

How Can You Improve Soil Health?

Participants can explore testing the soil and understanding the results but then what???

TEACHING OBJECTIVES: WHY DO THIS?

- Gain working knowledge of how soil testing builds your understanding of the soil
- Try out the samp;ling and testing process with a lab of your choice
- Select activities that focus on points the farmers seek to improve their soil
- Gain knowledge to know what inpts the soil needs.

BEST LOCATION

The soil test needs to be done in a field then understanding results can be indoors where discussion can be held those observations in activities.

BEST TIME OF YEAR

Testing the soil can be done when it is not frozen but best to do same time each year or each time tested.

LEARNING OBJECTIVES: WHAT CAN PARTICIPANTS LEARN?

- This module will guide learners to estimate how well the soil can grow crops.
- Students will experience the process to sample soil and send it to a soil lab for analysis.
- Students can observe how tillage affects the soil to guide them to make smart decisions on soil management.
- Students will explore what practices can improve crop production AND soil health.



IMPORTANCE FOR BEGINNING FARMERS

- Becoming familiar with the soil on your farm will guide you to plan for success.
- Understanding how practices affect the soil will help to plan which practices to include or modify to meet farming goals and improve the soil.
- Becoming familiar with possible inputs to the soil to meet nutrient needs of the crops and improve the soil's health

UNIQUE ASPECTS OF THE CURRICULUM

- Most important part of farming. If soil is not good, the crops will not be good either.
- Chance to share and learn from reallife situations and one another.
- Learners will be able to make unique choices for farm changes depending on their specific farm goals and access to resources.

Facilitator Planning & Preparation

Activity	Est. Instructional Time
Testing your soil for nutrients	30 Min
Selecting a soil lab	30 Min
Understanding your soil test results	2-3 hours
How to plan soil inputs: Fertilizer & Compost	1 Hour



Technical Content

KEY WORDS:

- Organic soil amendments. These are inputs such as compost, manure, worm castings, and adding plant materials (especially legumes) back into the soil. They provide nutrients like NPK and organic matter to improve the soil health.
- Chemical fertilizers. Contain a specific amount of NPK so you can easily add what is needed to the soil based on the soil test and crops' needs. They quickly provide the nutrients to the crops once added to the soil
- Soil Health This is the state of soil that farmers work towards and it includes improving the soil in terms of its biological, chemical and physical state. Soil is manged through smart tillage and needed inputs are added such as compost, fertilizers and manure. To improve the physical conditions tof he soil is "covered" by growing cover crops when crops are not growing

FACILITATOR BACKGROUND INFORMATION:

Managing farm soil is a slow and continuous process. Management requires adding enough nutrients for the crops but the bigger challenge is to manage the soil to reduce problems.

Soil is made of sand, silt and clay. This is known as the soil's texture. This cannot be changed EVER. But by adding good quality inputs like compost and manure and growing cover crops the soil's health can be improved and grow better and healthier crops. These inputs can be added each year, and how much depends on what is already in the soil (nutrients) and the needs of the crop to be grown.

Learners can gain knowledge and experience to test the soil and what to look for across the field. With the test results they will gain insight to understand what the soil test indicates and how to use the information to improve the soil and crops. Overall, this curriculum will improve farmers' understanding of how to better manage the soil through inputs and growing cover crops.



FACILITATOR BACKGROUND INFORMATION (cont.):

Soil health seems complicated since we cannot see it. It is a combination of actions to improve the soil from practices, to inputs and testing. We encourage the learners to "build" soil health and "assess" soil health but how to do that without seeing it as a thing can be difficult. We can not forget that every soil is different even within the same field or garden. We need to be aware of this uniqueness and not expect the same growing results from one soil to another. Growers also need to be aware of what that their plants need and consider how to manage the soil to meet these needs. For example you would not plant a desert cacti in a cool wet environment so why should you plant a crop that likes course textured sandy soils (very well drained) in a fine loamy soil and expect it to thrive. With that being said there are some steps and practices that can be taken to ensure that our soil is healthy for crop needs.

First, we need to consider is how we can promote healthy soils before we know what the current health of the soil. Soil health can be determined by the plant's health, from leaves to roots, how the soil is managed from year to year and what is the soil's texture. Sandy soil is more difficult to improve than a loamy soil.

But the real test is how well the soil supports plants growth in that environment. Healthier soils will:

- hold water in droughts
- drain water when there is too much rain
- hold plant nutrients in the soil reducing nutrient loss and keeps them in the root zone for plant use
- feed soil microbes that eat organic matter and break it down (such as mowed cover crops) releasing soil nutrients for plants' use



FACILITATOR BACKGROUND INFORMATION (cont.):

Organic matter is the primary ingredient to make a soil healthy. Organic matter, such as green plant material needs to be added to the soil on an annual basis. It provides nutrients and feeds soil microbes. Organic matter is slow to break down and free up nutrients but it adds to the "pool" of organic matter feeding plants and soil microbes this year and eventually some in years to come. These microbes live in the soil and continue to feed on plant and root material improving the soil, over time.

Organic matter is measured as a percentage and the amount in a soil can be calculated by soil labs when they test the soil. It is important to note that depending where you take the soil sample in your field, the organic matter can be different. therefore it is important to take a soil sample (made up of several trowels of soil across the field) and take separate soil samples when there are sharp differences in the soil texture in a single field. This is another reason it is important to ID the soil texture to determine if you need to send in more than one sample per field.

