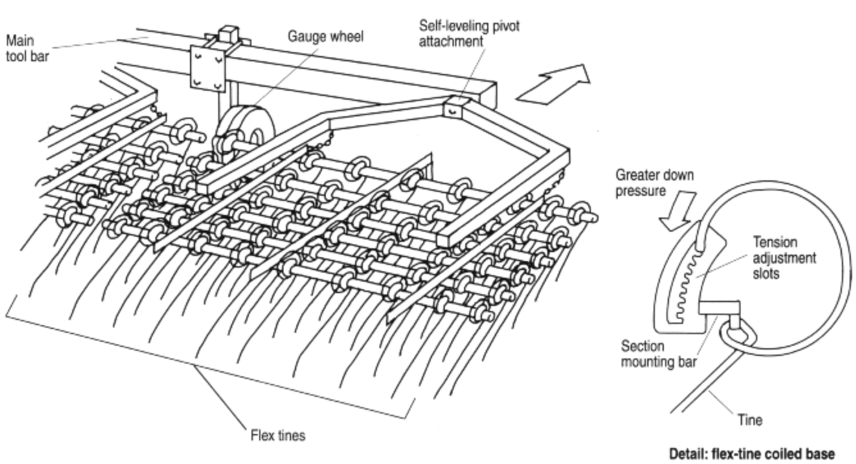
Blind weeding involves any implement that scratches the entire surface of the soil. This is sometimes done after seeding, but before the crop has germinated. It kills any weeds that have germinated before the crop.

A **chain harrow** is a series of chains dragged over the soil.

A **rotary hoe** is a series of wheels with 16-18 "spoons" on each that are rolled over the soil.

A **tine weeder** is a series of spring-mounted metal rods that vibrate when dragged over the soil, dislodging very young weeds. A tine weeder can blind weed even after some crops have sprouted. Large-seeded crops like grain or beans can withstand the tines, but most annual weeds have tiny seeds, and the seedlings are more easily killed.

Flex-tine Weeder



Reprinted from *Steel in the Field: A Farmer's Guide to Weed Management Tools*, with permission from the Sustainable Agriculture Network (SAN). www.sare.org

To Till or Not to Till

Tilling refers to moving or disturbing the soil to loosen it up and kill weeds. Loose, smooth soil is the best environment for planting and rooting. But tilling also destroys the soil structure, removes its protective plant cover leaving it prone to erosion, and accelerates the rate at which soil fauna consume organic matter. Moreover, the weight of heavy machinery causes compaction.

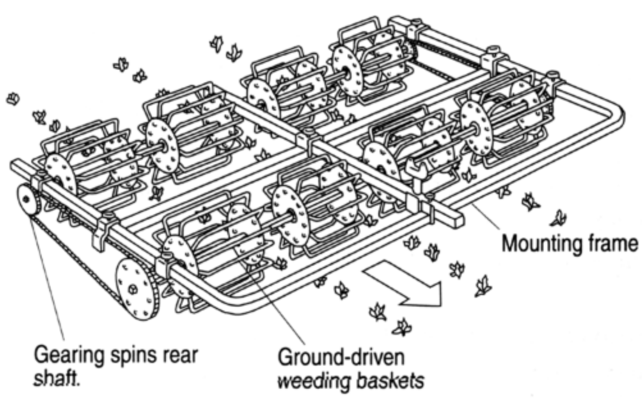
No-till or conservation tillage leaves most plant residues on the surface, disturbing only a narrow area around the seed zone. These methods are used on conventional farms where herbicides, drill planters and fertilizer injection devices reduce the need for tillage.

Rodale has developed an organic no-till method in which transplants are grown through a mulch from roller-killed rye or hairy vetch planted the previous summer or fall.

Although many farmers advocate no-till methods, organic growers need tillage to control weeds and to feed the soil with turned-in green manures. Even conventional vegetable growers need fine seedbeds for planting and avoid no-till methods.

