Integrated Nutrient Management
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## ON CULTURAL MANAGEMENT AND NUTRIENT DEFICIENCY

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What is integrated nutrient management (INM)?

INM is actually an integrated soil nutrient management ensuring adequate availability of plant nutrients. Management approaches use both natural and man-made or synthetic sources of nutrients, coupled by good water management, crop rotation, and recycling of crop residues.

Why is INM important?

INM seeks to increase agricultural productivity, safeguard the environment, and decrease nutrient loss through efficient fertilizer use. The incorporation of organic fertilizers supplements plant nutrients, reduces the use of inorganic fertilizers to some extent, and improves the physical and biological properties of the soil.

What are the essential elements for rice?

There are 16 elements needed by the rice plant to complete its life cycle. They are generally grouped into 9 macroelements and 7 microelements. The rice plant requires relatively high amount of macroelements and small amounts of microelements. The most important nutrients are N, P, K, S, Zn, and Fe.

<table>
<thead>
<tr>
<th>Macroelements</th>
<th>Name</th>
<th>Symbol</th>
<th>Microelements</th>
<th>Name</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Carbon</td>
<td>C</td>
<td>Zinc</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hydrogen</td>
<td>H</td>
<td>Iron</td>
<td></td>
<td>Fe</td>
</tr>
<tr>
<td></td>
<td>Oxygen</td>
<td>O</td>
<td>Copper</td>
<td></td>
<td>Cu</td>
</tr>
<tr>
<td></td>
<td>Nitrogen</td>
<td>N</td>
<td>Molybdenum</td>
<td></td>
<td>Mo</td>
</tr>
<tr>
<td></td>
<td>Phosphorus</td>
<td>P</td>
<td>Manganese</td>
<td></td>
<td>Mn</td>
</tr>
<tr>
<td></td>
<td>Potassium</td>
<td>K</td>
<td>Boron</td>
<td></td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Calcium</td>
<td>Ca</td>
<td>Chlorine</td>
<td></td>
<td>Cl</td>
</tr>
<tr>
<td></td>
<td>Magnesium</td>
<td>Mg</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sulfur</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
What are inorganic fertilizers?

Inorganic fertilizers are commercially manufactured fertilizers that contain high levels of readily available nutrient elements. They dissolve in water, making nutrients readily available for plant's use.

What inorganic fertilizers should I apply in my ricefield?

Before applying fertilizers to the ricefield, determine the kind of nutrients that are sufficient or limiting in the soil. The soil can be diagnosed using soil test kits, laboratory analysis, and the minus-one element technique. The need of the crop for N can be diagnosed using the leaf color chart. (Refer to tools, page 12)

I have been applying fertilizer to my ricefield for more than 15 years but the yield has not increased. Why?

Long-term application of inorganic fertilizers does not increase rice yield when 1) the applied fertilizer does not provide all nutrients needed by the plants, 2) the amount of fertilizer and water are insufficient, 3) the amount of fertilizer is too much and unbalanced, 4) the fertilizer is applied at the wrong time and place, and 5) the maximum yield potential of variety has been reached.

If you have been putting the same fertilizer nutrients (e.g., N, P, K, or N and P only, or N only, P only, or N and K only) over the years, you
have only been replenishing the same kind of fertilizer nutrients but depleting other nutrients (macroelements and microelements) that the rice plants need to produce high yield.

Also if high N fertilizer is applied without balancing it with corresponding K fertilizer, more likely yield becomes lower.

Which is a better N fertilizer source, ammonium sulfate (21-0-0) or urea (46-0-0)?

The use of either type of N source depends on the farm condition. For instance, flood-prone areas with high pH have high N use efficiency with the ammonium sulfate. However, ammonium sulfate has greater acidifying effects on the soil than urea. Urea contains a higher percentage of N than ammonium sulfate, so fewer bags are applied per hectare, making it cost-saving.

In general, grain yield response to ammonium sulfate and urea are similar when N is the only element in question. However, ammonium sulfate may be better N source in sulfur-deficient soil.

