EXERCISES SECTION 3. SOIL MANAGEMENT

Goal

The participants should come away from these exercises with a clear understanding of the central position that organic matter management plays in the development of a sustainable agricultural system. Organic residues are the vehicle for managing soils.

24. *Yield and fertilizer trends*
25. *Nutrient "mining"*
26. *Rice nutrient budget*
27. *Straw-use analysis*
28. *C:N ratios*
29. *Soil problem analysis*
30. *Building compost*
31. *Doing farmer-based research on soils*

Tips on Running the Exercises

The first exercise is a quick and easy discussion on yield and fertilizer trends as a way of motivating the section. Exercises 25-28 should be run in sequence as they all relate, from different perspectives, to the analysis of why it is important to return plant organic matter to the soil using rice straw as an example. For the vegetable farmers on the other hand, Exercise 29 gives a procedure for building a hot-compost container. The last exercise promotes the idea that these exercises should be used to set the stage for season-long experiments by farmers on soil (organic matter) management.

EXERCISE 24. YIELD TRENDS

Background

This exercise is a quick and easy discussion the aim of which is to motivate interest in the overall subject of improved soils management. The participants are asked to provide a rough idea of yields and synthetic fertilizer inputs for the past several years (yield per unit area compared with inputs of synthetic nitrogen). In many cases the you will see a general downward trend in yields at the same time as a general upward trend in the total amount of synthetic nitrogen. Of course there are other factors that have affected yields – the introduction of new varieties for example – which may be cause for an increase in yields over time. This can be factored into the discussion.

Goal

To explore the long-term yield trends in relation to the trend in synthetic fertilizer inputs and other factors.

Time required

45 minutes

Materials

Pens

Newsprint

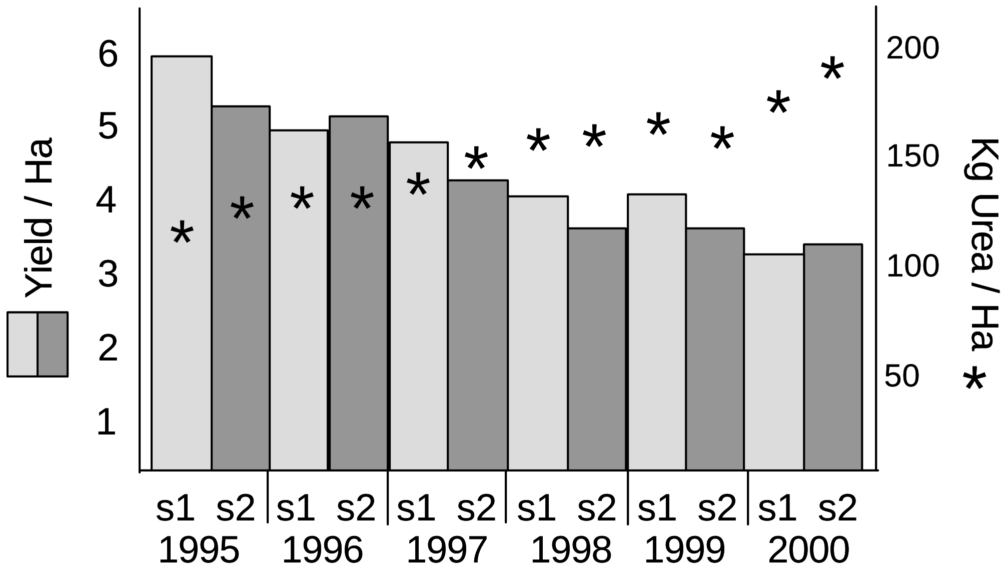
Tape

Steps

If working with farmers this should be done as a small group exercise with representatives reporting back to the large group. In this way you have a sample from several different farm experiences. If this is for a TOT for trainers, the idea can be put across quickly as a group discussion only.

1. Decide on one farmer per small group as a representative case. Begin with a blank graph, with time on the horizontal axis and average yield on the vertical axis (left) and average input (kg) for urea on the vertical axis (right). **You will need to estimate the range of values that will be used for both yield and urea, in order to be able to set the scales such that they overlap nicely.
2. Ask the participant to begin with the latest year's values and to plot yield per hectare (or whatever the most appropriate units might be for your area) measured against the left-hand axis. Draw a box (vertical column) to represent yield for this year.

3. Next, for this same year, put a mark down for total Kg urea applied for this same representative field (measured against the right-hand axis). The urea graph can be drawn as a line graph, from point to point, or simply as points.
4. Now do the same thing for the year before, then the year before that—going backwards in time as far as the participant is able (10 years would be a good graph).
5. Discuss the implications of the graph comparing trends in synthetic nitrogen inputs with yields. Report back to the large group.



Questions

1. What do the trend lines show?
2. If yields are going down while fertilizer use increases, why might this occur?
3. What other factors might be influencing these trend lines? (e.g., changes in varieties)

EXERCISE 25. NUTRIENT "MINING"

Background

One of the problems associated with the dependence of farmers on synthetic fertilizers results from the thinking that "N,P,K" is all that a plant needs for food. In fact there are some 20 different nutrients that are necessary for plant growth. Nitrogen, phosphorus and potassium are needed in relatively large quantity by the plant, and are therefore called ***macronutrients***. Others, such as zinc and magnesium, are only needed in minute amounts, and are called ***micronutrients***.

The very best way to ensure that a proper balance of nutrients is fed to the soil is to return as much of the original plant material as possible to the soil after harvest. For vegetable crops, this would best be done by providing an application of ***compost*** (see later exercise). For rice plants this would involve putting the straw and stubble back into the soil before the next planting season. However, in many locations farmers burn their rice straw, or feed it to the cattle or use it for cooking fuel. In essence this puts the farmer in the position ***of continually extracting, or "mining" his soil for nutrients***. The farmer is most often unaware of this, thinking that adding N,P,K will make up for lost nutrients. While nutrient mining may not cause nutrient deficiency problems this season, or next season, eventually the soil will become deficient in one or more critical nutrient. This is one reason why yields are in general declining around the world.