Once the crops are up, more aggressive weeding can take place between the rows. Any of a number of shapes of blades can be dragged between the rows, uprooting all plants that are not in the row. This is called ***scuffling*** (it is the same as wheel-hoeing, but done with a tractor). The tractor may be high clearance (if you want to cultivate tall crops), and the motor may be offset, with the implements mounted beneath the driver (belly-mounted), rather than behind as with most tractors. Some of these blades throw soil into the row, burying any young weed seedlings. For crops like lettuce that must be kept free of soil, a **basket weeder** consists of metal cages that roll between the rows and scuff the soil without throwing it. Mechanical cultivation is tricky; it requires careful field planning and planting. The farmer needs to ensure that the rows are spaced exactly and that the tractor is driven carefully to avoid ripping up the crop.

Basket Weeder



Reprinted from *Steel in the Field: A Farmer's Guide to Weed Management Tools*, with permission from the Sustainable Agriculture Network (SAN). www.sare.org

HARVESTING EQUIPMENT

Harvesting equipment can be the most elaborate and most costly.

A **combine** harvests dried crops such as grain and soybeans. New, it can cost over $300,000, but second hand equipment is much more affordable. Machines have been developed to harvest some vegetable crops, but most are too expensive for all but the largest farms. A **potato digger** is the only one you are likely to encounter on a smaller farm; simple versions bring potatoes to the surface where workers can easily pick them up.

Once the crops are harvested, crop residues and any weeds are worked in to the soil with the secondary tillage implements described at the beginning of the chapter.

Traditional Tilling

Historically, there are three types of tilling: turning up the soil to plant wheat, barley, and vegetables. This originated in the Middle East; manual tilling with a hoe to make small mounds for planting corn, bean and squash, which is from the Americas; and working the soil to create a sealed layer that prevents water loss when rice paddies are flooded, from Asia. In recent years, more mechanized systems have replaced these traditional methods.

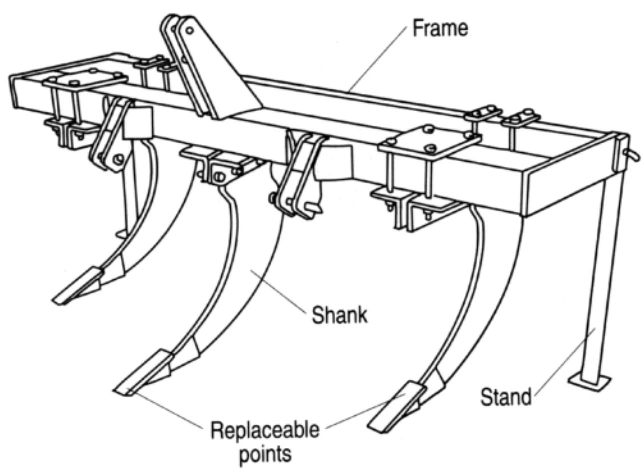
ADDRESSING COMPACTED SOIL

Soil is easily compacted by the weight of humans and equipment.

A **chisel plow** can break up compacted soil after a few years of cropping. It consists of heavy, slightly curved shanks that loosen the soil up to 12 inches. A chisel plow does not incorporate residues or turn over the soil layer. It does not mix the sub and topsoil and allows water to penetrate better. A chisel plow may be used before planting deep-rooted crops such as carrots and parsnips.

A **subsoiler** is useful for hardpan or for earth that is really compacted. A hardpan blocks the penetration of roots and prevents healthy plant growth. It can form if the soil has been plowed or tilled consistently at the same depth. A subsoiler is similar to a chisel plough but consists of fewer shanks that rip deeper into the soil. A subsoiler is not typically used on an annual basis.

Subsoiler



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Compacted soil can also be addressed by planting species such as alfalfa and sweet clover, whose deep taproots can break through hardpans and compacted soil.

Most implements are attached, by pins, to the 3-point hitch behind the tractor. A three-point hitch allows you to raise and lower the implement, controlling the depth at which it is dragged through the soil.

Congratulations!

You have just completed your first year of farming.

GOING FURTHER

1. What implements are used on your farm?
2. Identify the type and use of each implement.
3. What are the advantages and disadvantages of each implement?