The typical range of soil organic matter is typically between 1.5-4% and is noted in a soil test. For organic matter to increase it takes careful management and regular use of organic materials such as compost and manure or growing cover crops, crops. Rather than harvesting cover crops they are either turned into the soil or their top (canopy) can be removed through other means such as chemicals, grazing, mowing, or even burning. This plant material, especially roots, feed soil microbes that in turn excreted (poop) materials into the soil that have plant nutrients and slowly produces soil aggregates. This will be discussed in the soil aggregation activity later in this module.



FACILITATOR BACKGROUND INFORMATION (cont.):

Approaches to improving soil can provide several benefits but the improvement takes time.

Here are some practices farmers can use to improve the soil. Adding manure and compost provide food for microbes that help provide plant nutrients. Although its a quick way to feed the soil it requires time to break down, as with any organic soil input. Planting cover crops do take a little more time and work but they give several more benefits. Their roots hold soil, reducing erosion. The roots grow for several months a more steady supply of food for soil microbes. The above ground parts even provide a wind break, another erosion reducer. Of course they also provide organic matter as they break down. So adding manure and/or compost plus growing cover crops when there is a break in vegetable production is a real gain toward soil health.



FACILITATOR BACKGROUND INFORMATION (cont.):

Manure is a good source of nitrogen and phosphorous. When it is fresh or has not been made into compost is should be added to the soil at leas 120 days before harvest. So 4months before harvest of vegetables typically means it should be applied either late fall or early spring. When added to the soil it is best to turn it into the soil and not let it set on the top of the soil, to reduce loss of nutrients. If you are in an area that often get frequent rain in the spring, your best option may be to add manure in the fall. It is important NOT to till or turn the soil when it is wet as that damages the soil's structure, break aggregates that are important to protect organic matter.

Compost can be made with manure mixed with a carbon source such as dry leaves or dry grass . A form of compost can also be made from only vegetation such as dry leaves and legumes (nitrogen fixing) plants like alfalfa or bean plants. Compost is a good option to add plant nutrients at any time of the year, even when crops are growing.

Plant nutrients from organic sources do provide nutrients to plants, but slowly. It takes about 2 months before any organic material (cover crops, compost, manure, vermicompost) starts to release nutrients since it takes time for the soil microbes to do their job-feeding on the organic matter to release nutrients. AND **chemical fertilizers when calculating the application to the field**. Here is an online calculator so you know the amount of nutrients you apply to the soil, based on type of soil input. https://extension.oregonstate.edu/catalog/pub/ em-9235-osu-organic-fertilizer-cover-crop-calculator-predicting-plant-available



KWL Process

Know, Want to Know, Learn

Suggested prompting questions for farmers to share from their experience:

- How would you describe the soil on your farm or garden?
- Share how you have managed and added to the soil since you started farming or how you plan to manage it.
- Which inputs do you favor over others to the soil? Why?
- What do you believe are the challenges to grow vegetables given the quality of your soil?
- What equipment do you have or hope to use for your farm? What will be the "job" of the equipment?

Suggested prompting questions to find out what participants want to learn:

- Why do you do a soil test every so often on your farm? What is the purpose?
- What is your greatest farming challenge that impacts crop improvement?
- What soil management practices have you heard about that you would like to learn more about?



Primary Activities

Overview of the main activities in this module

Activity 1

Testing Your Soil for Nutrients

Knowing how to take a soil test is very important to grow productive crops. If a soil test is not taken correctly the results could be incorrect and farms could over or under fertilize their crops. This not only could reduce yields and income but this could also harm the environment, especially the ground water.

Activity 2

Selecting a Soil Lab

There are many labs that test soil. Producers need to carefully choose a lab that is certified and located in their general eco-zone (eg. Midwest, USA).

Activity 3

Understanding Your Soil Test

Understanding what nutrients are in each bag of fertilizer is needed to be sure you are adding only what the crops need. Adding too much and you have problems with nutrients leaking into the ground water. Too little and the crops are not as healthy. Each bag of fertilizer or compost will say the percentage of each nutrient (NPK plus micro nutrients).

Activity 4

Planning for Soil Inputs: Fertilizer & Compost

Then depending on your soil test results you can calculate how much to put on the field. Nutrient inputs include manure, compost, fish emulsion and of course mineral fertilizers like (N)nitrogen, (P)phosphorous, and (K)potassium (NPK) and urea which is high in nitrogen



1. Testing Your Soil for Nutrients

OVERVIEW

Before you grow a crop, it is important to know the status of the soil:- that is, how much of each nutrient is in the soil what is needed for good crop production? What is the pH? What is the % organic matter (OM)? What is the soil texture? A soil test or analysis will give you this information but first the soil sample must be collected. Collecting several small samples from across the field then combining them will provide a more sure results of what the whole field needs.The test results will help you understand if it is adequate to grow healthy crops.

MATERIALS NEEDED

- Soil probe or shovel
- A clean bucket to collect the samples of soil
- A plastic bag to place the sample(s) in
- A label to place in the bag with the soil with name, date, field name and contact info of farmer.



FACILITATOR BACKGROUND INFORMATION

Soil can be very different even within the same field. So it is important to determine if more than one test-sample should be collected for soil analysis. Take a soil sample (collection of 10 soil probes or trowels and mixed) for each area that is very different from other parts of the field. Send each soil sample for a soil analysis. The test results may be different, needing different inputs and management. Soil samples should be collected from across the field to get a representative sample.

To decide if you need more than one sample to submit per field (each will be analyzed by the lab separately) consider where there are extreme differences within a single field if:

- Soil texture
- Drainage
- Crop health

Are very different within the same field.

