Sustainable Agriculture with biofertilizers and organic fertilizers by smallholder farmers in Thailand

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Ministry of Agriculture and Cooperatives
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Outline of the presentation

1. Introduction
2. Biotechnology (organic fertilizers and biofertilizers)
3. LDD microbial products
4. Transfer technology
5. Extension on biotechnology to substitute chemical agriculture substances
6. Vetiver grass
Soil Resources of Thailand

Thailand covering total area 51.31 m.ha

- **agricultural area**: 46.5 %
- **not agricultural area**: 20.1 %
- **forest area**: 33.4 %
### Land Use of Thailand

**Agricultural area 22.2 million ha**

- **Paddy Field** 11.28 million ha
  - Cassava 1.70 million ha
  - Sugarcane 1.67 million ha
  - Maize 1.65 million ha

- **Field Crop** 5.02 million ha
  - Cassava 1.70 million ha
  - Sugarcane 1.67 million ha
  - Maize 1.65 million ha

- **Perennial Crop** 4.42 million ha
  - Para Rubber 3.31 million ha
  - Oil Palm 0.60 million ha
  - Eucalyptus 0.51 million ha

- **Orchard** 1.54 million ha
  - Mixed Fruit 1.16 million ha
  - Coconut 0.19 million ha
  - Longan 0.19 million ha

<table>
<thead>
<tr>
<th>Land Use Type</th>
<th>Area</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paddy Field</td>
<td>11,280,000</td>
<td>5.02%</td>
</tr>
<tr>
<td>Field Crop</td>
<td>5,020,000</td>
<td>2.24%</td>
</tr>
<tr>
<td>Perennial Crop</td>
<td>4,420,000</td>
<td>2.00%</td>
</tr>
<tr>
<td>Orchard</td>
<td>1,540,000</td>
<td>0.69%</td>
</tr>
<tr>
<td>Total</td>
<td>22,242,000</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

**Note:**
- Areas are in hectares (ha).
- Percentages may not add up to 100% due to rounding.

**Source:** Analyzed from orthophoto, satellite images, and field survey.
Conventional agriculture production in Thailand need more application of chemical fertilizer to accelerate plant’s growth including utilization herbicides, insecticides and fungicide for eradicating weed, pests and disease.
Problem of chemical agriculture

Directly affect the health of farmers and consumers

Cause the contamination in agricultural products and environment

Adverse impact to the soil properties

Hardening and crusting of soils  Soil aggregate by organic matter and root
How to encourage using organic fertilizers/biofertilizers

- **Measurement of biomass utilization**: agricultural waste, agro-industrial waste, animal manure, could be used as organic fert. for soil improvement
- **Giving knowledge management to farmers**

Incorporated plant stubble

Making compost

Making bio extract

Making biochar
Function of organic fertilizer for soil improvement

- Improve soil structure and porosity
- Improves water holding capacity
- Source of plant nutrients and helps to keep nutrients available
- Increase CEC (exchange and sorption function) and Stimulate microbial and enzymatic activities
Role of biofertilizer to improve soil productivity

Beneficial activities of biofertilizer:

- **N₂ fixing** activity by transforming atmospheric N to ammonium form.
- **Increase** plant nutrient availability of P, K through chelation, exchange reaction, production of organic acids promote plant growth by producing hormone to increase plant growth, speed up seed germination, improve seedling emergence, help the expansion of root system
- **Secrete** antifungal compounds to suppress soil borne pathogens, reduce to use pesticide, enhance plant drought tolerance
## Total amount of biomass residues in Thailand