When is the right time to apply N?

a. For transplanted rice, apply N fertilizer as basal before or during the final harrowing. Base succeeding fertilizer applications should be based on the leaf color chart (LCC). (Refer to tools, page 12)

b. For direct seeded rice, determine when to topdress N by using the LCC.

The first application promotes production of more tillers thus increases the potential number of panicles. The second application increases the number and weight of spikelets in a panicle.

Is it necessary to apply basal N fertilizer?

a. For transplanted rice, it is necessary to apply the first dose of N as basal so that the plant will absorb more nitrogen. Mix fertilizer thoroughly with the soil so that it will not be easily lost and it will be
closer to the roots of the plants. However, for soils with indigenous N supply (INS) greater than 40 kg/ha, basal N is often not required because this amount can sustain the early crop growth requirement.

b. For direct seeded rice, basal application is not recommended because: 1) seedlings are too small for the large N supply; 2) seedlings still have food up to 15 days after sowing; and 3) water is drained from the field up to 10 days, thus, there will be higher N losses. If INS is greater than 40 kg/ha, basal application is also not needed.

What is split application of N fertilizer?

A 2-split application is when N fertilizers are applied in two batches. For varieties that mature in 115 days, $\frac{1}{3}$ to $\frac{1}{2}$ of the N fertilizer is applied as basal and $\frac{2}{3}$ to $\frac{1}{2}$ is applied at early panicle initiation. For 125-130 day maturing varieties in coarse-textured soils, split the N into 3: $\frac{1}{3}$ as basal, and $\frac{1}{3}$ each at tillering and early panicle initiation.

With this type of application, a sufficient amount of nitrogen will be available at the stage when the plants need it most. This will also increase the efficiency of fertilizer use. LCC can be used to indicate the time when N should be applied. However, if the amount of fertilizer to apply is just a small amount, e.g., 30 kg for 1 hectare, do not split its application. Apply it at early panicle initiation stage.

How do we make full use of the N fertilizer?

1) Use responsive varieties, 2) maintain good water control to decrease N loss, 3) controlling weeds that compete with the rice plant, 4) control insects and diseases for the plant to fully express the benefit from the added nitrogen, and 5) apply N at the right time using the right method.
Why is the rate of N fertilizer application higher during the dry season than the wet season?

Owing to higher solar radiation in the dry season, crop growth rate is high. Hence, N fertilizer requirement is high.

What is the importance of phosphorus fertilizer?

Phosphorus (P) is essential for root development and production of tillers. Thus, P fertilizer must be applied at the start of tillering and root elongation. It must be incorporated into the soil or topdressed 10-15 days after seeding. Apply 10-15kg P (23-34 kg P$_2$O$_5$ per hectare) for a grain yield target of 5 t/ha to re-supply P that was removed at harvest in normal soil.

What is the importance of potassium fertilizer?

Potassium (K) increases leaf area, spikelet number, stress resistance, and percentage filled grain and grain weight. Thus, a portion of K (50-75%) can be applied as basal and the remaining 25-50% of the total K requirement at early panicle initiation stage.

How much potassium should be applied in a hectare?

It depends on the soil type, variety, cropping intensity, and straw management. If rice straw is removed from the field and K from other sources is small, apply 50 kg K (60 kg K O per hectare) for 5 t/ha yield to re-supply K removed. Thus, it is advised not to burn straw or throw away threshed materials. Instead, these materials should be returned and incorporated into the soil.

In clay soils, K may be incorporated basally along with nitrogen and phosphorus fertilizers. In sandy or coarse-textured soils, K will leach. Thus, it should be topdressed at early tillering stage. If a small amount of K will be applied, it is better to topdress it once at the rapid tillering stage.
Is it advisable to apply foliar fertilizer?

Yes, only when applying fertilizers that contain microelements, which are needed in small amount. Foliar application is not advisable when applying fertilizers that contain macronutrients, which are needed in large amounts, because it is tedious to apply.

What does 14-14-14 and 21-0-0 or 21-0-0-25 S mean?

These are fertilizer grades or percentage nutrients in the fertilizer materials. For example, 14-14-14 means 14% each of N, P and K in the fertilizer material. Ammonium sulfate or 21-0-0-25 means that the fertilizer has 21% N, no P and K, and 25% sulfur Fertilizers with S at the end contain sulfur in the form of sulfate.