Decisions, decisions

You have inherited a field. It has not been farmed for 7 years, and has been lost to goldenrod and daisies. The field is slightly sloping and has a sandy loam soil. You have a limited budget, but want to start farming. What types of crops would you like to grow? What implements will you need? What will you use to pull them? Use this table to draw up a shopping list for your farm equipment, and justify each purchase. If you choose to buy a tractor, how big will it be? How powerful? Think right through from initial field preparation to harvest.

Implement	Use	Advantage / Justification for purchase

NOTES

Chapter 10
Certification: To Be or Not to Be

Introductory Activity

True or False

1. Once a farm receives organic certification, an annual inspection is mandatory.

   True or False

2. In the USA, if you are going to use the word organic to describe your vegetables you must be certified.

   True or False

3. Under new regulations, each certification body in Canada uses its own standard for certifying farms as organic.

   True or False

4. During transition, farms are allowed to have organic and conventional production of the same crop.

   True or False

5. As of June 30, 2009, all organic products will have to carry the Canada Organic logo.

   True or False

6. After June 30, 2009, any food product marketed as “organic” must have been produced according to the Canadian Organic Standard.

   True or False

(Information in this chapter is subject to change. It is accurate at the time of publication.)

Organic Standards History

As the organic market continues to grow, organic certification is becoming more common. In the absence of a direct relationship between farmers and customers, certification guarantees that food was grown using standard organic practices.

Farmers initiated the certification system in the 1970s, to protect the word organic from fraudulent claims. These farmers developed the first organic standards. They described the necessary practices for production and listed prohibited practices and substances. They also created the first certification bodies to enforce these standards.

In the 1990s, there was a push in both Canada and the USA to create national organic standards. The need to codify organics has been largely driven to meet European and Japanese trade regulations and pave the way for North American organic goods to compete in the international market.

Canadian national standards which were agreed to in 1999, drew upon the internationally recognized guidelines prepared by International Federation of Organic Agriculture Movement. Unlike Europe and the United States however, Canadian organic standards were voluntary.

From voluntary to mandatory

Under new regulations, (published in 2006) all products labeled as organic must be produced according to the Canadian Organic Standard (COS). For inter-provincial or international trade, products claiming to be organic must comply with the new federal regulations.

Quebec and a handful of other provinces have created their own laws that will make certification to the COS mandatory even for sales within the province. Currently, the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) does not intend to require certification for food grown and sold in Ontario. (Labeling laws however, will reference the Canadian Organic Standard and require certification within the province on products at the grocery store.) Certification is required if a food crosses a provincial boundary or carries the Canada Organic logo. The Canadian Food Inspection Agency reserves the right to inspect farms if the farm chooses not to certify.

The new regulations regulate the use of the term Canada Organic, as well as the terms "organic", "biodynamic", "biological", "ecological", or words of similar intent. Farms will be inspected by officers who work for accredited certification bodies. Farms have to maintain organic growing practices and keep a paper trail for auditing purposes.

The Canadian Organic Standard

The new regulations – which come into full force on June 30, 2009 – are designed to:

- make marketing and trade of organic products easier
- protect consumers against deceptive labeling practices
- help to develop organic markets by using a single organic standard

Certification

Under the new regulations the Canadian Food Inspection Agency (CFIA) will oversee organic certification including both accreditation and certification bodies. Accreditation means that the CFIA authorizes private certifying agencies to enforce the government's organic standard.

According to the new rules, (that come into effect June 30, 2009) certifiers have to be accredited by the Canadian Food Inspection Agency (CFIA) in order to certify farms as organic. Prior to the new regulations, each certification body maintained its own standards for organic certification. The standards were mostly similar but they also had some specific differences. Some certifying bodies are provincial, others international, and still others certify certain types of organic growing methods (Demeter certifies biodynamic farms, for example). Under the new regulations, all organic products could continue to say "organic", or "biodynamic" or "Canada Organic," for example, but they must all follow the Canadian Organic Standard.

