SUSTAINABLE FERTILIZER MANAGEMENT

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Messages

• Application of chemical fertilizers in combination with bio-organic fertilizer is one of alternative method to achieve sustainable fertilizer management

• This alternative can reduce the fertilization cost, reduce environmental pollution, improve soil properties and soil systems, and enhance crop yields
AGRICULTURE SOILS IN INDONESIA

- LOW pH (4-5) – due to parent materials and high rainfall
- Al & Fe TOXICITY, LOW AVAILABLE P
- LEACHING OF NUTRIENTS (HIGH RAINFALL)
- MOST AGRICULTURE SOILS IN INDONESIA HAVE BEEN DEGRADED, WITH LOW ORGANIC MATTER CONTENT

<table>
<thead>
<tr>
<th>Area</th>
<th>Organic Matter</th>
</tr>
</thead>
<tbody>
<tr>
<td>73%</td>
<td>&lt; 2%</td>
</tr>
<tr>
<td>23%</td>
<td>2 - 3%</td>
</tr>
<tr>
<td>4%</td>
<td>&gt; 4%</td>
</tr>
</tbody>
</table>

CHEMICAL FERTILIZERS USED

FOOD CROPS:
RECEIVE GOVERNMENT SUBSIDIZATION
- NATIONAL RECOMMENDATIONS
- REGIONAL RECOMMENDATIONS
- DISTRICT RECOMMENDATIONS
- SUB-DISTRICT (KECAMATAN) RECOMMENDATIONS
  – ISSUED BY THE MINISTRY OF AGRICULTURE

PLANTATION CROPS:
- NOT SUBSIDIZED
- APPLICATIONS BASED ON SOIL AND PLANT ANALYSES
FERTILIZERS SUBSIDIZE FOR DIFFERENT SECTORS 2014

<table>
<thead>
<tr>
<th>SUB-SECTORS</th>
<th>KIND OF FERTILIZER (TONS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>UREA</td>
</tr>
<tr>
<td>FOOD CROPS</td>
<td>2,481,552</td>
</tr>
<tr>
<td>HORTICULTURE</td>
<td>195,819</td>
</tr>
<tr>
<td>PLANTATION/small holder</td>
<td>521,113</td>
</tr>
<tr>
<td>ANIMAL HUSBANDRY</td>
<td>102,663</td>
</tr>
<tr>
<td>FISH CULTURE</td>
<td>116,853</td>
</tr>
<tr>
<td>TOTAL</td>
<td>3,418,000</td>
</tr>
</tbody>
</table>

FERTILIZATION

IN PRINCIPLE, FERTILIZER APPLICATION SHOULD BE:
• RIGHT DOSAGE/LEVELS
• RIGHT TIME
• RIGHT KIND OF FERTILIZERS
• RIGHT METHOD OF APPLICATION

IN REALITY - MANY PROBLEMS!
• DOSAGES VARY BY SUB-DISTRICT RECOMMENDATION
• NOT THE RIGHT TIME
• NPK VS. NEED NP-NK
• METHODS OF APPLICATION
### CHEMICAL FERTILIZER CONSUMPTION (KG/HA)

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>N</th>
<th>P</th>
<th>K</th>
<th>TOTAL</th>
<th>YIELD</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>58</td>
<td>22</td>
<td>-</td>
<td>80</td>
<td>5400</td>
</tr>
<tr>
<td>FRANCE</td>
<td>126</td>
<td>43</td>
<td>-</td>
<td>169</td>
<td>7244</td>
</tr>
<tr>
<td>GERMANY</td>
<td>120</td>
<td>30</td>
<td>-</td>
<td>150</td>
<td>6470</td>
</tr>
<tr>
<td>CHINA</td>
<td>171</td>
<td>71</td>
<td>-</td>
<td>242</td>
<td>4756</td>
</tr>
<tr>
<td>INDONESIA</td>
<td>200-250</td>
<td>100</td>
<td>50-100</td>
<td>350-450</td>
<td>5000</td>
</tr>
</tbody>
</table>

NPK CONSUMPTION IN INDONESIA IS HIGHER NUTRIENT-UPTAKE EFFICIENCY LOW

### LOW SOIL ORGANIC MATTER (SOM)

**WHY?**

- FARMERS RECOGNIZED ONLY CHEMICAL FERTILIZERS -- VERY HANDY AND SIMPLE, BUT THEY **ONLY SUPPLIED N, P, AND K**
- THEY FORGOT OR WERE RELUCTANT TO USE ORGANIC FERTILIZER
- SOILS **WERE GOOD QUALITY** TO BEGIN WITH, HIGH SOM, HIGH YIELDING
- BUT VERY INTENSIVE AGRICULTURE WAS PRACTICES, WITH 2-3 GROWING SEASONS/YEAR
- PLANT RESIDUES **WERE BURNED** OR REMOVED FOR ANIMAL FEEDING, OR FOR USE AS MATERIAL FOR MAKING PAPER, E.G.
- THIS MEANT REMOVAL OF NUTRIENTS, BOTH MACRO AND MICRO-NUTRIENTS
SOIL ORGANIC MATTER (SOM) IS THE SOUL OF SOILS

• HIGH SOM MEANS GOOD SOIL; LOW SOM MEANS BAD SOIL
• SOM IMPROVE SOIL PROPERTIES:

PHYSICAL PROPERTIES
   WATER HOLDING CAPACITY, POROSITY, PORE DISTRIBUTION, SOIL AERATION, BULK DENSITY, SOIL STRUCTURE, ETC.