I was told to apply 120-30-90 kg NPK fertilizer per hectare. What fertilizer and how many bags should I apply?

The weight of nutrients (kg) in a bag of commercial inorganic fertilizer is only one half of the percentage indicated in the bag. For example, 14-14-14 means there are 14% each of N, P and K that are equivalent to 7 kg each of N, P and K per bag.

<table>
<thead>
<tr>
<th>Fertilizer Source</th>
<th>Fertilizer Grade</th>
<th>Amount of Fertilizer (kg per bag)</th>
<th>Nitrogen</th>
<th>Phosphorus</th>
<th>Potassium</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea</td>
<td>46-0-0</td>
<td>23</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Ammonium sulfate</td>
<td>21-0-0-25 S</td>
<td>10.5</td>
<td>0</td>
<td>0</td>
<td>12.5 Sulfur</td>
<td></td>
</tr>
<tr>
<td>Ammonium phosphate</td>
<td>16-20-0</td>
<td>8</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Solophos</td>
<td>0-18-0</td>
<td>0</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>NK fertilizer</td>
<td>17-0-17</td>
<td>8.5</td>
<td>0</td>
<td>0</td>
<td>8.5</td>
<td></td>
</tr>
<tr>
<td>Murate of Potash</td>
<td>0-0-60</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Complete</td>
<td>14-14-14</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>
Computation:

NOTE: 1 bag fertilizer equals 50 kg

kg of fertilizer needed per hectare = recommendation for 1 hectare of the element in the fertilizer

Steps in computation:

1. In a fertilizer recommendation (120-30-90 kg NPK per hectare), satisfy first the lowest nutrient requirement. In this case, 30 kg P/ha.

2. Use the fertilizer containing the most number of nutrients.

3. With the use of 14-14-14 fertilizer:
   kg P per hectare = 30 divided by 0.14 = 214.3 kg
   214.3 kg of 14-14-14 equals 4 1/3 bags.
   This also gives 30 kg N per hectare and 30 kg K per hectare.

4. Additional N (120 - 30 = 90 kg) is required.
   With the use of urea (46-0-0):
   kg N per hectare = 90 divided by 0.46 = 195.7 kg
   195.7 kg of urea is about 4 bags

5. Additional K (90 - 30 = 60 kg) is required.
   Use muriate of potash (0-0-60)
   kg K per hectare = 60 divided by 0.60 = 100 kg
   100 kg of muriate of potash equals 2 bags

To satisfy the above recommendations, apply 4 1/3 bags of 14-14-14, 4 bags of urea, and 2 bags of 0-0-60.

When can I detect zinc-deficiency symptoms?

Zinc deficiency symptoms appear 2-4 weeks after transplanting (See page 19 for symptoms). In moderate deficiency, the rice plants recover starting at 6 weeks after transplanting.
If I have a budget for only 1-2 bags of urea, when should I apply these to obtain a maximum return?

Apply urea one week before the visible panicle initiation stage or about 40 days after transplanting for a 120-day old variety. The rice plant will use absorbed N during the reproductive stage to enhance grain yield. The plant will use some INS during vegetative growth. Make sure that the field is not weedy to avoid competition with weeds.

ON ORGANIC FERTILIZERS

Why should I apply organic fertilizer?

Organic fertilizers (OF) help improve the physical, biological, and chemical properties of the soil. OF increases the water holding capacity of soil, enabling the plant roots to have better access to available nutrients.

Organic materials also increase microbial populations and diversity. These are essential to transform fertilizer materials into available form for plant’s use and to rejuvenate soil. OF serve as supplement to inorganic fertilizers because they contain microelements and macroelements. Sources of organic fertilizers include rice straw, green and animal manures, composts, and organic wastes.

OF can be applied in the seedbed to ease pulling of seedlings.
When is the best time to apply OF?

Unprocessed or undecomposed organic materials should be incorporated into the field 3 to 4 weeks before transplanting for these materials to be fully decomposed. This will give ample time for the harmful organic acids to be eliminated.