Review the following to better understand crop nutrients and when to add them to the soil.:

https://ucanr.edu/sites/Nutrient_Management_S olutions/stateofscience/Meet_Crop_Nutrient_Re quirements/



1. Testing Your Soil for Nutrients

PROCEDURE

- Refer to your field map that you made when doing observations of your field. If you did not draw a field map take a few minutes to sketch out your field, noting where each crop grew last year and what will grow this year. Then identify areas that are troublesome or unique that may need a separate soil test done. These areas can include very weedy, drains very slowly, or very dry (all compared to the other parts of the field.) These areas should be sampled and analyzed separately. If there are no differences in the field and if the field is less than 3 acres then a single soil sample is adequate. Note a soil sample is made up of several small samples (sub-samples) then mixed together. This helps to get an even sample from the entire field or area being tested.
- To begin the soil sampling, brush away debris on the soil surface, dig straight down into the soil (try for at least 6 inches, -consider where roots grow) and collect the soil and place this into the bucket. This is one subsample of the whole sample. You should now collect at least 9 more and place in the same bucket.
- Continue to collect at least 10-15 sub-samples from across the field, spacing the soil collection sites to cover across the field (as per diagrm below).Do in any shape but cover the field. Here you see a "W".



1. Testing Your Soil for Nutrients

PROCEDURE (cont.)



Space the soil sub-samples to cover the whole field. Each --> represents where you collect 1 sub-sample.

- Take the bucket of soil with the 10-15 sub-samples and remove all rocks, leaves and roots, then break up any soil clods.
- Mix the soil well.
- Fill a quart size bag with this soil from the bucket.
- Label each bag (per field or per area of the field that will be tested) for you and for the soils lab. Include field or field section name, your name, date, email address, address and phone number.
- Try to sample the field the same time of each year soil .



1. Testing Your Soil for Nutrients

DIVE DEEPER

- Once you collect your soil samplel compare the steps you took with the other learners. Ask:
- How many shovels or cores of soil did you take?
- What pattern did you follow to collect the soil?
- Do you think you need to collect more than 1 sample to send in? Why this decision?
- Where will you send the sample for analysis?

VARIATIONS

Ask a farmer in the area if you can visit their farm when they do a soil sample

Ask them questions about their process to collect the soil

Ask how the soil has tested in years past

Ask what he/she/they have added to the soil to improve it

Ask why these chose each input

CONNECTIONS TO OTHER MODULES

- All of the soil activities can give you a new understanding as you learn more about the soil.
- Soil is the challenging to learn about, it is underground and the things we test we cannot see with your eyes.
- All parts to the soil curriculum will help you decide if the soil in a field that you may use is good to grow crops. It will also give you knowledge of questions to ask the owner about how well the crops have grown on that soil in the past and are there spots where water stands after rains.



OVERVIEW

First step is to select the lab where the soil will be analyzed. Soils test results typically take 2-4 weeks for the lab to send you the results .The results are based on what will be grown in that field. The information sent to you includes levels of nutrients in the soil, pH+, Cation exchange capacity, % organic matter, and the macro nutrients, potassium (K) and phosphorous (P) and recommendations of what to add to the soil. The information will indicate the actual amounts of nutrients to add to the soil The report will also show if there are any nutrients too high, ok or low for the crops you will grow.

MATERIALS NEEDED

Visit a couple of labs on the web : Each state often has one or more labs and its good to go with a local lab (of not in your state then in your region) as they know the local soil set set their lab standards to that. So either the facilitator or the learners can seek "soil testing labs in my state (or area)" on the WEB to see what is offered. Use the list you find to determine which lab is the best choice given the following points:



Bean plant lacking nitrogen



FACILITATOR BACKGROUND INFORMATION

Soil sampling is important to do, especially the first time the field will be planted with a crop by that farmer. It gives the farmer tested information of the level or status of the nutrients in the soil. Note that the most important nutrient, nitrogen, will not be listed on the soil text because it changes daily, if not hourly. As temperatures and moisture in the soil changes, microbes work at different rates to break down organic matter and make nitrogen available. This is how nitrogen becomes available to the plants when using organic matter like compost. Plant nitrogen leaches or escapes easily from the soil, so nitrate testing is not reliable. The best way to tell if a soil has enough nitrogen is by observing the plants. Are the plants dark green or pale? Pale indicates lack of nitrogen. User the soil test for other nutrients and pH. The lab will make suggestions to follow too.



Soil texture analysis in a soil testing lab





Procedure

If you have never had the soil tested by a lab you should take time to select the lab that best fits your needs. Consider calling or emailing them if you have questions beyond what they share on their website. If you had the soil tested before and are happy with the results its good to go back to that lab so the soil analysis process is the same.

Which lab you choose to do the soil analysis is up to you. Questions to consider:

- Is the lab located in your region? Labs choose the best testing methods for your area's soil types then adjust their testing methods. So choosing a lab in your area is best.
- Do they provide good guidance on their WEB site how to collect and send soil sample?
- Does the lab provide the results in your preferred style (electronic, paper).
- Do they do the tests that you are seeking (maybe lead testing is needed or other less common tests?)
- Do they offer customer service to explain results if needed?
- What is the cost for the service?
- How long will it take to get the results?

Visit this site to find a soil testing lab that matches your needs : https://www.canr.msu.edu/news/testing-for-contaminants-in-soil-water-and-plants

Procedure (cont.)