<table>
<thead>
<tr>
<th>Type of Raw materials</th>
<th>Amount (mil t/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice straw</td>
<td>25.45</td>
</tr>
<tr>
<td>Corn &amp; Sorghum stalk</td>
<td>7.34</td>
</tr>
<tr>
<td>Legume residue</td>
<td>2.23</td>
</tr>
<tr>
<td>Sugar cane leaf</td>
<td>9.75</td>
</tr>
<tr>
<td>Bagasse</td>
<td>24.09</td>
</tr>
<tr>
<td>Sawdust</td>
<td>1.44</td>
</tr>
<tr>
<td>Rice husk</td>
<td>3.75</td>
</tr>
<tr>
<td>Corn cob</td>
<td>1.36</td>
</tr>
<tr>
<td>Cassava peel and cake</td>
<td>6.11</td>
</tr>
<tr>
<td>Oil palm empty fruit bunch</td>
<td>2.49</td>
</tr>
<tr>
<td>Total</td>
<td>84.01</td>
</tr>
</tbody>
</table>
Measure total amount of animal manure in Thailand

<table>
<thead>
<tr>
<th>Type of manure</th>
<th>Amount (million ton/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>13.17</td>
</tr>
<tr>
<td>Pig</td>
<td>6.29</td>
</tr>
<tr>
<td>Poultry</td>
<td>7.48</td>
</tr>
<tr>
<td>Total</td>
<td>26.94</td>
</tr>
</tbody>
</table>
Farmers can use farm manure substitute chemical fert.

<table>
<thead>
<tr>
<th>Type of manure</th>
<th>Nutrient (%)</th>
<th></th>
<th>OC%</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>P$_2$O$_5$</td>
<td>K$_2$O</td>
<td></td>
</tr>
<tr>
<td>bat manure (new)</td>
<td>9.31</td>
<td>4.42</td>
<td>1.42</td>
<td></td>
</tr>
<tr>
<td>bat manure (guano)</td>
<td>2.69</td>
<td>15.70</td>
<td>0.59</td>
<td></td>
</tr>
<tr>
<td>pig</td>
<td>2.41</td>
<td>3.38</td>
<td>1.31</td>
<td>25</td>
</tr>
<tr>
<td>goat</td>
<td>2.19</td>
<td>1.49</td>
<td>3.58</td>
<td>26</td>
</tr>
<tr>
<td>chicken</td>
<td>2.22</td>
<td>3.23</td>
<td>1.82</td>
<td>25</td>
</tr>
<tr>
<td>duck</td>
<td>1.09</td>
<td>2.74</td>
<td>0.46</td>
<td></td>
</tr>
<tr>
<td>buffalo</td>
<td>1.23</td>
<td>0.55</td>
<td>0.69</td>
<td></td>
</tr>
<tr>
<td>cow</td>
<td>1.39</td>
<td>1.03</td>
<td>1.75</td>
<td>21</td>
</tr>
</tbody>
</table>
Distribution successful innovation of LDD microbial products for increasing crop production

First group: to improve soil properties, increase soil fertility, produce plant hormone

Second group: to control plant diseases and insect pest
Encourage stop stubble burning

Losses of organic matter and soil nutrient • Changed soil structure, Depleted beneficial microorganisms, causes of air pollution & GHG

Campaign zero open burning activity focus on incorporated stubble for mitigate global warming and increasing soil organic matter
Using microbial activator Super LDD1
to encourage making compost

A group of high efficient microorganisms activate decomposing process of hardly decompose component (cellulose, lipid) to decrease composition time for making compost. This activator consisted of cellulolytic fungi and actinomycetes including lipid degrading bacteria.
Super LDD 1: raw material proportion
Component of making compost fert. 1 ton

- plant residue (dry weight) 1,000 kg.
- animal manure 200 kg.
- urea 2 kg.
- Super LDD 1 1 package

Hardily residual material decompose within 3-4 months. Easily residual material decompose within 30-45 days
making compost fertilizer
In devidual farm

- Residues from plants + farm manure
Producing bio-extract by using microbial activator Super LDD 2

A group of high efficient microorganisms activate fermentation and digestion process of fresh and succulent organic wastes such as residues from fruit, vegetable, fish, snail to produce liquid bio-extract that consisted of plant growth hormones, amino acid, humic acid, organic acid and minerals. Such bio-extract can promote seed germination, root tissue development, stem elongation, stimulate budding, flowering and fruit growth.
SuperLDD 2: raw material to produce bio-extract from plants /animal residue