Processed organic fertilizers can be incorporated into the soil during the last harrowing, a week before transplanting or sowing.

<table>
<thead>
<tr>
<th>Organic Fertilizer</th>
<th>When to apply*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncomposted rice straw</td>
<td>28-30 days before transplanting</td>
</tr>
<tr>
<td>Succulent green manure</td>
<td>1-2 days before transplanting</td>
</tr>
<tr>
<td>Commercial organic fertilizer Rice</td>
<td>7-10 days before transplanting</td>
</tr>
<tr>
<td>straw with EM 1**</td>
<td>21-30 days before transplanting</td>
</tr>
<tr>
<td>Composted rice straw</td>
<td>7-10 days before transplanting</td>
</tr>
</tbody>
</table>

* Based on N release patterns in incubation studies.
** EM1 or Effective Microorganism 1.

What are the advantages of using green manure?

Green manure is an inexpensive source of organic fertilizer providing both the macro and microelements for plant growth. Most green manure crops are legumes and they can accumulate nitrogen (30-60kg N/ha) rapidly in 45-60 days of growth. Legumes have the ability to fix N from the air through the help of N-fixing bacteria that lives inside their root or stem nodules.

Indigo, Azolla and Sesbania are commonly used green manures
When is the best time to incorporate green manure crop?

The best time to incorporate a green manure crop is when the crop is about to flower since biomass and cumulative N is highest at that stage.

What is the advantage of applying fully decomposed organic materials?

Organic materials, such as rice straw and manure, should be fully decomposed before incorporating into the ricefield because the decomposing organic matter may be toxic to the plants’ roots. During the decomposition process, the organic materials produce organic acids that affect root growth of the newly transplanted rice seedlings. Until fully decomposed, organic materials temporarily immobilize N which will make plants deprived of N supply. Likewise, undecomposed organic materials cause some release of GHG.

Why is it that more weeds grow when I use OF?

Normally, weed seeds become dormant during the processing of OF. When OF is applied, microorganisms present in OF produce hormones that enhance the growth of weeds. Hence, more weeds grow when OF is applied.

Why is it that mud deepens after using OF?

Applying OF loosens and increases water holding capacity of the soil because of the increased organic matter supplied. Mud deepens when the hard pan breaks due to too much tillage activity such as plowing after OF is applied.
How important is the rice straw?

Rice straw is one of the cheap sources of organic fertilizer. It contains the entire mineral elements taken up by the rice plant. At harvest, a 5-ton rice straw produced from 5 tons of palay can provide 25-40 kg nitrogen, 3-6 kg phosphorus, 60-85 kg potassium, 2-5 kg sulfur, 200-350 kg silicon, 2,000 kg carbon, and several other nutrients upon total decomposition.

What is the effect of burning rice straw?

Burning of rice straw results in the loss of about 25% phosphorus, 20% potassium, 5-60% sulfur, and almost complete loss of nitrogen. Burning also kills beneficial soil microorganisms directly through heat and indirectly by removing their food source. It also adds pollution to the environment. However, burning transforms straw into a mineral K nutrient source.

What is the best commercial organic fertilizer (COF)?

There is no best COF. There are two kinds of COF: fortified and natural. The fortified COF is enriched with commercial fertilizer to increase the nutrient level. It contains >7% total plant food. Natural COF are processed plant and animal parts, manures, and other natural products i.e. rock phosphate and zeolites. They usually contain 1-3% plant food.

Do COFs differ in their composition?

Yes, because of the different substrates used and the method of processing. Some COFs contain some percentage of inorganic fertilizers.
How many bags of OF will I apply in a hectare?

There is no exact amount of OF recommended. The amount depends on the amount of organic matter (OM) in the soil. A fertile soil contains about 4% OM. Regular application of OF is needed to sustain soil health and productivity because of the high rate of OM mineralization in the tropics such as the Philippines.

The following table shows how much phosphorus and potassium are produced by a ton (1,000 kg) of the organic materials.