Which tests you select can depend if your field had an old house or building on it. (common for urban farms)

- Selecting which tests that you want the soils lab to run may be confusing when reviewing what the soil lab offers. Read their descriptions found on thier WEB site or infopacket. If you still are not sure you can call them and they can offer guidance. Typically, the most common package includes pH+, phosphorous (P), potassium (K), Cation exchange capacity (CEC), and % organic matter (OM). You may have to pay extra for additional tests. If you have been told a crop is lacking in a micro-nutrient (based on how a plant looked while growing) by someone or you suspect a deficiency based on last year's crops you can request the micro-nutrient in question to be included in the test. Note that test does cost extra.
- For land that is located in rural areas, Typically the standard soil test for crops is adequate. This would include determining the levels of nutrients, CEC and pH+ as noted above.
- For land in urban areas and If the land was used for non agriculture purposes in the past then you may want to include a test for heavy metals as described for in the Land Assessment in the urban land section (LINK?).

Procedure (cont.)

Possible soil contaminants: If your testing soil in an urban area you may want to not only have the soil tested for the standard crop nutrients but also check for the presence of chemicals (heavy metals) that can be harmful to humans such as lead, arsenic and mercury. Pre -1975, lead was used in house paints and gasoline. Now when older houses are demolished or even refurbished the paint is scraped and ends up in the soil, posing a risk to humans. Its small paint chips or dust can be inhaled while working in the soil, and the heavy metals can be carried into the plants through their roots. See the module on Land Access and Selection (link) for additional details on management of soil with lead and other heavy metals.

Houses pre 1975 contain lead in the paint When remodeled or torn down, paint chips-dust can be inhaled or contaminate garden soil- and taken up by plants.

Sample of an application form and test results from one company

COUNT NUME	BER							a	&		РС В С		RIES				3505 Cone Fort Wayne 26 algrea	stoga Dr e, IN 468 0.483.47 itlakes.co
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	SUBMITTED E	8Y								REFEREN	CE INF	ORMATION			RE	PORT OPT	ONS	
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							Fa	rm /	Locati	on					Graphic Repor	t (1 sample p	er page)	
							Fie	eld /	Site						Field Summary	Report (fi	eld average)	
							E-	mail	Addre	s				-	Other report sty	yles availat	ole, please inq	uire
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(max 10 char)	(lab use only)	S1	S1A	S1B	52	53	S 5	S6	S7	OTHER TESTS	R	Previous Crop	First Crop	Yield Goal	Second Crop	Yield Goal	Third Crop	Yiel Goa
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	EXPLANA	TION	NOF	SOIL	TES	T PA	СКА	GES					ADDIT	IONAL TES	TS OR INFORM	ATION		
- Organic i A - S1 plus B	EXPLANA matter, P, K, Mg, C iray P2	a, so	N OF il pH,	SOIL , buff	fer p	T PA H, C	EC	SS SS	- S, Zn - S, Zn	, Mn, Fe, Cu, B			ADDIT	IONAL TES	TS OR INFORM	ATION		
B - S1 plus s	odium bicarbonate	P						56	- S, Zn	, Mn, B								
- S1 plus s	oluble salts and so	dium	1					57	- Zn, M	An, B								

Complete a form similar to this one to submit the soil for testing

3505 Conestoga Dr. Fort Wayne, 1N 46808 260,483,4759 algreatlakes.com

For: GROWER NAME

To: COMPANY NAME 1234 STREET NAME CITY NAME, US 46804

Farm: FARM NAME Field: FIELD NAME

Date Sampled: 9/22/2015 Date Received: 9/24/2015 Date Reported: 9/25/2015 Page

	Attn: CO	NTACT	AME			SOIL T	EST REP	ORT			Date Rep	orted: 9	/25/20	15	Page: 1	of 2
Sample	Lab	Organic	Phosph	orus	Potassium	Magnesium	Calcium	Sodium	Soll	Buffer	CEC	Ş	Percent C	ation Satu	ration	191
ID	Number	Matter	Bray-1 Equiv ppm-P	Bray P2 ppm-P	K ppm	Mg ppm	Ca ppm	Na ppm	pH	pH	meq/100g	NK	% Mg	% Ca	хн	%Na
1	1001	2.8	90 VH	126 VH	198 н	245 н	1550 м	15 VL	7.0		10.4	4.9	19.7	74.8		0.6
2	1002	1.4	123 VH	165 VH	147 н	90 H	500 L	15 vi	6.1	6.9	4.9	7.7	15.3	51.1	24.5	1.3
3	1003	1.5	103 VH	155 VH	155 н	115 н	700 M	15 vi	6.1	6.9	6.1	6.5	15.7	57.2	19.6	1.1
4	1004	2.3	58 VH	86 VH	209 н	260 н	1250 M	15 vi	6.7	6.9	10.2	5.2	21.2	61.2	11.7	0.6
5	1005	1.1	89 VH	103 VH	133 н	90 н	750 н	15 vi	6.9	887852316	5.0	6.8	15.1	75.3	1.5	1.3
6	1006	2.1	46 н	69 н	174 н	185 н	1150 M	15 vi	6.6	6.9	9.0	5.0	17.1	63.9	13.3	0.7
7	1007	2.1	67 VH	93 VH	240 VH	200 н	1150 M	15 vi	6.9	2012/2021/0	8.2	7.5	20.3	69.9	1.5	0.8
8	1008	2.3	76 VH	97 VH	186 н	145 M	1050 M	15 vi	6.2	6.9	8.2	5.8	14.7	64.0	14.6	0.8
9	1009	1.8	39 н	42 M	102 M	140 M	1050 M	15 vi	6.7	6.9	7.9	3.3	14.7	66.1	15.1	0.8
10	1010	2.3	49 н	61 н	181 н	310 н	1800 M	15 vi	7.6		12.1	3.8	21.3	74.3	20 30	0.5