Certified or not

The choice to be certified depends on the cost, on the farm's market, and on the farmer's philosophy regarding the connection between farmer and eater. Some CSA and direct-market farms choose not to certify because the customer can see and ask the farmer directly how food is grown. Wholesalers and processors however, will not buy organic produce unless it is certified.

The cost of certification depends on several factors including the transition year that the farm is in, the size of the farm, and whether the farm has organic livestock. It also depends on the certifying body. Some base their fees primarily on acreage; others may have different criteria. On average, a small farm can expect to pay at least $500 a year for certification.

PROS AND CONS OF CERTIFICATION

Pros	**Cons**
Allows for confident advertising; it is required for all products labeled organic Adds value to the farm's products, which can help a farm's bottom line Increasingly, consumers want and trust organic food. A label indicating certification can be the first step in gaining a new customer Supports the farmers who are already certified Many farm organizations and farmers have invested significantly in the development of the Canadian Organic Standard.	Certification fees Time to fill out forms Time and capacity to keep records of field activities and purchases Need to receive approval from certifying body before application of any restricted-use inputs Time for inspection Possibly extra time required for field work

Certification Steps

1. Define your market for organic products; local, national, international.

2. Select the certifying bodies that will work with your market.

3. Contact a few different CBs and compare what they offer to choose the best CB for you. Consider their familiarity with your type of operation, the cost for your type of operation, the type of application they use (are the forms straightforward?), how they communicate (do they prefer forms to be faxed, but you don't have easy access to a fax machine?), and other farmers' experiences with them.

4. Get an information and application package.

5. Throughout the year, take clear notes of your field activities and purchased inputs, according to the requirements of the CB you have selected. Ensure that all of your operations are in accordance with the organic standard. Your certifying body will be able to answer any questions about eligibility of your operations for organic certification, provide you with references for the Canadian Organic Standards, and help you to understand the implications of the standards for your operation.

6. Complete your application by the CB's deadline, in a clear and understandable fashion.

7. Once you have submitted the application form, the certifier will contact an inspector who will make an appointment to conduct an inspection. The inspector will verify information on the application form, tour the fields and facilities, and will audit production records. Having clear records of your field activities and of your purchased inputs makes inspection and certification an easier process.

8. The report will be reviewed, and a decision on whether certification is granted will be made by the certifier's evaluation committee.

9. Your certification lasts for one year, so you will need to apply for certification annually. Continue to keep good field and purchase records as required by your certifier and the second application should go smoothly.

Answers to Introductory Activity

1. **True** Yearly application and annual inspection are required.

2. **False** As of October 2002, every farmer in the USA using the word "organic" must be certified to the National Organic Program (NOP) rule. Farms whose gross sales are under $5000 do not need to be certified. They must however, still follow the rule.

3. **False**

4. **False** This is called "parallel production" and it is forbidden under the Canadian Organic Standard. During transition, a farm can have a "split operation; organic and non-organic production for different crops that can be kept separate during production, storage and transportation. The National Organic Program in the US does not use the term "parallel production", and makes no restrictions about organic and non-organic production.

5. **False** Use of the logo is voluntary.

6. **True**

GOING FURTHER

1. Is your farm certified? What prompted this decision?

2. Which certifying bodies will work with your market?

3. What is the annual cost of certification? (If possible, review a certification application as well as the inspection report for a certified farm to get a sense of what's involved)

NOTES

Chapter 11
The Local Food System

Introductory Activity

Although many of us claim to prefer locally produced food, it is almost certain that our diet contains many imports. There are advantages and disadvantages to both local and imported food. Think about the reasons behind our food choices. Brainstorm, and fill in the chart below.

	Advantages	**Disadvantages**
Local food		
Imported food		

WE ARE WHAT WE EAT

To eat in the modern world is to participate in the global food system. Our olive oil comes from Italy, our basmati rice from India, and the flour in our pancakes from Saskatchewan. Much of what the typical consumer eats has traveled an average of 2500 km and changed hands numerous times before it arrives on the table. When we don't know the source of our food, it's hard to grasp the impact on the environment of its production, processing, and transport.