<table>
<thead>
<tr>
<th>One ton</th>
<th>Phosphorus (kg)</th>
<th>Potassium (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh azolla</td>
<td>2.5</td>
<td>1</td>
</tr>
<tr>
<td>Rice straw and old cattle manure</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Fresh ipil-ipil leaves</td>
<td>6</td>
<td>1.0</td>
</tr>
<tr>
<td>Old poultry dung</td>
<td>1.5</td>
<td>1.0</td>
</tr>
<tr>
<td>Old swine manure</td>
<td>1.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Sesbania rostrata (fresh)</td>
<td>1.5</td>
<td>4.0</td>
</tr>
</tbody>
</table>

ON TOOLS AND METHODS IN DETERMINING SOIL FERTILITY

What is the importance of soil analysis?

Soil analysis determines the kind and amount of fertilizers to apply. It is a tool for decision making. Soil should be analyzed every five years.

The different kinds of soil analysis include laboratory analysis, soil test kit (STK), or a nutrient-deficient diagnostic kit called Minus-One Element Technique (MOET). The leaf color chart (LCC) through leaf color reading can indicate if soil N is limiting and thus the need to apply N.
What is the proper way of collecting soil sample?

The soil sample should represent the area from where it was collected. The soil sample must represent an area that is uniform in slope, texture, depth of sampling, drainage, and cropping and fertilizer history. Avoid contaminating the soil sample. (Refer to Appendix 3, page 24)

What is STK?

Soil test kit (STK) estimates the level of organic matter, pH, nitrogen, phosphorus, potassium, and calcium in the soil. It can show whether these elements are present at low, medium, or high levels. Based on the nutrient level, a corresponding fertilizer rate for a particular crop is indicated in the kit.

What is MOET?

The minus-one element technique (MOET) determines nutrient deficiency as exhibited by the plant itself in actual field condition. It can test for sufficiency or deficiency of nitrogen, phosphorus, potassium, zinc, sulfur, copper, and other elements in the ricefield.

When is the best time to use MOET?

It is best to conduct MOET at least 45 days before planting so that you can adjust fertilizer application at the time of transplanting.

What is LCC?

The leaf color chart (LCC) is a handy plastic “ruler” with strips of four shades of green to compare the color of rice leaves under field conditions. It is a cheap, fast, and handy field instrument to measure green color intensity of leaf, which is related to the plant’s nitrogen content.
Yellowish green (No. 1 in the LCC) represents the lowest nitrogen concentration and dark green (No. 4) as the highest. The topmost fully expanded and healthy leaf from a rice plant is placed on top of the LCC and graded according to the corresponding color strip on the “ruler.” The result of the grading, taken weekly, forms the basis of nitrogen fertilizer application.

**When is the best time to use LCC?**

Start taking readings at 14 days after transplanting or 21 days after seeding. Readings should be taken at the same time of the day (8-10 am or 2-4 pm). Avoid the sun's glare when taking readings. Do not take readings early in the morning as dewdrops can make reading difficult. It is best if only one person takes the readings.

**What are the advantages of using LCC?**

With LCC, the nitrogen requirement of the plant and the time of application can be easily determined without sampling or destroying the plant. Moreover, with LCC-based application, unnecessary application of N is avoided. Thus, farmers can save at least two bags of fertilizer, which cost about P1,000.

**Will the LCC fade over a long time if it is exposed to sunlight?**

The LCC will fade (discolor) if continuously exposed to intense sunlight. But using the LCC properly can avoid this. The person taking the readings must always keep his back to the sun's glare to avoid directly exposing the LCC ruler to intense sunlight. After using the LCC ruler, cover it and place it in a shed to avoid discoloration.
ON CULTURAL MANAGEMENT AND NUTRIENT DEFICIENCY

When should I apply fertilizer?

The time of fertilizer application is based on 1) variety grown, 2) crop establishment method and intensity, 3) water management, 4) type of fertilizer, 5) method of fertilizer application, 6) soil physico-chemical properties affecting nutrient transformations, and 7) climate.

The rice plant is usually responsive to nitrogen fertilizer right after transplanting and just before the reproductive stage (5-7 days before panicle initiation). Applying N at these stages will influence the number of panicles per unit area, the number of spikelets per panicle, and the dry matter produced.

What is the best time of the day to apply fertilizer?