Sample ID	Sulfur S ppm	Zinc Zn ppm	Manganese Mn ppm	iron Fe ppm	Copper Cu ppm	Boron B ppm	Soluble Salts mmhos/cm	Nitrate NO ₃ -N ppm	Ammonium NH4-N ppm	Bicarb-P P ppm	Chloride Cl ppm	Comments
1	8 м	5.9 н	50 VH	70 VH	1.6 н	0.6 м	0.3 VL	16 M	81	45 H	50 L	1
2	9 м	5.3 н	41 н	60 VH	1.0 M	0.2 VL	0.1 vi	18 M	9 1	62 VH	41 L	
3	8 M	8.8 H	41 н	36 н	1.1 M	0.3 VL	0.2 vz	16 M	81	52 VH	41 L	
4	61	4.3 M	49 н	37 н	1.4 н	0.4 1	0.2 vt	12 M	61	29 н	49 1	
5	7 1	3.4 M	37 н	30 н	0.8 M	0.2 VL	0.1 vz	14 M	71	45 H	37 L	
6	5 1	3.9 M	44 H	34 н	1.1 M	0.3 VL	0.2 vi	10 M	5ι	23 M	44 L	
7	5 1	4.7 M	46 H	37 н	1.0 M	0.3 VL	0.2 VL	10 M	5 L	34 H	46 L	
8	6 L	3.8 M	48 н	41 н	1.0 M	0.2 VL	0.1 vz	12 M	61	38 н	48 L	
9	51	2.7 1	43 н	24 н	0.9 M	0.2 VL	0.1 vt	10 M	5 ι	20 M	43 L	
10	41	3.6 M	52 VH	22 н	1.2 н	0.4 1	0.2 vt	8 1	4 vz	25 M	52 L	

3. Understanding Your Soil Test

OVERVIEW

It typically take 2-4 weeks to get the soil test results. The results are based on what will be grown in that field. The information sent to the farmer (you) includes levels of nutrients in the soil, pH+, Cation exchange capacity, % organic matter, and the macro nutrients, potassium (K) and phosphorous (P). The information will indicate the actual amount in the soil sample and also if the amount is high, ok, or low based on the crops' needs.

MATERIALS NEEDED

- Soil test results
- Information provided with test results to guide your understanding
 - Look at the numbers but also the text that describes what the numbers mean referring to the amounts of nutrients in your sample.
- If the internet is available, visit the WEB site of the soil lab company as they often have fact sheets to help understand the test results. If not choose a handout offered on the next page to print out for the learners. (In Extensions)

FACILITATOR BACKGROUND INFORMATION

Getting soil analyzed on a timely basis is important so that there is time to adjust what you will or will not add to the soil.

Encourage each learner to try and understand as much about the soil analysis results using the information that was supplied by the soil lab and watching noted video or other resources listed. Then suggest a conversation about the sample soil test results and answer questions. If there is a question that cannot be answered perhaps call the lab and use a speaker phone so all learners can gain this knowledge. Help the learners to prepare the questions before calling so each learner has the opportunity to ask questions.

The soil lab that tested your soil can help when the information is not clear.

3. Understanding Your Soil Test

Procedure

After you submit the soil sample note the date. Review the information from the lab, either on the WEB site or if you received written information. How long did they estimate for your results? Note the day you send and start the countdown to receive the results. Note if you chose the option to receive the results via email it will be faster, and if you are computer savvy, easier to maintain this information year to year.

Once you receive the results read what the lab found from the soil test. Review what they offer for help on their WEB site. Then if you still have questions refer to the section on the next page called "Deeper dive". There you will find links to a YouTube and fact sheet to help you gain further understanding.

University Extension		So For l	il Test Re Lawns and	eport Gardens		Serial I H46	№. 109H-1	E	County Soone	Region
Columbia	23 Mum Columbi	ford Hall a, MO 65211	-MU Laborator o	P.O. Box	160 lle, MO	Submit	nted 27/2010	Proces	sed 3/29/2	010
	(573) 88	2-0623		(573) 379	-5431	http://w	www.soilte	st.psu.missour	i.cdu/	
ample ID: Home	garden I						Lab No:	CO10399	7	
ast Limed: unkno	wn		This repo Lawn Gare 1000 Univ Columbia,	rt is for: den Ave MO 65201						
	-					RATIN	G			
SOIL TEST	RESULTS		Very low	Low	M	edium	H	igh Ve	ry high	Excess
pHs	5.5		*********		***		10.00			
Phosphorus (P)	7	lbs/a	***							
Potassium (K)	191	lbs/a	********	********						
Calcium (Ca)	5253	lbs/a	********	********	******	*****	****			
Magnesium (Mg)	495 .	lbs/a	********	*******	*****		*			
Organic Matter:	2.6 %		Neutr. Aci	dity:	2.0 mc	q/100 g		CEC:	16.0	mcq/100g
		Fertili	izer & Limest	one Recommo	endations	(lbs/10	00 sq ft)		(0)	
rop		Nitro	gen(N) Phos	sphorus(P2O3)	Potasi	1 (K2O)	Zinc(Z	n) Suin	ir(S)	LIME
blueberries		. 12	0.3	4.0		1.0			0	100
omments:			1.0	4.0		1.0			0	0
**Fertilizer rates ar **The soil needs ad	e given in ditional or	pounds o	f actual nutrier	t per 1000 sq.	ft to be ap	oplied wns. Se	e MU Pu	blication G	6950. "S	tens in
ertilizing Garden So	oil" and Ge	956, "Manths to re	aking and Usin act with the so	g Compost". il. Apply lime	three to si	ix month	s before	planting.	, .	