Community Supported Agriculture is a response to this loss of connection. CSAs strive to bring the grower and eater closer together. Many farmers are concerned about how they grow food, who consumes it, and how it reaches the community. The revival of local farmer's markets and the spread of CSAs and of roadside stands challenges the global food system. It embodies the ethic of creating bonds of place and community by supporting the farmer down the road. It means watching the weather and learning how to eat seasonally. Selling to local consumers is an opportunity to educate people about the food in their own backyard.

Supermarket food is cheap because it's highly subsidized. Large-scale commodity farmers often receive direct subsidies. Government dollars pay for irrigation canals, dams, and for the highways that are used to transport food, and cheap energy subsidizes the cost of fertilizers, packaging, and refrigeration. We all pay the costs of air and water pollution that the system produces. If these costs were included in the price of food, the 2500 km dinner would be far more expensive than a meal made with local food.

Organic agriculture propels us toward more local food production. It is built upon the principle of working with the soil and knowing your land. There is no such thing as a global agricultural ecosystem. Every farm is different and farmers have to be responsive to their own land and ecosystem. This kind of experience and know-how is enormously important in organic agriculture and is deeply rooted in the local. Agricultural knowledge that comes from the lab or test plot can carry the organic farmer only so far. It cannot take the place of careful observation, trial and error, and familiarity with a particular farm. The farmer is the keeper of local knowledge and craft.

The Future of Food

The success of organics in the last 20 years has exposed the split between those hoping to tap into organic agriculture's growing economic niche and those in a grassroots constituency who remain committed to small-scale farming. Whether organics evolves in a way that is consistent with its original goals and principles or transforms into something more akin to the conventional food system, remains to be seen. In either case--large scale or local--it's the action of eaters that shape organic food distribution. When the economics of cheap

"If you ate today, thank a farmer"

-- Ontario bumper sticker

imported food change (due in part to the rising cost of fossil fuels) eaters will have no choice but to consume less imported food and eat more locally. Doing so will go a long way in creating a food system that is not just free of synthetic chemicals but also brings us back to a relationship with our land, our neighbours, and our farmers.

GOING FURTHER

1. How do you balance organic and local food purchases in the winter season? What are the advantages and disadvantages of your choice?

2. At the end of this season, what does the word "organic" mean to you?

3. After working on a small-scale farm, do you feel this form of organic agriculture is viable? Consider economics, ecology, and human resources to reflect on the sustainability of the enterprises on your farm.

Local Food Systems and Organic Agriculture: My Future

Use the chart below to begin to map your future plans and how to get there.

Looking ahead...	**Goals**	**Opportunities & ways to meet goals**
6 months		
1 year		
3 years		
5-10 years		

NOTES

Glossary

Words that are underlined in the main text are defined below.

Annual (Ch.8): Any plant which lives for only one season.

Aggregation (Ch.2): Clumping together of soil particles into light, porous conglomerates. Aggregation produces a soil with greater pore space and thus better aeration and greater water holding capacity. Humus is the principal glue that holds these clumps together.

Applied biological control (Ch.7): The intentional release of living organisms into a farm ecosystem, in order to control a specified pest.

Basic soils (Ch.2): Soils that have a pH above 7. Soils with a pH below 7 are acidic. The pH of any solution is determined by the relative proportions of hydrogen ions (H+) and hydroxyl ions (OH-). Basic soils are also called "alkaline".

Blind weeding (Ch.9): Dragging an implement over a seeded field that scratches the entire surface of the bed, including crop rows. These implements are light enough that they do not destroy the crop but destroy very small weed seedlings.

Cover crops (Ch.4): Crops which are planted not for their potential harvest, but for soil building, erosion control, nutrient management, or weed control purposes.

Crop residues (Ch.9): are the plant materials that remain on the soil after the crop has been harvested (stalks, stubble, vines, etc.).

Denitrification (Ch.4): A step in the nitrogen cycle where nitrate (the form of nitrogen that is usable by plants) is converted back into nitrogen gas and out of the soil.