Apply fertilizer when the leaves are dry (usually in the morning 9-10 am) so that the fertilizer will not stick to moist leaves and cause leaf burn.

What are the factors to consider in topdressing?

The factors that should be considered before topdressing are the soil N and K supplying capacity or indigenous N supply, water management, weather (heavy rainfall can wash fertilizer away), the type of fertilizer, and crop growth stage. It is also important that topdressing be done with 3-5 cm standing water to reduce losses of applied fertilizer.
How much and what fertilizer should I apply to over-aged seedlings (30+ days)?

For transplanted over-aged seedlings, the amount of basal N fertilizer should be increased from $\frac{1}{2}$ to $\frac{2}{3}$ of the recommended N fertilizer rate. Use the typical fertilizers but there should be higher dosage of N fertilizer. However, it is advised to avoid planting more than 30 day-old seedlings because their fertilizer use efficiency is very low.

How much fertilizer is needed for a grain yield target of 7 t/ha?

Generally, 17 kg N + 3 kg P + 17 kg K (nutrient uptake) are needed to produce a ton of grain yield assuming that other nutrients are not deficient. Therefore, a yield target of 7 t/ha in the dry season will take up 119 kg N/ha (= 17 kg N/ton yield x 7 t/ha), 21 kg P/ha (= 3kg P/ton yield x 7 t/ha), and 119 kg K/ha (= 17 kg K/ton yield x 7 t/ha).

If the indigenous N supply is 60 kg/ha, indigenous P supply is 15 kg/ha, indigenous K supply is 85 kg/ha and apparent recovery efficiency (RE) for N, P, and K fertilizers are 40%, 20%, and 40%, respectively, then the amount of fertilizer to apply to attain the yield target of 7 t/ha can be obtained from the following calculations:

• **N fertilizer** = 119 kg N/ha - 60 kg N/ha, the INS 0.40 or RE for N
  \~ 148 kg N fertilizer per hectare

• **P fertilizer (P2O5)** = 21 kg P/ha - 15 kg P/ha, the IPS 0.2 or RE for N x 2.3 to convert P to P2O5
  \~ 70 p fertilizer per hectare

• **K fertilizer (K O)** = 119 kg K/ha - 85 kg K/ha, the IKS 0.40 or RE for K x 1.2 to convert K to K O
  \~ 102 kg K fertilizer per hectare
Can I mix different fertilizer materials and apply all of them at the same time?

Yes, if they will be applied immediately in the field. For granular fertilizer materials, those that have same size of granules can be mixed. However, different fertilizer materials must not be mixed if they will be stored. These materials may “stick together,” making fertilizer application difficult.

Can I mix fertilizer and pesticides?

Yes, if both of your fertilizer and pesticides are granular or liquid and compatible. However, this is not a common practice. Managing fertilizers, particularly N or K can reduce pest incidence.

Is it advisable to apply fertilizer in a weedy field?

No. The weeds will compete with the plants for the nutrients. Weed competition is critical during the first 30-45 days after transplanting. Weeds are also more efficient users of fertilizers.

What is the best water level to apply fertilizer?

The farmers’ practice of applying basal nitrogen fertilizer to the floodwater causes tremendous loss of nitrogen, which escapes into the air as gas. Therefore, it is advisable to apply basal N fertilizers at saturated soil condition (no floodwater or standing water).

Why is the growth of my plants not uniform?

The uneven growth of the plants may be caused by uneven application or distribution of fertilizer or nutrient limitation. Insufficient land leveling during land preparation is another factor. It may also be caused by border effect, mixtures/impurity, and pest damage.
How do nutrient deficiencies differ from pest damage symptoms?

Nutrient deficiency symptoms usually begin in wide areas of the field while pest damage symptoms can be observed, first in small areas of the field, then increasing in areas affected.

Do the plant nutrients supplied in commercial fertilizers pose a greater or lesser threat to the environment compared to nutrients in animal manures and forage legumes?

No. Commercial fertilizers are the most controllable sources of nutrients for crop production. Through careful selection of rates, placements, sources, and timing, it is possible to supply nutrients at rates close to the levels necessary to achieve optimum economical and environmental efficiency.