- Fruits and/or vegetables 40 kg.
  (if using animal: fish, snail residue) 30 kg.
- Molasses or other sugar 10 kg.
- Water 10 litres
- Super LDD 2 1 package
Utilization and application rate of bio-extract

- Dilute bio-extract with water 1:500-1:1,000
- Spray at leaf or stem every 10-30 days
  - Rice: Spray at 30, 50 and 60 days during growing stage
  - Field crop: spray every 10 days before flowering stage
  - Vegetable and flower: spray every 10 days
  - Fruit tree: spray every 1 month before flowering stage
utilization of biofertilizer on growth and yield of Casava in Nakhon Ratchasima

- Dilute bio-extract with water ratio 1:500
- Spray at 1 and 2 months
- Application rate 100 liters/rai

utilization on growth of Orchid in Nakhonpatorn

- Dilute bio-extract with water ratio 1:500
- Spray every 2 weeks
- Application rate 100 liters/rai
utilization of biofertilizer on yield and of super sweet corn and cabbage
Microbial activator Super LDD 9

This activator consisted of phosphate solubilizing microorganisms to release P particularly in acidic or acid sulfate soil (pH< 4) from unavailable form (inorg. phosphorus complex or phosphorus fixed by Fe Al) to available form for increase phosphate solubility.
Raw material to LDD 9 cultivation

- Compost 500 kg.
- Molasses or other sugar 10 kg.
- Water 10 litres
- Super LDD 9 1 package
Bio-fertilizer LDD 12

A group of effective microorganisms can produce nutrient element or convert insoluble of inorganic compounds to soluble form to increase soil fertility especially N, P, K and produce plant growth hormone to enhance plant growth.
Bio-fertilizer LDD 12

- Compost 300 kg.
- Rice bran 3 kg.
- Super LDD 9 1 package

Advantages of bio-fertilizer LDD12

Increase N content in soil 30-50 kg./ha/year

Increase P (rock phosphate soluble) 15-45%

Increase K-feldspar soluble 10%

Produce hormone stimulate root and plant growth

Reduce chemical fertilizer utilizing at least 25-30%

Increase plant yield 15%
Utilization and application rate of propagated LDD 12

**Rice:** 1.87 t/ha, broadcast throughout planting area

**Field crop, vegetable:** 1.87 t/ha, banding along the row of plant
Fruit tree: use the propagated 3-5 kg/ plant

Applied on bottom of the hole for young plant and around the circle of bush
**Green manure**

Green manure is one kind of **organic fertilizer**. Legume crops usually are planted before cash crops two months and incorporated into soil to increase organic matter and plant nutrients especially, increase nitrogen content. Legume green manures are utilized in Thailand such as *Sesbania* sp., *Crotalaria* sp., *Canavalia* sp., *Vigna* sp. and *Cajanus* sp.
# Nutrient content in green manure crops

## Nutrient content (%)

<table>
<thead>
<tr>
<th>Green manure</th>
<th>N</th>
<th>p</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Sesbania rostrata</em></td>
<td>2.87</td>
<td>0.42</td>
<td>2.06</td>
<td>0.82</td>
<td>1.74</td>
<td>2.27</td>
</tr>
<tr>
<td><em>Crotalaria juncea L.</em></td>
<td>2.76</td>
<td>0.22</td>
<td>2.40</td>
<td>1.53</td>
<td>2.04</td>
<td>0.96</td>
</tr>
<tr>
<td><em>Canavalia ensiformis L.</em></td>
<td>2.72</td>
<td>0.54</td>
<td>2.14</td>
<td>1.19</td>
<td>1.59</td>
<td>0.77</td>
</tr>
<tr>
<td><em>Vigna spp.</em></td>
<td>2.68</td>
<td>0.39</td>
<td>2.46</td>
<td>0.87</td>
<td>1.59</td>
<td>0.48</td>
</tr>
<tr>
<td><em>Cajanus cajan</em></td>
<td>2.34</td>
<td>0.25</td>
<td>1.11</td>
<td>1.45</td>
<td>1.92</td>
<td>0.54</td>
</tr>
</tbody>
</table>
Microorganism LDD 11 promoting growth of green manure

