Program 20 - EACH PLANT A MUSCLE SHOALS - February 17, 1941
(How Legumes Add Nitrogen to the Soil)

SOMETHING TO DO AND TALK ABOUT FIRST

1. What is Muscle Shoals? The energy developed there is used to capture nitrogen from the air and produce a chemical compound rich in nitrogen that is used as fertilizer.
2. Suggest that Trailhitters inquire at a store that sells fertilizers the trade name of this particular fertilizer.
3. What elements do plants need for growth?
4. Of what elements is air composed? How much of each?
5. What plants have the ability to take nitrogen from the air? What name is given to this group of plants? (These plants are the "Muscle Shoals" referred to in this broadcast.)

DO YOU KNOW THESE WORDS?

bacteria	nodules	nitrogen	legumes
rotation	element	oxygen	

LISTEN FOR THESE IDEAS

1. What has been a source of nitrogen fertilizers?
2. Where did these rich deposits come from?
3. Is there any danger of their exhaustion.
4. How necessary is nitrogen to plant life?
5. How do certain plants add nitrogen to the soil? Name these plants. What tree is among them?
6. Why is lime in some form often added to the soil before a legume is planted?

SOMETHING TO DO AND TALK ABOUT LATER

1. Bats living in Mammoth Cave for untold years caused the accumulation of nitrogenous products which were used to make gun powder during Civil War days. It would have made good fertilizer. How do you account for the accumulation of marl in the bottoms of some marshes and lakes?
2. What besides erosion makes soil poorer?
3. What are good farmers doing to prevent this depletion?

Wisconsin School of the Air
Afield With Ranger Mac
February 17, 1941

EVERY PLANT A MUSCLE SHOALS

Hello Boys and Girls:

Out in the lobby here in Radio Hall is a large book. There is one of them in every library. There is one of them in every schoolroom, though maybe not so large. We go to that book to find out how to spell words, find out their pronounciation and their meanings. It is the dictionary. It contains thousands of different words, from the shortest ones with only one letter, like A and I, to the longest ones with many letters, none of which we will attempt to pronounce. There are thousands of words, but every word is made up of a combination of letters. These letters we call the alphabet and in the alphabet there are just twenty-six letters. All the words that it is possible for us to use are made up of a few or more of these letters of the alphabet.

Now, this is not new to you, I know. It is so commonplace that you may be wondering what Ranger Mac is trying to get at. Well, it is just this. In the material world about us there is something quite similar to the dictionary and the letters of the alphabet. By material world, I mean the earth - soil, air, trees, birds, wood, chalk, eraser, book, blackboard, our own bodies. These are material things. There are more of these material things on the earth than there are words in the dictionary. So I want you to think about this earth, and the atmosphere surrounding it, as a dictionary that has in it all these material things. Just as every word is made up of a certain combination of letters, so every material thing is made up of one or a combination of elements. In the dictionary we call the parts of a word letters, so in the dictionary of the earth we call the parts elements. In the word dictionary we spell water - w a t e r, but in the dictionary of the earth it is spelled H2O - hydrogen and oxygen. So at the table when you want some water, instead of using the dictionary of words and simply asking for water as: "Mother, please pass the water," you might use the dictionary of the elements and say, "Mother, please pass the H2O". Or with salt, you might request "Please pass the sodium cloride,

for sodium and choline are the elements that spell the word salt in the dictionary of the earth. Now the dictionary of the earth has 92 of these elements. Every material thing in the world - the animal, vegetable and mineral kingdoms, the air surrounding us, is made up of one or more of these elements. Let's take sugar as another example. Sugar is made up of three elements - carbon, hydrogen and oxygen. If you burn sugar and drive off the hydrogen and oxygen, you have pure carbon left. So is starch made up of carbon, hydrogen and oxygen, but in a different combination, just like changing the letters around in a word you get a different word.

On our trail today we are going to talk about one element more than any other - and that element is nitrogen. Nitrogen is necessary for the growth of plants. The growth of the stalk and the leaves and the greenness of color are due largely to nitrogen. If a plant is yellow and has a sickly appearance, and refuses to grow, it is quite likely that it is starving for want of nitrogen. Then it is that the farmer's attention should be turned to methods of getting nitrogen into the soil so that plants can use it. Barnyard manure contains nitrogen, and by applying it to the soil plants are fed not only nitrogen but phosphorus and potash which are other elements needed by plants. The farmer can but commercial fertilizers that contain nitrogen, but these are expensive. Many of these commercial fertilizers come from the packing houses, and are made up of the bones and tissues of the slaughtered animals which have been dried and ground up into usable form. There is another interesting source of nitrogen for plants. On the coast of Chili there are high cliffs overlooking the Pacific Ocean. Birds for centuries and centuries have roosted and made their homes on these cliffs. Here they have died, falling on the rocks below. The manure from these birds and their dead bodies have been piling up for centuries. This is called guano, and is rich in nitrogen that plants can use for growth. But it is expensive, and Chili is protecting this rich deposit. Sewerage disposal plants of the large cities produce fertilizers that are rich in nitrogen which plants can use for food. But it costs money, about 2 cents a pound.