Direct-seeded crops (Ch.8): Crops for which the seeds are planted directly into the field, rather than being seeded in a greenhouse and transplanted into the field.

Fallow (Ch.5): To take a field out of production. The term can refer to leaving the field totally bare, through repeated tillage (as in "summer fallow") or leaving the field in cover crop or weeds (the latter not recommended).

Floating row covers (Ch.7): Long sheets of spun or lightly-woven fabric (usually polyester) that are draped over crops to keep them warm, to protect against frost, and as a barrier to insects.

Green manure (Ch.4): A crop that is planted in order to increase soil fertility; usually with nitrogen. Green manures are incorporated into the soil to provide nutrients for the next crop.

Hardpan (Ch.9): A layer of compacted soil that may form just below the depth of ploughing. Heavy field traffic compacts soil, and ploughing only breaks it up again down to a certain depth. Deep implements and certain deep-rooted crops can break up a hardpan to allow the movement of moisture and nutrients from the subsoil.

Humus (Ch.2): The stable form of soil organic matter. It is formed from the decay of plant or animal matter in the soil. Humus is important for holding plant nutrients to soil particles until they are taken up by the roots.

Incorporate (Ch.4, 9): To take plant material on the surface and mix it in to the soil such as through ploughing or rototilling. See “turn under”.

Lime (Ch.3): A mineral source of Calcium that can help neutralize acid soils, i.e. raise soil pH. Agricultural lime is Calcium Carbonate ($CaCO_2$), which is commonly used by organic farmers. Lime forms include calcitic lime, which is different from dolomitic lime, which contains magnesium. Dolomitic lime is generally not recommended unless the soil is deficient in magnesium. Otherwise, excess magnesium can displace calcium in the soil, which is needed by plants in much greater amounts. Ideally, a balanced soil has a calcium:magnesium ratio of 6:1. Dolomite has a Ca: Mg ratio of 2:1 – too much magnesium. Calcium oxide (CaO) is a white powder obtained by heating limestone (calcium carbonate), which is not permitted in the Canadian Organic Standard.

Loam (Ch.2): Soil that is made up of the ideal mixture of sand, silt, and clay. This mixture of particle sizes produces a soil well suited to plant growth.

Nitrogen leaching (Ch.4): The washing away of nitrogen through the soil, before plants have an opportunity to use it. Because soil nitrogen is usually in the form of nitrate (an anion), it is not held by soil particles and is thus more prone to leaching than other nutrients.

Nitrogen fixation (Ch.3): The transformation of atmospheric nitrogen gas (N2) into a water soluble form that plants can use, such as nitrate (NO3-), or ammonium (NH4+).

No-till (Ch.9): A method of crop production in which crop residues are left on the surface of the soil, and the following crop is planted amongst these residues. By leavings residues on the surface rather than tilling them in, soil erosion can be reduced.

Perennial (Ch.8): Any plant which lives for more than two seasons.

Pore space (Ch.2): The space between soil particles. In ideal circumstances, about half of the volume of a soil will be pore space and half of this space will be filled with water.

Potting soil mix (Ch.4): A soil-like product used for starting seedlings in pots or seed trays. They are generally made with mixtures of peat, compost, and other nutrient-rich organic materials.

PTO (Power Take Off) (Ch.9): A shaft, connected to the motor of a tractor and protruding from the rear. Any implement that requires power--rototiller, snowblower, pump, or generator-- can be attached to it, allowing the tractor motor to provide the power.

Raised bed (Ch.9): Making the seedbed higher than the aisles or tractor tracks. In home gardens, beds may be raised with wooden walls, but on farms the beds are generally mounded up with a tractor-pulled implement. Raising beds encourages drainage and warming of the soil in the spring.

Seed bank (Ch.8): The weed seeds present in a soil at any time. Since some seeds can survive for many years, the seed bank may be the result of many years of seeds being deposited on the soil.

Smother crop (Ch.5): A crop that is planted not for the potential harvest, but in order to grow quickly and thickly in order to smother weed seedlings.