CHEMICAL PROPERTIES
   NUTRIENT SUPPLY (MACRO-MICRO NUTRIENTS), CEC, BUFFERING CAPACITY, NUTRIENT AVAILABILITY, ETC.

BIOLOGICAL PROPERTIES
   STIMULATE GROWTH OF BENEFICIAL SOIL ORGANISMS, SOIL BIODIVERSITY, POPULATION OF SOIL ORGANISMS

ENHANCING SOIL ORGANIC MATTER IS THUS VERY IMPORTANT FOR IMPROVING SOIL PROPERTIES

CHEMICALS FERTILIZERS VS. ORGANIC FERTILIZER

COMPLEMENTARY

• N-P-K
• HIGH NUTRIENT CONTENT
• PARTLY CHEMICAL
  MORE NUTRIENTS
  LOW NUTRIENT CONTENT
  PHYSICS-CHEM-BIOLOGY

BOTH FERTILIZERS ARE BEST USED TOGETHER FOR OPTIMIZING RESULTS

NOTE THAT ORGANIC FERTILIZERS ARE NOT ALTERNATIVES OR SURROGATES FOR USING CHEMICAL FERTILIZER

THEIR FUNCTION OF ORGANIC FERTILIZER IS TO IMPROVE SOIL PROPERTIES AND FUNCTIONING OF SOIL SYSTEMS, WHICH IS MORE THAN JUST ADDING NUTRIENTS TO THE SOIL
FERTILIZER APPLICATION IN INDONESIA

• 1965-1970
FIRST INTRODUCTION OF CHEMICAL/INORGANIC/ARTIFICIAL FERTILIZERS TO INDONESIAN FARMERS (UREA/TSP-SP-36/KCl)
SOILS WERE GOOD, WITH HIGH SOIL ORGANIC MATTER, GIVING SIGNIFICANT INCREASES OF YIELD, WITH LITTLE OR NO USE OF ORGANIC FERTILIZERS

• 1970-2000
UREA, TSP/SP-36, KCl WERE PROMOTED
LESS OR NO USE OF ORGANIC FERTILIZER
UNBALANCED FERTILIZER APPLICATION, NO MICRONUTRIENTS
ENVIRONMENTAL POLLUTION PROBLEMS
PEST AND DISEASE PROBLEMS INCREASED
LEVELING OFF OF YIELDS
INCREASE OF FERTILIZER PRICE (GOVERNMENT SUBSIDY 18 T IDR)

FERTILIZER APPLICATION IN INDONESIA (continued)

• 2000 – UP TO NOW:
SOILS HAVE BECOME DEGRADED, LOW YIELD, LOW NUTRIENT UP-TAKE EFFICIENCY
NEED FOR NPK FERTILIZER + ORGANIC FERTILIZERS
NEED FOR GOOD QUALITY OF ORGANIC FERTILIZER
NEED FOR BIO-FERTILIZERS
BIO-ORGANIC FERTILIZER = ORG. FERTILIZER + BIOFERTILIZER

NEED FOR A NATIONAL PROGRAM FOR PROMOTING OF THE USE OF ORGANIC FERTILIZERS TOGETHER WITH CHEMICAL FERTILIZERS
REDUCE DOSAGES OF CHEMICAL FERTILIZERS; USE ORGANIC/BIO-ORGANIC FERTILIZER, BUT THE TOTAL COST OF FERTILIZERS SHOULD BE THE SAME OR LESS
STRONG SUPPORT FROM GOVERNMENT

PROMOTION OF USING PLANT RESIDUES OR ORGANIC FERTILIZER (INCENTIVE FOR NO PLANT RESIDUE BURNING, PLANT CHOPPER AID TO FARMER GROUPS)

SUBSIDIES FOR ORGANIC FERTILIZER (DIRECT FERTILIZER AID TO FARMERS)

MINISTRIAL REGULATION FOR CHEMICAL FERTILIZERS, ORGANIC FERTILIZERS, BIOFERTILIZERS, AND SOIL AMENDMENTS (GUIDANCE FOR PRODUCERS AS WELL AS FOR FARMERS -- MINISTRIAL REGULATION NO. 28 YEAR 2009 AND NO. 70 YEAR 2011)

2005-2011 MINISTRY OF AGRICULTURE

HAVE BEEN REGISTERED:

• 1,477 CHEMICAL FERTILIZERS
• 533 ORGANIC FERTILIZERS
• 126 BIOFERTILIZERS
• 162 SOIL AMENDMENTS

SOURCE: PPI, 2011
PUPUK ORGANIK (KOMPOS)
Dies IPB (1993)