- Symbiotic nitrogen fixing bacteria (*Rhizobium* sp.) specify to each kind of green manure.
- Promote growth and increase the biomass
  - *Sesbania rostrata* (lowland area, salt tolerant)
  - *Crotalaria juncea* (upland area, drought tolerant)
Constraints in biofertilizer technology

The biofertilizer technology is low cost, eco-friendly technology and several benefits of bio-inoculants. However, it is quite not popular among the farming community. There may be several reasons such as:

1) chemical fertilizers are more effective than biofertilizers,
2) biofertilizers are not used by fellow farmers in the village,
3) low credibility of source for purchasing,
4) lack of motivation from extension agencies etc.
Ministry of Agriculture and Cooperatives issued the first standard of biofertilizer in 2007. Identity genus and quantity of microorganism must to declare in biofertilizer product. This standard consist of 6 kind of biofertilizer:

1. Rhizobium fertilizer
2. PGPR fertilizer
3. Blue green algae fertilizer
4. Arbuscular mycorhiza fertilizer
5. Phosphate solubilizing fertilizer
6. Potassium solubilizing fertilizer
Transfer technology

To achieve less chemical used in agriculture for conservation of soil resource and environment
- Soil and Water Conservation
- Soil Organic Matter

To use of the products of LDD and appropriated technology for promotion and extension by Volunteer Soil Doctor to farmers
Volunteer Soil Doctors

They are farmers in the village and try to help LDD to solve soil problems.

Transferring new technology and LDD products to their neighbours and participating in LDD activities.

To conduct the demonstration plot of vetiver grass for soil and water conservation and soil organic matter improvement.
Training program

Intensive training VSD
Learning by doing
Net - work building
Materials distribution
Two training courses annually
Extension on biotechnology to substitute chemical agriculture substances

Objectives

- Farmers understand the effective utilization of LDD products on biotechnology
- Strengthening farmer groups and their alliances depend on the sufficiency economy philosophy by his Majesty the King (moderation, reasonableness and self immunity)
- Develop farmer groups and their alliances to be organic agriculture groups
Establishment the farmer groups about 17,000 groups in rural area in Thailand (farmers 50 persons/group/village)

Strengthening capacity building the farmers in perspective dimension of achievement innovation of biotechnology from LDD by training and demonstration

Distribution successful innovation to farmers

Follow up and evaluate the procedure farmers group and their alliances
Starting in 2007 until 2011, we have farmer groups about 17,000 groups. From 2012 - 2015, we developed farmer groups and their alliances to organic agriculture groups. On average, 500 farmers/year/800 ha (1.6 ha/farmer) are developed to organic agriculture system.
Organic fertilizer and seed bank

- Farmer groups produce the compost and green manure seeds for other farmers.

- Organic fertilizer bank distribute in every province and some provinces have seed bank.
Vetiver grass is regarded as a miracle plant for land reclamation due to rapid growth, huge biomass, massive and long roots, that can penetrate vertically into soil and bind soil particles tightly to prevent soil erosion including maintain soil moisture content.
His Majesty the King of Thailand interested in vetiver grass and encourages government to utilize the beneficial matter of vetiver grass especially in soil and water conservation purpose, reclamation of infertile soil and environmental protection.
**Vetiver grass** has been applied widely in agriculture, soil and water conservation. It is one of the most effective and low cost natural methods of environmental protection and soil fertility improvement.

Contour planting of vetiver across the slope to prevent soil erosion  
Increase soil moisture
Overall Advantage

Producers:

- Reduce utilization of chemical fertilizer
- Increase crop yield and economic return
- Improve soil health and farm ecology
- Upgrade the quality of farmer’s life
chemical substances usage decreased 34.39 %
Saving budget 28,828 million bahts/year

increasing yields 15.14 %

Average farmers’ incomes increase 29.21 %/family
Overall Advantage

Consumer:

- Food safety with less pesticide residues in products
- High nutrition food
Overall Advantage

Environment:

- Rehabilitation of degraded environments
- Reclamation bio-diversity for sustainable agriculture
Thank you for your attention