This is an example of a soil report that the grower received. Each lab has a little different approach. So be sure to read it and the information they offer once you receive it to help understand the results and what you can do to improve the soil. If you still have questions you can call the lab for further explanation.

3. Understanding Your Soil Test

DIVE DEEPER

Visit this soil testing website of the lab where your sample is being processed.

Or go to <u>this link</u> for a handout for the learners.

Also for details of the value and why bother with a soil text this extension bulletin provides relevant information for gardeners and beginning farmers, <u>visit this link</u>.

<u>This is a video</u> that shows a soil test results with extensive explanations of how to read the test and how to determine what to add. Go to 5.16 minutes to get directly to the soil test T<u>his video starts with sampling</u> <u>procedures and ends with</u> <u>understanding the results.</u>.

if you rather use a paper version for this exercise refer to <u>this document</u> that describes the different sections of a soil test report.

<u>This handout</u> explains each test and what it can mean for your farming practices.

VARIATIONS

If the learners cannot get a soil sample from their own field you can:

- Seek a soil test results from a farmer you know or contact your local county extension office
- Use a sample test results that is provided in this activity and learn what do look for so learners can use this information when they get their own soil sample tested. To review, you can show one of the videos that discuss understanding a soil test found in "Resources".

CONNECTIONS TO OTHER MODULES

If the land had a building that was torn down refer to the Land Access Curriculum on Urban soils.

	(MSU) Extensio	n, 2016)										
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Resources for Soil Sampling, Soil Testing and Finding a Soils Lab

Resource 1

Steps from sampling soil to understanding the soil test results

This is a good video to show the whole process. Skip ahead to 5:20 minutes if you want to learn how to interpret the soil test. Later (11:07) it explains sources of the major nutrients (NPK) and the minor inputs such as sulfur, iron and calcium.

https://www.bing.com/videos/riverview/re latedvideo? &q=understanding+the+soil+test+results& &mid=3D80034569AFCDD129163D80034 569AFCDD12916&&FORM=VRDGAR

Resource 2

Soils labs in the Midwest area

Visit this site to help you select a soil testing lab. This list includes soil testing lab are across the US but its best if you can select a lab in or near your state so the soils they use for reference are more similar to your soil. If you cannot find a lab on this list near you you can look online and search for "soil lab near me" or call your local agriculture extension office.

https://www2.mda.state.mn.us/webapp/li s/soillabs.jsp

Resource 3

Anatomy of a Soil Test

This handout provides definitions of words referring to soil test results

https://www.canr.msu.edu/resources /the-anatomy-of-a-soil-test-report

4. Planning for Soil Inputs: Fertilizers

OVERVIEW

Learning how to understand a soil amendment label is the first step to determine what your soil needs and the amount of nutrients contained in each product. Learners will be able to determine how much of each nutrient is in a "bag" of fertilizer, manure, and compost so they can plan how much to apply to their garden/field based on their observations of the crops and the soil test results.

MATERIALS NEEDED

- Fertilizer Label Examples
- Fertilizer Calculations Sheet
- Fertilizer Calculation Examples
- Manure sample example
- Compost sample example

(There is a handout for learners for each of these materials)

FACILITATOR BACKGROUND INFORMATION

This activity will introduce students to fertilizer products and how to calculate how much of each plant nutrient they they contain and need to apply to their field (based on a soil test and observations). This activity will require basic math skills, a calculator and paper. If you do not have a commercial bag of compost or fertilizer with such a label you can find examples of one on the following pages in the photos.

The single most important way to maintain and improve soil structure is to add organic matter. Also, managing the soil environment (pH and fertility) is important to support microbes found in fresh organic matter that has been turned in the soil. As microbial organisms eat the organic matter they produce a glue like substance that helps to 'cement' soil together to form soil aggregates. Adding crop residues, such as cover crops or compost or manure to the soil on an annual basis is a good practice to increase the percent of soil organic matter and feed the soil microbes. Over a few years (3-7) you should see an increase in percent of organic matter if you follow these steps. But it is important to add inputs based on crop needs, do not just add large amounts to build organic matter. Inputs like manure contain organic matter but also macro nutrients. Too much of a good thing can cause problems like water pollution.

4. Planning for Soil Inputs: Fertilizers

PROCEDURE

Reading the label: The soil test results will list the nutrients needed to add to the soil and and the amounts needed to support healthy plants. However, the actual amount of the fertilizers and organic amendments in each bag must be calculated. The numbers on the bag represent the percentages (%) of nutrients in the bag. Growers must convert these percentages of nutrients into pounds so the correct amount can be added to the soil. The amount needed will depend on the soil test results. This is the perfect activity for learners to help one another and learn together, inside or outdoors.

Calculating example: It may be helpful to begin by discussing something that everyone works with on a daily basis: Money! Think about the value of a dollar bill compared to the value of a quarter. We know the value of a quarter is only one forth or one quarter of a dollar, or 25 percent. When we express that value as a decimal instead of a percentage, we say that a quarter is 0.25×1.00 , or $0.25 \times$

4. Planning for Soil Inputs: Fertilizers

PROCEDURE (cont.)