This exercise is a simple simulation aimed at demonstrating the concept of ***"nutrient mining"***. There is no easy way to know which nutrient might first be depleted, as nutrient composition of soils vary from location to location, and are available or not depending on fairly complex soil chemistry.

The important point of this exercise is the idea that if farmers "mine" their soils, eventually one or another nutrient will be depleted and begin to reduce the farmer's yield.

Often the response by farmers to a declining yield is to add more NPK, thinking that the soil needs more fertilizer. Unfortunately, adding more of the three macronutrients when the limiting nutrient is something else altogether will, at best, be a waste of money, but may even cause an increase in the problem by causing an even greater imbalance in the soil.

One farmer in Bangladesh put it quite well: he said "I understand the idea—if I am trying to make a nice curry sauce, but don't have enough coriander, it does me no good to just keep adding chilies!"

Note to facilitator: One pitfall to avoid is the ***focus*** on trying to determine specific nutrient deficiencies for soils. We do not want farmers to think they must rush down to the store and buy an increasing array of synthetic fertilizer products! Rather, the best solution is to put a compost or some adequate source of organic matter back into the soil.

Goal

To understand the concept of limiting nutrient through playing a simulation game.

Time required

45 minutes

Materials

Newsprint

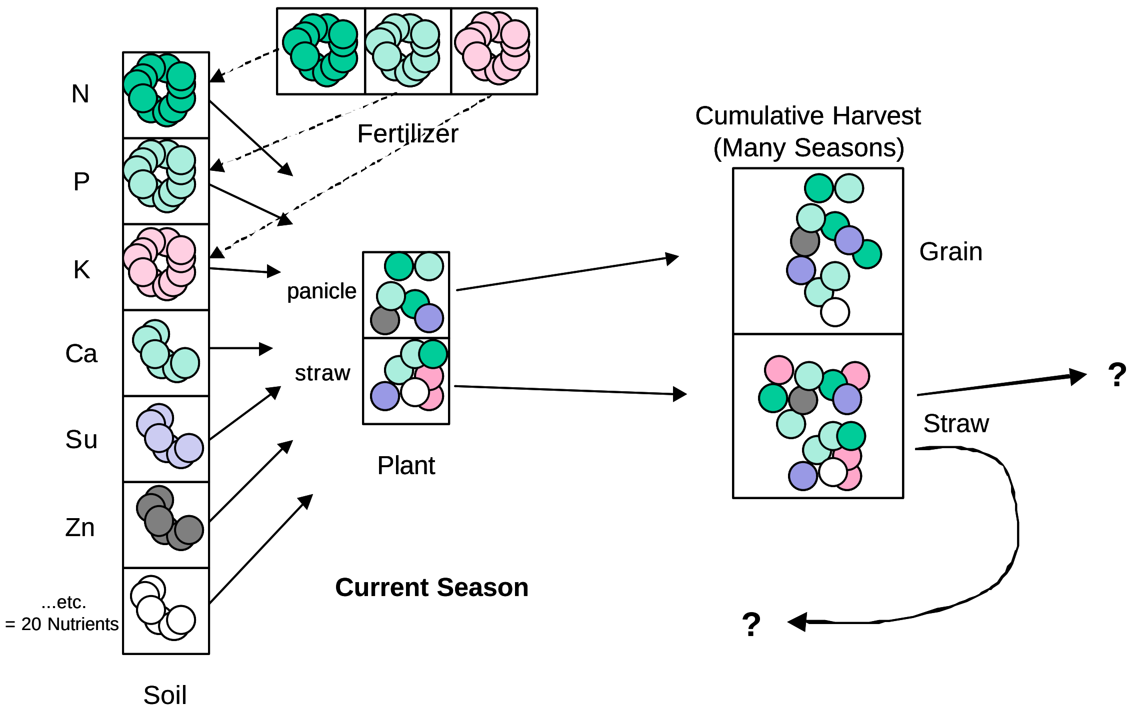
Pens

100 gm seeds of 6 different types.

Steps

1. Draw a set of squares, similar to the diagram below, on a large piece of newsprint.
2. Cut up a dozen or more small pieces of paper in different sizes or colors depending on the materials you have available. These will represent several different kinds of nutrients. A better alternative is to use seeds of different sizes and colors (easier if large seeds)
3. Begin "season 1" by placing a good number of "nutrients" in each of the squares in the "soil" boxes. Then transfer a couple from **each** soil nutrient box into the "Plant" boxes. Distribute these between panicle and straw if you are familiar with the distribution (recall that virtually all the K^+ goes into the straw).
4. "Harvest" the crop by removing all the nutrients from the "plant" boxes into the "harvest" boxes.
5. Begin the next season by adding "fertilizer" from the NPK fertilizer boxes into the NPK boxes in the "soil".
6. Repeat the process of "growing the plant" and "harvesting". Allow the "harvest" boxes to grow each season to show the cumulative or total amount of nutrients "mined" from the soil over the years.
7. Continue until one of the boxes in the soils compartments is empty. Ask the participants what might be happening to yields at this time.
8. Now look at the large accumulation of nutrients in the harvested "straw" box. Change the scenario and ask what the soil would look like if the nutrients from the straw had been put back in the soil each year.