Stale seedbed technique or Stalebedding (Ch.8): Repeatedly tilling the soil shallowly so as to reduce weed seeds in the cultivated layer. Tilling encourages weed seeds to germinate, and the seedlings are killed by the next tillage.

Structure (Ch.2): The physical condition of the soil. Soil texture, pore space, and aggregation contribute to its structure. Worm channels and channels from decayed plant roots are both part of the soil structure. Soil with good structure holds moisture yet drains well, has good aeration, and allows roots to penetrate easily.

Surface pan (Ch.9): A layer of compacted soil on the surface, generally caused by rainfall on soil with no plant cover. A surface pan prevents water from soaking into the soil, resulting in runoff and erosion.

Soil texture (Ch.2): The relative proportions of sand, silt and clay that make up a soil. It therefore describes the sizes of the rock particles that make up a soil.

Tilth (Ch.2): The state of aggregation of soil and its condition for supporting plant growth. Soil with good tilth, is well aggregated and generally well-suited for plant growth.

Top dressing (Ch.4): Any amendment applied on top of the soil, next to the plant, after the plant has established.

Trap crop (Ch.7): A crop that is planted not for its harvest value, but in order to lure a certain pest away from an economically valuable crop. The trap crop is eaten by the pest, while the harvested crop is spared.

Turn under (Ch.4): To take plant material on the surface and mix it in to the soil through ploughing or rototilling for example. See "incorporate".

Underseed (Ch.5): To plant a cover crop in the same bed as a crop intended for harvest. Often, cover crops such as clover are seeded into grain fields before the grain is harvested, so that the clover has more time to establish. Clover may be underseeded into a squash field in order to smother weeds.

Windrow (Ch.4): A long pile of composting manure, on the soil. A common method of preparing solid manure for field application is to transport it in a manure spreader to the field edge, and pile it into these long rows for composting. The term windrow is also used with other constituents, e.g. to windrow plant material such as straw before it is collected for some purpose.

Worked in (Ch.9): To take plant material on the surface and mix it in to the soil through ploughing or rototilling for example. See "incorporate".

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Additional Resources & Internet Links

Technical Assistance

ATTRA Appropriate Technology Transfer for Rural Areas
www.attra.org

Sustainable Agriculture Network and Sustainable Agriculture Research & Education
www.sare.org

Natural Resource, Agriculture & Engineering Service
www.nraes.org

Growing for Market
www.growingformarket.com

Compost Council of Canada
www.compost.org

Next Step

Canadian Farm Business Management Council
www.farmcentre.com

Step UP – Farm business management internships
http://www.farmcentre.com/Features/TheNewFarmer/Resources/StepUp/

The New Farmer
http://www.farmcentre.com/Features/TheNewFarmer/

Collaborative Regional Alliance for Farmer Training - CRAFT Ontario
www.craftontario.ca

Stewards of Irreplaceable Land (SOIL)
www.soilapprenticeships.org

Farmers Growing Farmers – Everdale Farm and Environmental Learning Centre
www.everdale.org

FarmStart
www.farmstart.ca

Ontario Ministry of Agriculture and Rural Affairs
www.omafra.gov.on.ca/ - for resources and funding

Support Organizations

Alternative Farming Systems Information Centre
http://afsic.nal.usda.gov/nal_display/index.php?tax_level=1&info_center=2&tax_subject=286

New England Small Farm Institute
www.smallfarm.org

Growing New Farmers
www.growingnewfarmers.org

International Federation of Organic Agriculture Movements
www.ifoam.org

Canadian Organic Growers – numerous publications & on-line lending library
www.cog.ca

Ecological Farmer's Association of Ontario
www.efao.ca

International Organic Inspection Agency
www.ioia.net

Organic Agriculture Centre of Canada
www.organicagcentre.ca

Rodale Institute
www.rodaleinstitute.org

Food Security Organizations

Equiterre
www.equiterre.org

FoodShare
www.foodshare.ca

LifeCycles
www.lifecyclesproject.ca

Farm Folk, City Folk
www.farmfolkcityfolk.ca

City Farmer
www.cityfarmer.org