Why is the soil in my field yellowish?

The tint of the soil varies from brown to yellow especially when the organic matter content of the soil is very low. Reddish yellow streaks indicate that the soil was subjected to flooding.

What is the cause of soil acidity?

Soil acidity develops when calcium, phosphorus, magnesium, and sodium are leached out leaving the soils with more hydrogen and aluminum ions, thereby decreasing soil pH (5 or lower). This can occur in upland soils when rainfall is high. However, in lowland soils, flooding increases pH of acid soils and decreases pH of alkaline soils. This increases the availability of most nutrients needed by the rice plant except zinc, sulfur, and copper.

In general, acidity of the soil is not a problem in most lowland soils.
# APPENDIX 1. Some Nutrients Needed By Rice

<table>
<thead>
<tr>
<th>Element</th>
<th>Function</th>
<th>Deficiency symptoms</th>
</tr>
</thead>
</table>
| **Governer** | • Gives green appearance to plant parts  
• Promotes rapid growth or increased height and tiller number  
• Increases size of leaves and grains, number of spikelets, and protein content in the grains  
• Stimulates root development  
• Promotes earlier flowering and ripening, particularly under cool climate | • Stunted plants with limited number of tillers  
• Narrow and short leaves, which are erect and become yellowish green as they age (young leaves remain greener)  
• Old leaves become light straw colored and die |

| **Phosphorus** | • Encourages more active tillering  
• Promotes good grain development and gives higher food values | • Stunted plants with limited number of tillers  
• Narrow and short leaves that are erect and dark green  
• Young leaves remain healthier than older leaves, which turn brown and die  
• Reddish or purplish color may develop on leaves of varieties that tend to produce anthocyanin pigment |

| **Potassium** | • Favors tillering and increases the size and weight of the grains  
• Increases response to phosphorus  
• Plays an important role in physiological processes in the plant including opening and closing of stomata and tolerance to unfavorable climatic conditions  
• Renders resistance to diseases such as blast and Helminthopshorium | • Stunted plants and tillering slightly reduced  
• Short, droopy, and dark green leaves  
• Brown spots sometimes develop on dark green leaves  
• Irregular necrotic spots may develop on the panicle  
• Long, thin panicles form  
• Wilting when there is excessive imbalance with nitrogen (low K-N ratio in plant) |

| **Zinc** | • Probable connection with the production of auxin, one of the best-known plant growth regulators  
• Important in seedling development | • Midribs of younger leaves, especially the base, become chlorotic  
• Brown blotches and streaks in lower leaves appear followed by stunted growth, although tillering may continue  
• Reduced size of the leaf blade but with the leaf sheath affected slightly  
• Uneven growth and delayed  
• Maturity in the field |
<table>
<thead>
<tr>
<th><strong>Sulfur</strong></th>
<th><strong>Iron</strong></th>
<th><strong>Copper</strong></th>
</tr>
</thead>
</table>
| • Involved in the formation of vitamins and synthesis of some hormones  
• Important in the functioning of many plant enzymes, enzyme activators and oxidation-reduction reactions | • Related to the formation of the chlorophyll  
• Required in protein synthesis  
• An inhibitor of the absorption of potassium by the rice plant | • Required for lignin synthesis (cellular defense) and constituent of enzymes  
• Key role in photosynthesis, respiration, fertilization, and pollen formation |
| • Similar to those of nitrogen deficiency, which makes it difficult to distinguish the two deficiencies by visual symptoms alone  
• Initially on leaf sheaths, which become yellowish, proceeding to leaf blades, with the whole plant chlorotic at the tillering stage  
• Reduced plant height and tiller number  
• Fewer panicles, shorter panicles, and reduced number of spikelets per panicle at maturity  
• Older leaves become greener | • New leaves do not unroll  
• Reduced tillering  
• Pollen viability reduced  
• Leaves develop chlorotic streaks followed by brown necrotic lesions on leaf tip | • Entire leaves become chlorotic and then whitish  
• Newly emerging leaf becomes chlorotic if iron supply is cut suddenly |
APPENDIX 2. How to Collect Soil Samples

Proper collection of soil samples is extremely important. The correct interpretation of the soil test can be made only when the samples are truly representative of the soil conditions in the field.