Nutrient Mining Simulation



Questions and points to emphasize

1. Ask farmers what their fathers did with straw from the rice fields? What other practices have changed from the time of their fathers?
2. If farmers point out that they have higher yields than did their fathers, try to steer the discussion towards the reasons for these higher yields—presumably the big reasons are the use of modern HYV varieties, along with additional boost from synthetic fertilizers. Ask whether it is possible that soil health was better during their fathers' time, even if yields for the varieties was less at that time.
3. What scope exists for farmers to put straw back into the soil? Could they begin with an experiment on just a small part of their soil (maybe 20% or 25%)?
4. ***Analogy:*** With our children, the best strategy for their nutrition is not to worry about providing this or that specific nutrient, and trying to evaluate this or that nutrient deficiency! Rather, we make sure to provide them with a balanced diet (fruits, green and yellow vegetables, meats and fish, milk, etc.). Similarly with the soil, the best strategy is to make sure the soil has a "balanced diet" by replenishing the extracted nutrients through the application of organic matter.
5. Recall that this exercise is only about nutrients. Ask the participants to quickly review the many other reasons they have learned for why organic matter is beneficial for soil health.

EXERCISE 26. RICE NUTRIENT BUDGET

Background

This exercise is especially for rice farmers, although the general principles hold for any crop. The basis of the exercise is a focus on only the three principal macronutrients (NPK). The aim of the exercise is to help farmers calculate the amount of NPK that is being removed from the soil after each season. A "budget" calculates both inputs and outputs. A real nutrient budget would need to take into account many more complex factors that would be difficult to measure (e.g., the amount of N that is being fixed by the blue-green algae in the rice field water). This exercise, therefore, is a very rough estimate. Note that we have limited our discussion to just three nutrients, and remind the participants not to lose sight of the many other ways in which rice straw (and organic matter in general) is important as an input to production.

Goal

To enable participants to be able to make a rough estimate of the amount of NPK going into and out of their rice fields each season, and to appreciate the nutrient value of rice straw.

Time required

60 minutes

Materials

Newsprint

Pens

Tape

Calculator

Steps

1. Facilitator draws an outline of the diagram for the nutrient budget analysis (see below).
2. Except for fairly advanced participants, this should be a facilitated large-group discussion as the exercise is moderately complex.
3. INPUTS: include only the synthetic sources of fertilizers (to keep things simple). There are many types of synthetic fertilizer, each with its own percentage of active ingredient. The participants will usually know these values. For example, urea is 46%, TSP is 48% and KCL is usually 60%. Fill in the values for Kg inputs, and percentage active ingredient; then calculate the value of active ingredient provided as input to the field.
4. STEP 2: losses of N in the field. Research at the International Rice Research Institute (IRRI) has demonstrated that even in a good soil,

roughly 40% of the N from fertilizer is lost back to the atmosphere as N_2 gas (denitrification by soil microbes). Also, about 20% remains trapped in the soil, unavailable to the plant. This leaves about 40% of the original synthetic nitrogen being taken up by the plant (Note: in a sandy soil with no organic matter this value for N lost can be much higher).

5. STEP 3: Based on the value given by the participant for his/her grain yield per hectare, calculate the amount of rice straw per hectare (use the local unit measure rather than kg/ha if appropriate). The ratio of kg rice straw per kg grain yield will vary based on the variety. The ratio varies between about 1.2 to 1 and 2.0 to 1. Traditional varieties have more straw (2:1) compared with high-yielding varieties (1.2:1). If you aren't sure what value to use, use a value of 1.5:1 as this is in between.
6. For the grain yield, and then also for the straw yield, calculate the amount of NPK given the values listed below. Multiply the percent of N,P,K times the number of kilograms of grain and straw, then divide by 100.
7. Enter the values for N,P,K in the Summary Table for kilograms of Inputs, the amount lost in the field (only for N), the amount taken away in the harvest, and the amount removed in the straw (assume for the first part of the exercise that the straw is removed).
8. Total the outputs and subtract these from the inputs to estimate the NET amount (positive or negative) of NPK that remains in the field after one season.
9. ALTERNATIVE. A quick alternative to this exercise, if time is short, is simply to calculate how many kg of NPK exist in the amount of straw from one hectare of average yield. Then calculate the amount of synthetic fertilizer this represents, the market value, and the value of a 10% increase in yield.