Calculating amount of fertilizer from %: Fertilizer rates are calculated using the same method. For example, Juan wanted to apply one pound of nitrogen per thousand square feet to his herb bed. He has a fertilizer with a grade or analysis of 25–3–3 which is marked on the bag. Juan knows that this means that the product contains 25 percent nitrogen, and that 25 percent expressed as a decimal is 0.25 (to express a percentage as a decimal, always move the decimal point two places to the left). He uses the following formula:

Pounds of nutrient needed (as indicated on the soil test results) divided by the percentage of that nutrient in the fertilizer (expressed as a decimal) equals the pounds of fertilizer to apply.

lbs.of fertilizer needed= <u>lbs. of nutrient needed</u>. Note that the 3 numbers are for %Nitrogen, %Phosphorous, %Potassium-in this order.

4. Planning for Soil Inputs: Fertilizers

PROCEDURE (cont.)

Fertilizer application rate:

Example: Juan sent in a soil sample from his garden to determine which nutrients he may need to add. The recommendation is that he needs 1 pound of nitrogen. per 1,000 sq ft. The fertilizer that he has is 25-3-3. He writes each nutrient as a decimal to represent the % of nutrient ,.25 = N in this bag. This equals 4 pounds of the 25-3-3 fertilizer to be applied per 1,000 square feet.

Lbs. of fertilizer needed= $\underline{1}$ = 4 lbs./1,000 sq. ft. of 25-3-3 needed to meet N 0.25

How much fertilizer does Juan need? He has already measured the bed and found it to be 50 feet long and 40 feet wide. Juan simply multiplies 40 by 50 to arrive at 2,000 square feet of garden that needs fertilizer.

Fertilizer needed for bed: Length x Width = sg. ft. of bed

Juan's garden bed is: 40 x 50=2000 sq. ft.

Fertilizer needed - Because he calculated a fertilizer rate of 4 pounds per 1,000 square feet, and has 2,000 square feet to fertilize, Juan will use a total of 8 pounds of fertilizer to cover the garden. Note this will need the the soil's need for nitrogen only.

Note: If after calculating the amounts of Phosphorous and Potassium needed are too high if you use this fertilizer then select a different fertilizer with less Phosphorous (P) and Potassium (K)

*Instructors please use an example that mirrors your fertilizer or compost/manure label

- Garden bed = 40 ft x 50 ft = 2000 sq ft to fertilize
- 1 pound N needed/.25 = 4 pounds for each 1000 sq ft of garden
- His garden is 2000 sq ft so he needs 8 pounds of fertilizer for his garden
- Repeat process if he needs to add P and K.

You may have to see what organic or chemical fertilizers are available at the store then try to match them as close as possible to what is needed in the soil.

Fertilizer Labels Examples

Use these examples if class does not have any bags of fertilizer

6-20	NIIROGEN (N)
17.8	% LIDEA NITROGEN
AVAIL	ABLE PHOSPHOPIC ACID (P. 0.)
SOLUE	BLE POTASH (K-0)
TOTAL	SULFUR (S)
2.0%	FREE SULFUR
4.0%	COMBINED SULFUR
IRON	(Fe)

DERIVED FROM: Polymer-coated urea, sulfur-coated urea, urea,

ammonium sulfate, di-ammonium phosphate, muriate of potash, iron sulfate and iron oxide. *Contains 16.3% slowly available coated slow release

nitrogen from 3 different release components: 4.5% slowly available urea nitrogen from polymer-coated urea (15 micron coating thickness), 4.5% slowly available urea nitrogen from polymer-coated urea (22 micron thickness), 7.3% slowly available urea nitrogen from sulfur-coated urea.

Chlorine (Cl) not more than 12.0%

ZONE ONE:

Cool season northe grasses, such as Ke Annual and Perenr early spring after a This is usually in e and late fall. Appli American Choice' over lawn at the r 21 lb bag of Sam's will cover just ov ZONE TWO: Warm season son ern grasses, exce spring, summer spread Sam's Ar izer evenly over sq ft. This 21 lb 24-6-12 will co Centipede Gras early fall at the TRANSITI Turf grasses m grasses. Apply

4. Planning for Soil Inputs: Fertilizers

DIVE DEEPER

Do you know how a plants' leaves appear when it is lacking the nutrients it needs? Even micro nutrients (nutrients needed in very small amounts) can cause plants to discolor or not grow well,.

Here is a handout that can help you see how a plant looks when nutrients are lacking.

This handout has photos of plants that are lacking the listed nutrients.

UC IPM Nutrient Deficiencies

CONNECTIONS TO OTHER MODULES

The other soil health modules will be helpful to understand soil health and crop health. Food Safety modules will help understand how to care for plants when manure is included as a plant food.

VARIATIONS

 Calculating the amount of fertilizer to apply can be calculated for any field/bed/garden size. Do the calculations for different fertilizer products. Measure the field and practice using different bags of fertilizer.

ACTIVITY 4

- Some fertilizer blends include micro nutrients. Like its name, a plant only needs a little bit of these elements. They include boron (B), zinc (Zn), manganese (Mn), iron (Fe), copper (Cu), molybdenum (Mo), chlorine (Cl), Co) Cobalt and (Ni) Nickel. Learn a bit more about them at this site.
- For an in depth understanding <u>visit</u> <u>this link</u>
- Use compost/manure as a fertilizer source. If it is from a farm you can have it tested for its nutrient content, this is especially useful if you will get manure from there again.