Now nitrogen is not an uncommon element, like gold, helium, silver, radium and many other of the 92 elements we could mention. It is even more common than oxygen, and like oxygen is a gas. Four-fifths of the air we breathe is nitrogen; the other fifth is oxygen. If air were pure oxygen, any fire once started could never be put out. Oxygen causes iron to rust, coal to burn, wood to decay. Oxygen united quite readily with other substances. But nitrogen does not. I suppose you wonder why, with all the nitrogen in the air, there isn't enough to supply plants with all the nitrogen which they need without man's help. The trouble is that there are very few farm plants that can take this nitrogen from the air and use it. When that gigantic dam was built at Muscle Shoals in Tennessee, it was intended, among other things, to develop electricity with which to capture the free nitrogen from the air and make a fertilizer to spread over the soil and feed plants the nitrogen which they need. You see what Ranger Mac means. Here is nitrogen, so plentiful, forming 4/5ths of the air, yet only a very few plants have the power to use it. Water, water, everywhere, but not a drop to drink. Nitrogen, nitrogen, everywhere, but cannot be taken by plants. But man has discovered that by using tremendous electrical power he can take the nitrogen from the air and make a cheap fertilizer that will supply the nitrogen that plants need. That was one of the purposes for building the gigantic dam at Muscle Shoals in Tennessee.

But happily there are some plants that can do the same thing; can take the free nitrogen out of the air and make plant food of it. They do it quietly without making any fuss about it. Each one of these plants is a fertilizer-making factory in itself, making a fertilizer that contains nitrogen which it gets from the air. Each one of these plants is a Muscle Shoals in itself. Agriculture has no plants more valuable than these plants. These plants, each one of which is a Muscle Shoals in itself, are members of a family called the legume family. You are familiar with some of these plants, especially if you live on a farm because your fathers have planted them for hay crop and to build up the soil. Let's name a few of them, and then we'll find out just how these lgeumes work. These plants, each one of which is a Muscle Shoals, are the beans, the peas, the clovers, alfalfa, the vetches, and among the trees, the

black locust. You know that on these trips afield we talk about conservation of the gifts of nature, and among these gifts is the soil. These legumes are real upbuilders of the soil, and to plant them is real soil conservation. The federal government, for a number of years, has been carrying on a soil conservation program. You have studied about it in your school. Any farmer who signs up in the soil conservation program gets paid for planting these legumes, for the welfare of the nation depends upon the fertility of the soil.

Now let's see how these plants do this wonderful work. Really the work of taking this free nitrogen from the air is not done by the plants themselves but by germs that live in the soil and fasten themselves to the roots of these plants and build their homes there. These germs will not attach themselves to any other plants except those mentioned, the legumes, the peas, beans, clovers, alfalfa and the black locust. These germs, called bacteria, enter the root of these plants and start to grow and multiply. Soon they build up little swellings on the roots that look like tiny potatoes. These swellings are called nodules. They are about as large as pin heads. Small things, to be sure, but you and I have learned on these trips afield that there can be miracles in small things. After this broadcast, you look up in one of your books on agriculture, to find a picture of the root of a legume plant, and you will see pictured these nodules fastened to the roots. Or next summer you dig up a thrifty clover or bean plant; shake off the soil and examine the roots for these nodules. These are the Muscle Shoals - each a nitrogen factory.

Down the hall from Ranger Mac's office a number of men are working all the days and frequently into the night putting a jelly-like substance into bottles. When planting time comes, these bottles will be sent to farmers throughout the state. These bottles contain the bacteria that grow on the roots of legumes. These bacteria are grown in the laboratories at the College of Agriculture. A jelly-like substance is put into the bottles, and a few bacteria are poured on top of it. The bacteria feed on this substance and multiply very rapidly. When the farmer gets one of these bottles, he pours into it a little water, shakes well, and then pours the contents

over the seed of clover, alfalfa or of other legumes which he intends to plant. He does this to be sure that his soil will have these bacteria, for without bacteria of this kind in the soil, he is sure to get a very poor crop. Peculiar isn't it? how success in farming may depend upon living things that are so small that it takes a powerful microscope to see them.

But there is still another thing for us to consider. These bacteria will not thrive in every kind of soil. Soil that is sour, that is - does not have lime, or enough lime in it, is not the kind of soil in which this bacteria will grow. So the farmer tests his soil to find out whether or not it contains enough lime, and if it does not he must spread lime over the surface of the ground and then works it into the soil. You can see that it takes quite a man to be a successful farmer. I think it takes a better man to be a successful farmer than to be a success in most any other line of work. He must not only be a good worker, but he must know a great deal about most everything. He must be a scientist. He must be familiar with the dictionary of the earth. Uncle Sam may build a gigantic dam at Muscle Shoals to take the free nitrogen from the air to make a fertilizer, but the farmer who knows how to grow legumes can have a million little factories each one helping to build up his soil and at the same time furnishing him with the very best kind of feed for his livestock.

So this is what Ranger Mac means by "Every Plant a Muscle Shoals".

The other day I was in the workshop of a taxidermist. A taxidermist is a man who mounts skins of animals. There were heads of many animals and I compared noses, and I thought of all the different kinds of noses possessed by animals from the button-nose of the rabbit to the elongated nose of the elephant, and somewhere in between is man's nose - each nose suited to the animal's purpose. The nostrils of the deer open sideways enabling the deer to detect easily the approach of danger on the passing breeze. The members of the dog family - the wolves, foxes and dogs, all have flat-tipped noses. These creatures are hunters, and the flat nose enables them to follow tracks by power of scent with the nose close to the

ground. Man has a rather prominent nose, but he doesn't use it as much as the eyes and as a result he cannot detect different fragrances in the same manner as he can detect colors. The fragrant-laden breeze from a field of legumes - like white clover for instance - should give him as much pleasure as seeing the beautiful blossoms or tasting the honey that comes from them. For some of our best honey comes from the nectar of the blossoms of legumes - for honey - the best.

So nature is an open book, and those who study its pages may discover an untold number of interesting facts.

Good luck, and

May the Great Spirit
Put Sunshine into your Heart
Today, and forevermore,
HEAP MUCH!