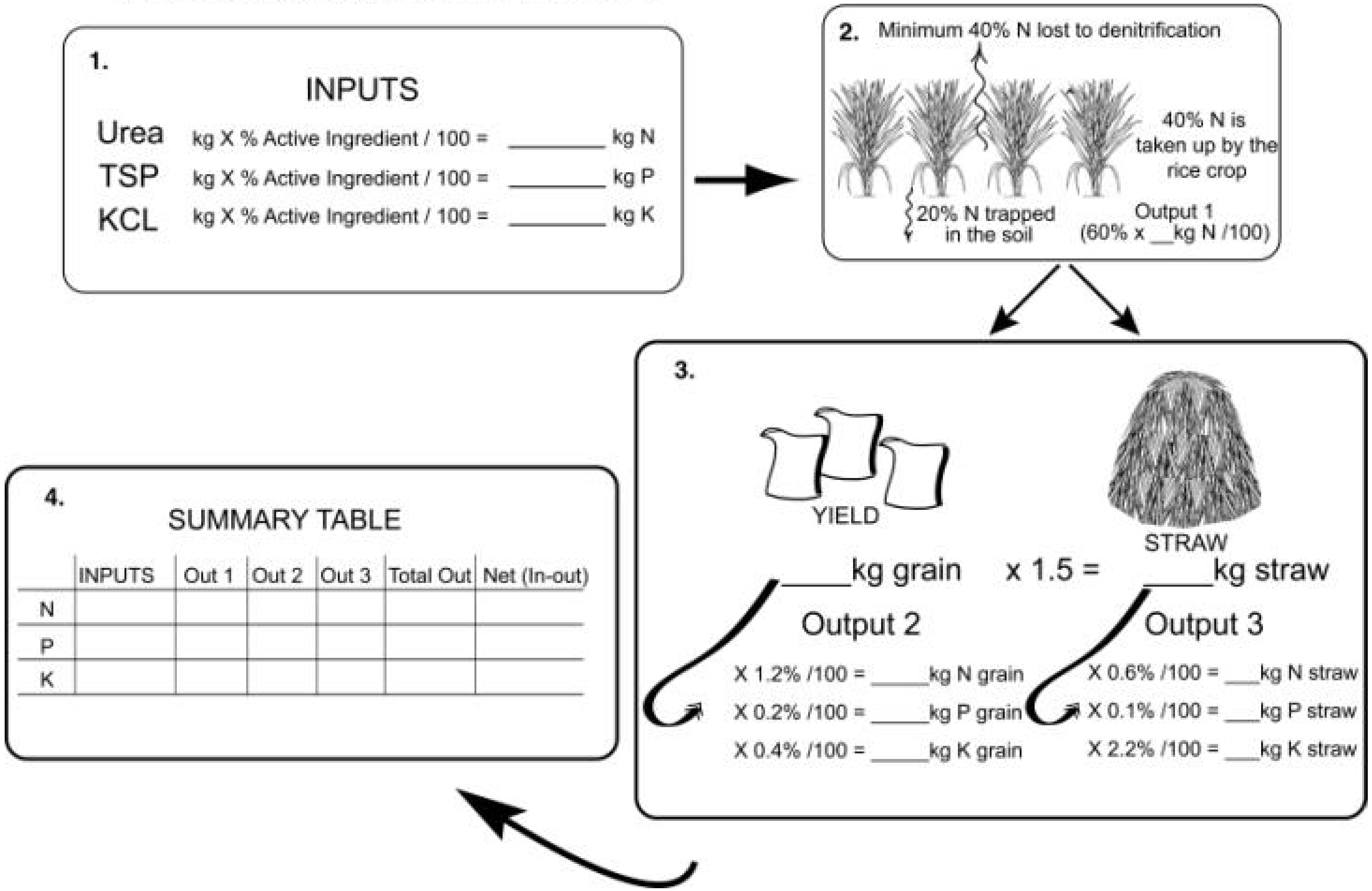
Questions & Points to Emphasize

1. Given the local costs for synthetic fertilizers, calculate the value (in terms of local currency) of the NPK in the straw from one hectare of rice. If straw is sold, calculate the loss of income from returning straw to the soil. Research shows that returning straw gives around a 10% yield increase beginning the second season. Factor this value into your calculations. If the farmer puts straw back into the field is he making a profit or taking a loss?
2. In our experience with this exercise so far, in most cases there is enough (or more than enough) P remaining in the soil after harvest. Results for N are highly variable based on location. Results for K are usually that K is being removed from the soil at rates somewhere around 100-150 Kg/ha for each season—even if the farmers are adding the recommended dosages of K. What are your results?
3. Note that many soils in the region are considered to have "enough" K so that farmers do not have to worry about K deficiency, even if the

budget shows a net loss each season. However, this is not universally true. Some soils are deficient in K to begin with (especially on land that is of somewhat higher elevation than the surrounding land). In West Africa, in the country of Mali, farmers were able to grow rice without returning the straw to the soil for 10 years before they started seeing yield reductions (due to K deficiencies).

4. What would the net results be if all the straw were put back into the soil before planting the next season?
5. Besides the NPK, what other nutrients are being put back into the soil with the straw?
6. Besides the question of nutrients, what other value is there to the straw being put back into the soil?
7. What problems do farmers in your area face in putting rice straw back into the field? Are there solutions to these problems?

RICE MACRONUTRIENT BUDGET



EXERCISE 27. STRAW-USE ANALYSIS

Background

Now that participants have an idea of the value of organic matter in general, and rice straw specifically, we can proceed with an analysis of how farmers use their straw. This varies widely from country-to-country and location-to-location. Our experience to date has shown a wide range of situations among rice farmers in Asia and Africa. In some areas, like the southern areas of West Java, farmers return their rice straw to the fields every season, and seem to realize this is a good practice for sustainable yields. In East Java we met farmers that were paying laborers (6 man-days per hectare) to chop up the rice straw with a machete in order to make turning the straw into the soil easier for the small rotary-tine tractors. However, farmers were seemingly unaware of the benefits of this practice and were only doing this because, as they said, the climate and water conditions were too moist to be able to burn the straw effectively, and they had no market or selling or otherwise getting rid of the straw (they were pleased to learn this was beneficial for their yields). In Bangladesh, Vietnam, Cambodia and Mali (West Africa), farmers were feeding the straw to cattle, or, as in the case of Bangladesh, were also using straw for cooking fuel. These cases pose a more difficult problem because even if farmers are aware of the value of straw to their long-term yield prospects, they face other constraints that must be solved first before the farmers have the option of returning straw back to their soils.

Goal

helping participants examine their constraints (and perceived constraints) to managing their organic residues.