MEMPERBAIKI SIFAT FISIK, KIMIA DAN BIOLOGI TANAH

PROF DR ISWANDI ANAS IPB 2011

11 JUNE 2010
STRATEGY FOR FUTURE FERTILIZATION

REDUCE DOSAGE OF CHEMICAL FERTILIZERS
COMBINE WITH ORGANIC FERTILIZERS

- INCREASE NUTRIENTS UP-TAKE EFFICIENCY
- IMPROVE SOIL QUALITY (PHYSICAL, CHEMICAL AND BIOLOGICAL PROPERTIES OF SOILS)
- MAKE SOIL SYSTEMS BETTER
- INCREASE CROP YIELD,
- REDUCE ENVIRONMENTAL POLLUTION
- REDUCE FERTILIZER SUBSIDIES 2013 (18 T IDR)

FNCA BIOFERTILIZER MEETING IN KUALALUMPUR
25-29 FEBRUARY 2008
## PRODUCTION OF BIO-ORGANIC FERTILIZERS IN CHINA

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of enterprises</th>
<th>Total production (1000 t)</th>
<th>Types of products</th>
<th>Registered products</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>110</td>
<td>100</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>1997</td>
<td>180</td>
<td>400</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>1999</td>
<td>280</td>
<td>900</td>
<td>8</td>
<td>59</td>
</tr>
<tr>
<td>2001</td>
<td>350</td>
<td>1,500</td>
<td>9</td>
<td>149</td>
</tr>
<tr>
<td>2003</td>
<td>450</td>
<td>2,000</td>
<td>11</td>
<td>286</td>
</tr>
<tr>
<td>2005</td>
<td>480</td>
<td>500</td>
<td>11</td>
<td>NA</td>
</tr>
<tr>
<td>2006</td>
<td>500</td>
<td>2,500</td>
<td>11</td>
<td>498</td>
</tr>
</tbody>
</table>

*Data provided by the Center of Supervision, Inspection and Testing of Biofertilizer Quality of MOA*

## NUMBER OF STRAINS USING FOR BASES FOR BIOFERTILIZERS IN CHINA

- Free-living N-fixing bacteria $> 40$
- Associated N-fixing bacteria 106
- Rhizobia $> 3000$
- Phosphate-solubilizing strains $\sim 80$
- Phosphate-decomposing strains $> 15$
- Silicate bacteria $V > 30$
- PGPR 150~200
- Antagonistic strains $V \sim 300$
- Pesticides degraders $\sim 300$

*(Fan, 2008)*
### Effect of Bio-organic Fertilizer in Combination with Chemical Fertilizer on Rice Yield

<table>
<thead>
<tr>
<th>Fertilization</th>
<th>Conv.</th>
<th>SRI</th>
<th>Ave-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without</td>
<td>4.50f</td>
<td>5.69d</td>
<td>5.10d</td>
</tr>
<tr>
<td>100% Inorganic</td>
<td>6.13c</td>
<td>7.75a</td>
<td>6.94a</td>
</tr>
<tr>
<td>75% Inorg+200 kg Bio-Organ-fert</td>
<td>5.55d</td>
<td>6.49b</td>
<td>6.02b</td>
</tr>
<tr>
<td>50% Inorg+200 kg Bio-Organ-Fert</td>
<td>6.01c</td>
<td>7.94a</td>
<td>6.79a</td>
</tr>
<tr>
<td>50% Inorg</td>
<td>4.98e</td>
<td>6.09c</td>
<td>5.53c</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td>5.43b</td>
<td>6.79a</td>
<td></td>
</tr>
</tbody>
</table>

### Effect of Fertilization on NPK Up-take by Rice Plant

<table>
<thead>
<tr>
<th>Treatments</th>
<th>N</th>
<th>P</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fertilization</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>NONE</strong></td>
<td>0.093c</td>
<td>0.011c</td>
<td>0.102c</td>
</tr>
<tr>
<td><strong>100% NPK</strong></td>
<td>0.274b</td>
<td>0.031b</td>
<td>0.258b</td>
</tr>
<tr>
<td><strong>75% NPK + 200 kg Bio-Organ-Ferts</strong></td>
<td>0.298b</td>
<td>0.033b</td>
<td>0.242b</td>
</tr>
<tr>
<td><strong>50% NPK+ 200 kg Bio-Organ-Ferts</strong></td>
<td>0.381a</td>
<td>0.049a</td>
<td>0.374a</td>
</tr>
<tr>
<td><strong>50% NPK</strong></td>
<td>0.164c</td>
<td>0.019c</td>
<td>0.161bc</td>
</tr>
</tbody>
</table>

Urea = 250 kg ha⁻¹, SP-36 = 75 kg ha⁻¹, KCl = 50 kg ha⁻¹; Bio-Organic Fertilizer (BIOST= 200 kg ha⁻¹)
Conclusions

• Application of chemical fertilizers in combination with bio-organic fertilizer is one of alternative method to achieve sustainable fertilizer management

• This alternative can reduce the fertilization cost, reduce environmental pollution, improve soil properties and soil systems, and enhance crop yields