4. Planning for Soil Inputs: Compost

OVERVIEW

The planned use of compost and/or manure is a good practice to improve soil health. The amount of nutrients in the manure must be known to avoid over- or under-application of macro nutrients (NPK). Too much nitrogen from any source including manure, compost and other organic materials can pollute groundwater or over-fertilize crops. Many gardens, lawns and fields that rely on manure have higher phosphorus content than is necessary for good plant growth. Too much phosphorus in the soil can wash into lakes and streams often causing phosphorous pollution which is the cause of algae blooms. This is harmful to the fish and aquatic animals.

MATERIALS NEEDED

- Compost/Manure analysis found on bag or from commercial testing
- Compost/Manure Worksheet (handout)
- Fertilizer Worksheet (handout)

FACILITATOR BACKGROUND INFORMATION

Besides manure and compost another way to improve the soil structure is to add crop residue. Cover crops or compost/manure are good for the soil's health but they also help manage the plant's environment by providing food for plants. Adding organic matter to the soil feeds soil microbes. As they feed they release a sticky goo that glues organic matter forming soil aggregates. Soil aggregates protect the organic matter in the soil, sort of like a shield. This is the goal of adding manure and compost to the soil; feed the microbes to create shield-like structures to protect organic matter.

Note: Use animal manure with caution. To avoid contaminating fruit and vegetables with pathogens such as E. coli, only add fresh manure 120 days or more before the expected crop harvest. Making compost that has been turned several times and reaches 180 F each time is considered safe. This is important particularly when a 120-day waiting period is not feasible. In addition to organic matter, manure adds important nutrients. Note that each type of animal manure contains different nutrients and how an animal is raised impacts the amount of nutrients in the manure. (See this link for table of manures and % of nutrients)

Additional Resources/Activities

Resource 1

Soil Health School

This resource offers an online course about how the soil that holds us up and sustains us and the crops we grow. It is an excellent overview of this module and offers a bit of in depth information on soil health and farming systems. This course will:

- Give you the basics of soil properties.
- Help you solve the problems in your fields by following soil health principles.
- Introduce the importance of soil health to your community at large.
- Help you implement soil health testing in your crop fields.

https://www.canr.msu.edu/courses/soil-health-schoolonline-course

Resource 2

Applying Fertilizer to your Farm/Garden

This extension bulletin shows you different approaches to add fertilizer to your garden as well as help you calculate how much to apply. It will guide you through calculating how much is it applying per unit area. Remember that fertilizer can come in an inorganic form like urea or N{PK or organic farm like compost or manure.

> English Version Espanol

Resource 3

A booklet on fertilizing crops with organic ammendments

This is a complete manual with information to guide a farmer on using organic soil amendments, uses, applying them and testing the soil. This manual does follow the National Organic Program rules (2023). This information is relevant to any farmer seeking best practices that include the use of organic soil amendments on their farm.

https://pubs.extension.wsu.edu/fertilizing-with-manure

Additional Resources/Activities

Resource 4

Cover crop selector tools

These online tools allow a user to enter their goals and different information about the crops and weather to guide the selector tool to identify the best cover crops for that purpose and area.

- 1. For those in the Midwest USA: https://www.midwestcovercrops.org/gettin g-started-correct/
- 2. For those in the South and 'East Coast: https://covercrop-selector.org/
- 3. Other regions and states in the USA do not yet have such a tool but consider using the Managing Cover Crops Profitably book noted above. The link for that book offers the entire book as a PDF, free.

Resource 6

Online nutrient calculator

Here is an online calculator that guides you through steps to determine the amount of nutrients to apply to the soil, based on type of soil inputs. organico r inorganic (such as compost or NPK).

https://extension.oregonstate.edu/catalog/ pub/em-9235-osu-organic-fertilizer-covercrop-calculator-predicting-plant-available

Resource 5

YouTube Look at soil aggregates- a Demonstration

This YouTube does a good job showing how to set up and understand a soil aggregate demonstration. It is useful to watch before starting to set up the demonstration as it shows what is needed and how to do the demonstration.

> https://youtu.be/KdVA9FKH-FE? si=5BNpq18aS7FKybZ4

Review and Encouraging Further Learning

Review and Evaluation Questions:

- What tillage practice can you use that would work for your soil and equipment? Consider cost, equipment availability and how it affects the soil.
- What soil inputs would be most suitable for your farm?
 Consider your typical crops, the soil test, and what you have available.
- How do different inputs vary in terms of providing nutrients?
- Do you need to add additional fertilizer (either organic or inorganic) to your soil depending on crop you will grow and/or soil test results?
- Where is your local NRCS office located? Which programs can you apply to?

Activities for Additional Learning:

- Learn about and discuss different approaches to preparing the soil on your farm:
 - To learn about different tillage ways visit this site: https:// cropwatch.unl.edu/tillage/advdisadv
 - https://blog-fruit-vegetable-ipm.extension.umn.edu/2024/02/ reducing-tillage-in-vegetable-crops.html

Review and Encouraging Further Learning (cont)

Taking your knowledge back to the farm:

- Visit your field throughout the year and takes notes of how well the cops are growing, notice if there are areas of better or worse growth and label that on your field map. Consider doing a separate soil test of these areas where crops are not growing so well.
- Talk to other farmers (maybe with a bit more experience) at field days and conferences of what they do to improve their soil and discuss their approaches and why they chose those approaches and inputs.
- Consider other soil amendments that will meet your soil's nutrient needs (in addition to NPK fertilizers) and include them when calculating amount of nutrients needed base on your soil test. You can use the soil nutrient calculator.
- Make an appointment to meet and visit your local NRCS or FSA office to discuss opportunities that are available for your farm around the topic of soil and water conservation. To find the office closest to you visit: https://www.nrcs.usda.gov/contact/find-aservice-center