Time required

60 minutes

Materials

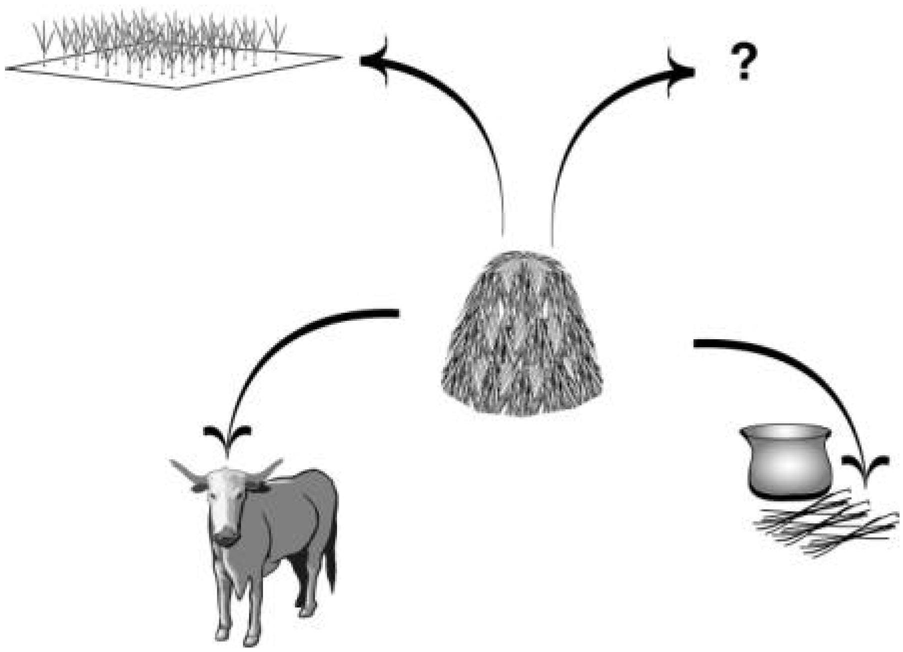
Pens

Newsprint

Tape

Steps

1. The facilitator can put up on the board a drawing as below, indicating the possible uses of straw in the farming system.
2. In small-group sessions, participants draw a two column matrix, as below, indicating the "positives" (benefits) and "negatives" (constraints) associated with returning rice straw to the field. (**this can, of course, also be done as a facilitated large-group discussion, depending on the judgment of the facilitator) .
3. Participants report back to the large group and discuss their findings. The facilitator should be knowledgeable enough on the subject to be able to distinguish "real" constraints from "perceived" constraints (some of which will have no real basis in fact). During the discussion try to bring out the difference between the two (see examples below).
4. Discuss the possible solutions to the constraints and see if this can lead into plans for farmers to do experiments on the topic in their fields.



Some real constraints to returning straw to a rice field

1. Not sufficient time to allow straw to decompose before transplanting or seeding rice: results in yellow rice seedlings

   (see exercise on C:N ratio).

2. Rice straw gets caught up in the rotary tines of the small tractors, causing problems

   [farmers in many areas get around this by paying the labor to chop up the straw—other solutions include partial decomposition before tillage].

3. Rice straw needed for cooking fuel, animal feed, building materials, or some other external need.

4. Long dry season (three months or more) means that rice straw must be stored. If turned under too soon it decomposes long before the next planting season

   [straw should not immediately be turned under as it will decompose in 6-to-8 weeks. Instead, store it in a pile until 2-to-4 weeks before planting].

5. Rats make homes under the rice straw piles

   [maybe, but then you know where they are and can more efficiently organize an effort to control them].

6. Rice straw "poisons" the new seedlings

   [in fact, under certain heavy clay soil conditions and cool temperatures, microbial breakdown under anaerobic conditions can produce organic acids, phenols and alcohols that are toxic to the roots of young seedlings. Most of the time in the tropics this should not be a problem.]

Some perceived problems that have little or no basis in fact

1. Rice straw is a reservoir for plant hopper eggs
   a. Plant hopper eggs are dependent on the plant for moisture. Dry straw is impossible to insert eggs into, and if they were inserted, they would quickly die from lack of moisture.
2. Rice straw is a reservoir for stem borers
   a. Stem borers that go through a resting stage usually do so in the very base of the plant, in the plant stem just above the roots and often below the soil surface. Straw is cut above this point. Also, any eggs or larvae of any insect would be destroyed by turning the straw back into the soil during soil preparation.
3. Rice straw is a reservoir for disease
   a. The International Rice Research Institute—IRRI— (Dr. Tom Mew) suggests that turning the straw back into the soil is the **best** way to dispose of straw from diseased plants. The disease spores are destroyed and the subsequent soils—richer in organic matter—are better able to suppress subsequent attacks by pathogens.
4. Synthetic fertilizers are better for rice yields
   a. [In fact, trials at IRRI and elsewhere have shown that the most productive choice of fertilizers will be a combination of organic matter and synthetics (most especially a synthetic nitrogen source). Among the organic inputs, ***rice straw*** has been proven to give the ***best response***—even better than equivalent amounts of cow dung— (rice straw is, after all, almost the same chemical make up as a growing rice plant)].

EXERCISE 28. CARBON – NITROGEN RATIOS

Background

This exercise refers to a possible problem associated with putting straw back into the soil of a rice field. However, the problem illustrates some basic principles of soil biology and management, and therefore is appropriate for discussion with vegetable growers as well. In areas where rice straw is incorporated into the soil less than one or two weeks before the seedlings are transplanted (or the seeds sown), farmers may be confronted with rice seedlings that are yellow and smaller than neighboring fields which do not incorporate rice straw. The cause of this problem is related to the general cycle of growth of soil microbial organisms, and their needs for nitrogen.

Of all the elements (atoms) in plants, Carbon is the most abundant. The dry-weight of a plant is roughly about 55% carbon, whereas it may only be 2 or 3% nitrogen. Plants have little difficulty accessing carbon for as we have seen earlier, C comes into the plant during the Dark Stage of photosynthesis in the form of CO_2 from the surrounding atmosphere. So C is not a limiting nutrient for plants as is often the case for N.