Sampling

Sampling is easy when the soil is moist. However, sampling may also be taken when the soil is dry or is naturally wet as in paddy fields.

Collect soil samples away from fences, roads, building sites, straw piles, manure piles, etc. Do not mix the following:
- light and dark colored soils
- samples from areas which vary in past fertilizer application or average crop yield
- samples from different textures
- samples from different elevations/slopes

Materials

Tools - a long narrow bladed shovel or other ordinary shovel or bolo, to collect soil samples
- for paddy field (wet soil), use a PVC pipe with about 2.5” cm diameter

Containers - a pail or basin for collecting and mixing soil samples
- plastic bags for packaging the samples from the field to the laboratory

Procedure

1. Divide the farm into lots. A farm may be level or sloping, it may have wet or stony portions. Collect a sample that represents an area, which has uniform slope, texture, depth, drainage, and crop grown.
2. Make a triangular cut to a depth of 25-30 cm (Fig 1). Slice 2-3 cm (Fig. 2) thick from each of the cut when using the shovel. Remove and place the collected soil in a container. Repeat this procedure in 10 different spots as shown in Figure 3.

Fig. 1. "remove the soil"

Fig. 2. "triangular cut must be 25-30 cm in depth"

Fig. 3. "soil slice to be collected for sampling (2-3 cm in thick) with the width of 10-25 cm"

Fig. 3. Ten different places in the field where soil sample should be collected.

Note: Avoid any contamination during the collection and processing of soil samples.
3. Mix all the soil in the container; break big clods into smallest possible size, then pour it on a plastic sheet. Divide the lot into four (Fig. 4) and discard the soil from appropriate quarters. Repeat the procedure until the desired volume of soil (1-2 kg) is attained.

Fig. 4. In the divided lot, collect only parts 1 and 4 and discard parts 2 and 3.

4. Fill up the soil sampling information sheet (Appendix 3) and attach it with the soil sample. Label the plastic bags with the following: 1) date and place of sampling, and 2) name of researcher or farmer.

5. In your station/laboratory, air dry the soil samples. Pulverize using a wooden mallet/pestle.
APPENDIX 3. Soil sampling information sheet

Name of farmer _______________________________ Date of sampling __________________
Mailing address ________________________________ Date submitted __________________
Location of farm ___________________ Date submitted __________________
Directions for finding the site/Landmark ________________________________
Area represented (ha) _______
Topography: _____ Plain _____ Rolling _____ Hilly
Previous crops ________________________________
Fertilizer applied to previous crops (amount and kind) ________________________________
Crop and variety to be fertilized ________________________________
Water source: ________ Irrigated (NIA/Pump/SWIP etc) _______ Rainfed
Yield (t/ha): in dry season ______________________ in wet season ______________________
Slope gradient ________________________________
Yield from previous cropping ________________________________

APPENDIX 4. Sources of inorganic fertilizers

<table>
<thead>
<tr>
<th>N sources</th>
<th>P sources</th>
<th>K sources</th>
<th>Zn sources</th>
<th>S sources</th>
<th>N-P sources</th>
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<tr>
<td>14-14-14</td>
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<td>10-10-20</td>
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<td>17-17-17</td>
<td>17-17-17</td>
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</tbody>
</table>
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We are a government corporate entity attached to the Department of Agriculture. We were created through Executive Order 1061 on 5 November 1985 (as amended) to help develop high-yielding and cost-reducing technologies so farmers can produce enough rice for all Filipinos.

We accomplish this mission through research and development work in our central and six branch stations, coordinating with a network that comprises 57 agencies and 70 seed centers strategically located nationwide.

To help farmers achieve holistic development, we will pursue the following goals in 2010-2020: attaining and sustaining rice self-sufficiency; reducing poverty and malnutrition; and achieving competitiveness through agricultural science and technology.

We have the following certifications: ISO 9001:2008 (Quality Management), ISO 14001:2004 (Environmental Management), and OHSAS 18001:2007 (Occupational Health and Safety Assessment Series).

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