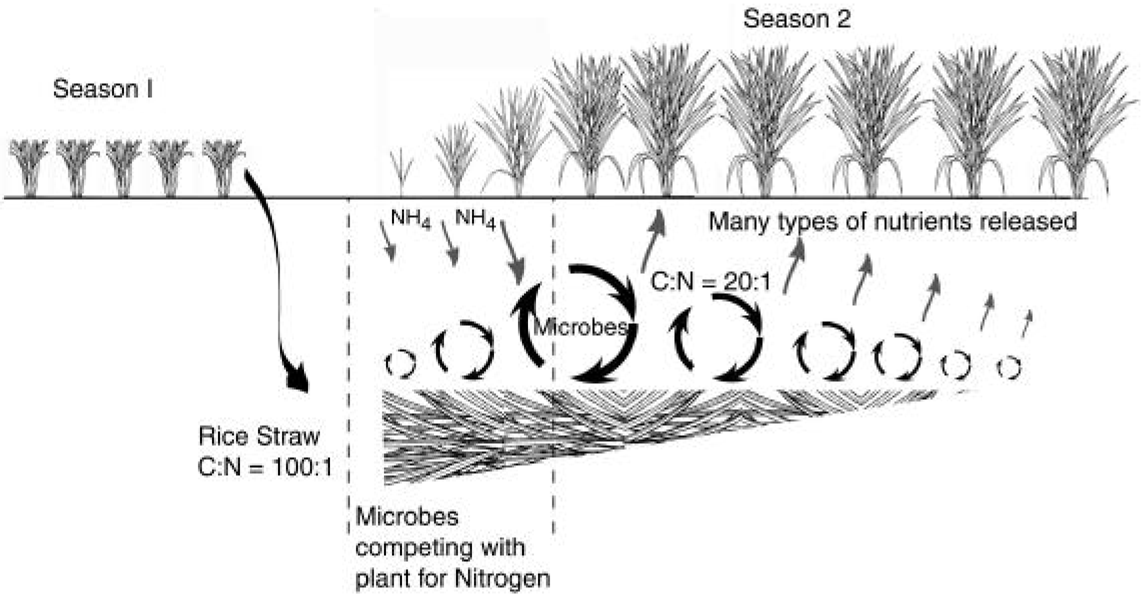
Microbes that live in the soil also require large amounts of carbon; however, they are unable to derive this directly from the atmosphere, but rather they depend on organic matter from decaying plants and animals for their source, or even sugars put out (exuded) from plant roots. Like all living organisms, microbes have need of a balance of nutrients for their growth and development. Roughly speaking, they need about 20 Carbon atoms for every Nitrogen atom, or a Carbon-to-Nitrogen ratio (C:N ratio) of 20:1.

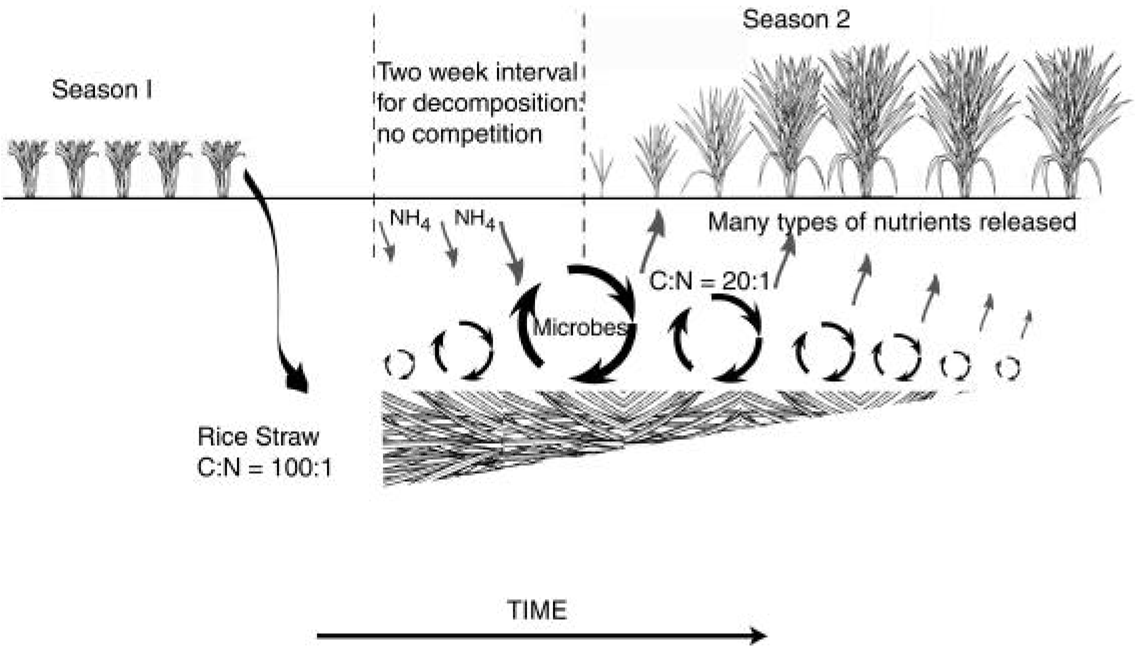
The C:N ratio of organic matter in the soil varies greatly depending on the source. A good compost, for example, has between a 30:1 and a 40:1 carbon-to-nitrogen ratio—this is in fact one of the benefits of compost. Cereal straw, on the other hand, has a C:N ratio closer to 100:1. This means that during the early stages of straw decomposition in the soil, the microbial populations have far more C than they do N; ***therefore, they must take N from the surrounding soil environment***. If rice seedlings have recently been planted, there is therefore a competition between the microbes (seeking to balance their meal of carbon with a meal of nitrogen) and the rice seedlings. The rice seedlings, therefore, end up looking yellow and develop slowly for the first several weeks.

Microbial populations as nutrient "banks"

The other point of importance is the fact that microbial populations, in addition to their role as ***decomposers*** of OM, act as a ***reservoir*** or storage area for nutrients. During their short life-times, microbes hold the nutrients as components of their bodies. As they die off, the nutrients are decomposed by the extra-cellular enzymes living bacteria use to "digest" materials (bacteria don't have mouths and stomachs!), and some of these nutrients will be taken up by the roots of the plants.

Microbial populations act to hold, and then slowly release nutrients to the roots of the plants. Without microbes, synthetic fertilizers added by farmers are quickly lost by leaching into the surrounding





Goal

This exercise aims to help participants understand the somewhat complex dynamics and interactions between soil organic matter, soil microbes and plants during the first few weeks after turning rice straw into the soil. Another objective is to give an idea of how microbes act as a storage area for nutrients.

Time required

60 minutes

Materials

Pens

Newsprint

Tape

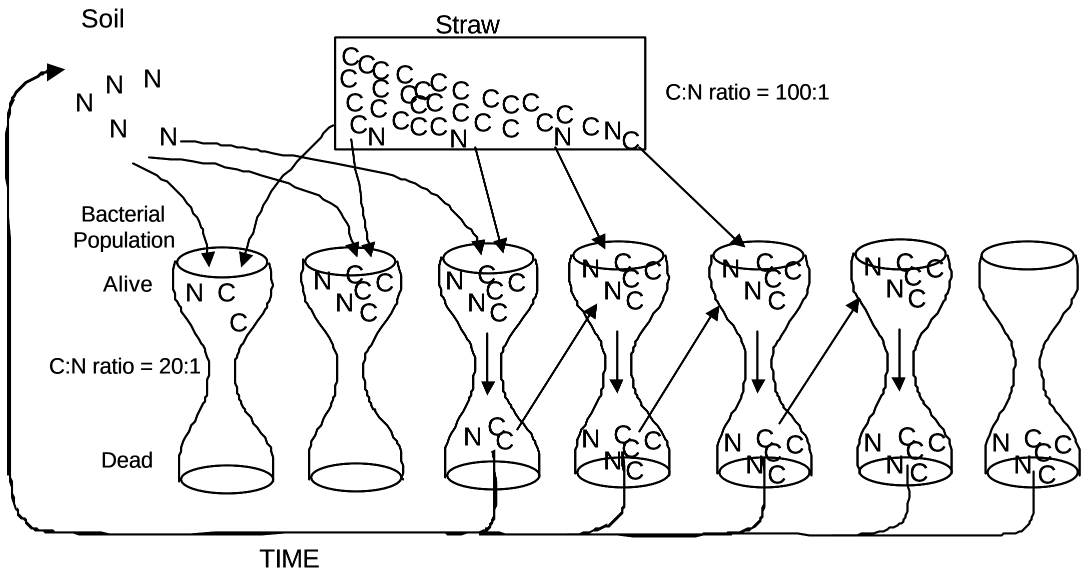
Several dozen small pieces of paper marked with the symbol N or C

Steps

This simulation is not meant to be quantitatively accurate, but simply to give and idea of the movement of nutrients in between soil, straw and microbial populations. The point to emphasize is that at the beginning of the process, N is taken out of the soil by the microbial population (a time of potential competition between microbes and plant roots for N), but that this N is later replenished by the dying microbial population.

1. The facilitator presents a drawing similar to the one found below (the "hour glass" compartments represent movement from one chamber (living) to another (dead), and prepares several dozen small pieces of paper marked either as N or as C. Each C paper represents 10 C atoms, whereas each N paper represents only 1 N atom. Participants break into small groups and play the simulation as follows.
2. The first hour glass shows C from the straw and N from both straw and soil being put into the "live" microbe chamber, representing the consumption of straw by microbes and the growth of the microbe populations.
3. The next hour glass shows the continued growth of microbial populations, and the accumulation of nutrients in this living "nutrient bank".
4. The 3rd hour glass is the same as the last, but in addition you have movement from the "live microbe" chamber into the "dead microbe" chamber, representing the death of a certain fraction of the microbe population.

5. The 4th hour glass is the same as the 3rd, but in addition you have breakdown of the dead microbes providing some of the nutrients required for the next time period.
6. The 5th hour glass is the same as the 4^{th}.
7. The 6^{th} hour glass is the same, except that the straw resources have been used up, and only nutrients from the dead microbes are feeding the same microbe population. This and the next hour glass represent the final stage in which all the original straw has been consumed, and the nutrients are now entirely within the microbial populations, both living and dead, and in the soil.



EXERCISE 29. SOIL PROBLEM ANALYSIS

Background

This exercise gives the participants a chance to apply some of the knowledge they have acquired in the analysis of local problems. It is inevitable that trainers face questions by farmers on how to solve local problems. The trainer should ideally be moving these questions back toward the farmer by suggesting the possibility of simple experiments. This exercise suggests that most soil problems fall into one of four categories.

Goal

To give the participants the opportunity to discuss the variety of local soil problems.

Time required

90 minutes

Materials

Pens

Newsprint

Tape

Steps

1. Break into small groups (based on similar work locations if participants come from several areas). Ask them to list the most important soils-related problems in their areas. Ask them to describe a likely approach for experimentation to help farmers see solutions for these problems.
2. Report back to the large group and compile the problems and experiments.
3. Facilitator asks the group to categorize the soil problems into a few categories. These will probably include:
   a. Physical (drainage, low water-holding capacity, etc.)
   b. Nutrient deficiency
   c. Toxicity
   d. Pathogen
4. How many of the solutions are based on the management of OM?

EXERCISE 30. BUILDING A COMPOST PILE

Background

We want to stress from the outset that hot compost is a practice best suited for dryland crops, especially high-value crops like vegetables. It is not the best use of energy and resources for rice culture for two very good reasons: First, because the process of making hot compost is ***aerobic*** (requiring oxygen) and the principal products derived include nitrogen in the ***nitrate*** form (NO_3). When the field is flooded soil conditions turn anaerobic within about two hours, and when this occurs, the nitrate rapidly undergoes denitrification by specific anaerobic bacteria. Denitrification results in your valuable nitrogen sources being lost back into the atmosphere as nitrogen gas (N_2). The second good reason is that a better method for improving rice paddy soils is simply to return the rice straw to the soil at least 2 weeks before planting.

There are many ways that people have found to build compost piles. The reader is encouraged to ask around to find other "recipes" and, of course, to experiment. The basic requirement of all (hot) compost piles is that:

1. the compost pile be large enough so that the heat generated is greater than the heat lost to the outside. This means that a "cubic" shaped pile is better than a wider, flat pile.
2. The compost pile receive enough oxygen so that the aerobic process of breakdown by microbes can take place. Therefore, hot compost "bins" are built above the ground.
3. Organic materials are put in as alternating layers to better ensure a mixture and aeration of the pile.
4. the pile needs to be "turned" or mixed up in order to bring the less-processed materials from the outside, to the inside, and to add oxygen to the pile. This should be done about once per month.
5. The pile needs to kept moist, in order to promote microbial growth, but not too wet (causing anaerobic conditions)

Goal

To build a compost bin out of locally-available materials

Materials

Wooden stakes, roughly 1.5m tall and 4-5 cm diameter

Plastic twine

Large knife for cutting branches for stakes

Plastic tarp covering

Succulent fresh weeds, banana leaves, almost any succulent plant materials

Cow dung

Lime

Steps

1. Layout an area about 1.5 x 1.5 m, some distance from the house
2. Cut between 30 – 40 straight wooden or bamboo branches from surrounding trees; each should be about 1.5 m tall. The four corner posts should be the biggest and somewhat taller
3. Insert and/or pound into the ground with a hammer in order to make a wooden cage. Spaces between branches should be 2-3 cm. Tie a horizontal branch from each of the four corner posts, to stabilize the structure. Tie the plastic twine along the horizontal branch, from branch-to –branch in order to further stabilize the structure.
4. Cut succulent weeds from roadside areas, and/or find banana leaves or just about any other leafy materials. Chop these up with a large knife to accelerate the breakdown process.
5. Collect cow dung (chicken and pig dung can also be used—these are higher in N, but also have more odor).
6. Begin with a layer of vegetation about 20 cm in the bottom of the bin; add then a layer of manure, then a second layer of vegetation; then a sprinkling of lime; vegetation; manure; vegetation; lime; etc., until you have reached the top (about 1 m).
7. After every layer of vegetation, tamp down the vegetation in order to compress the pile (not too much)
8. After every few layers, sprinkle a few liters of water on the pile to make the material damp, but not soaking wet
9. After the layers are completed, thrust a pole down to the bottom of the pile in 4 to 6 locations in order to create an air channel to the center of the pile
10. Cover the top with a layer of coconut fronds or plastic tarp to keep rain from soaking the pile
11. Monitor the pile weekly and add water as needed (if the center of the pile becomes dried out, white and "chalky" it means you need more water
12. Turn the pile on a monthly basis, bringing the outside materials in to the center, and the center materials to the outside.

13. If dung is not available, you will need to layer the pile with urea instead

The pile will be completed when the compost is a dark brown, crumbly consistency, with the odor of fresh earth. This may take three months, depending on the climate.

Once you have successfully created a compost pile, and carried it through to completion, you may want to build a series of compost structures and stock them on a monthly basis in order to create a consistent source of compost.

Photo. Final stages in construction of a compost bin in East Kalimantan (Borneo), Indonesia by IPM farmer participants. A plastic covering was later added to protect the compost from rainfall. Ingredients included local succulent weeds, cow dung and lime.

EXERCISE 31. FARMER-BASED RESEARCH ON SOILS

Background

It is likely that this manual will be used for three or four-day workshops with alumni IPM farmers. The format and pace of the exercises makes the assumption that the participants are already well familiar with the participatory IPM approach practices by them first in Farmer Field Schools. By the time you have gotten to the end of these exercises, there should already be thoughts by the participating farmers of doing season-long (or longer) experiments on their own fields. The facilitator should use this last session to promote a discussion on general conclusions and planning for future activities. This exercise does not intend to tell participants what type of experiments they should do, but rather to remind them of certain methodological points that may make the effort more efficient and less frustrating.

Goal

To provide a forum for discussions on conclusions and an opportunity to plan for future research activities.

Time required

3-4 hours

Materials

Pens

Newsprint

Tape

Steps

1. Begin with a group discussion stating what are the most important conclusions the participants see for the soils training workshop.
2. While still in the large group ask the participants to list the principal issues they see related to the conditions in their specific farming locations. Decide on the 5 (or whatever the number of small groups is) most important issues to explore.
3. Break into small groups and devise, one issue for each group, a plan for carrying out a season-long experiment to investigate the issue.
4. Report back to the large group and discuss the details.

Points to Emphasize

1. ***Keep it simple!*** The tendency is always to try and test too many factors at one time. The more factors varied in an experiment, the more difficult it is to interpret the results.
2. If the experiment involves putting organic matter back into the soil and evaluating the outcome, realize that ***effects may not be easy to see after the first season***. For paddy fields to show a strong response to recycling rice straw, you usually need to wait until the second season. A typical return on your labors to return rice straw is often around a 10% increase in yield beginning the second season, and increasing somewhat thereafter.
3. Look to evaluate a wide range of effects. If farmers wish to test a new method that has effect on their soil system, look at a full range of effects—not just on the yield, but the general appearance of the crop; the incidence of diseases , pests and natural enemies; the effects on the physical factors related to the soils.
4. Plan a time to get together again to go over the next step in carrying out their research plans (usually a couple of weeks pre-planting or pre-harvest).