



## Recent Developments on SSNM for Tropical Maize

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### **Site-specific nutrient management (SSNM)**

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An approach for “feeding” crops with nutrients as and when needed, to meet the requirements of a high-yielding crop. It advocates:

- optimal use of existing indigenous nutrient sources (e.g. crop residue, manure)
- timely application of fertilizers at optimal rates

**SSNM for maize** is an adaptation of the most recently published principles of SSNM developed for rice (Buresh and Witt, 2007; IRRI, 2007).

# Site-specific nutrient management in maize

IPNI Southeast Asia Program

## Indonesia

IAARD, ICFORD,  
ICATAD, AIAT, UN

## Vietnam

SFRI, WASI, IAS,  
Cantho University,  
CLRRI

## Philippines

UPLB Corn RDE  
network, DA-BAR,  
PhilRice, BSWM, GMA  
Corn, AFC

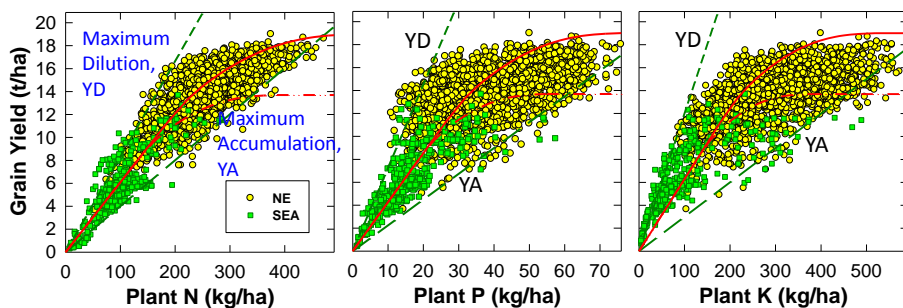
★ 2004-2010

★ 2005-2010

★ 2008-2010



## Estimating maize nutrient requirements with SSNM



Source: Setiyono et al (unpublished)

### Total amount of nutrient needed to achieve a yield target

- estimated from the relationship between grain yield and balanced uptake of nutrients at harvest (i.e., internal efficiency) as defined by the QUEFTS model (Janssen et al. 1990)

## Nutrient requirements of maize

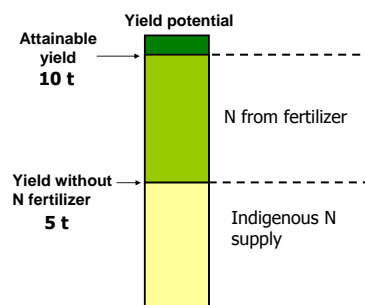
- based on optimal uptake as determined using the QUEFTS model (Janssen et al. 1990)
- estimation was done using data collected from SE Asia, with a  $Y_p = 14$  t/ha
- the values in the table refer to nutrient requirements at 80% of the  $Y_p$

	N	P	K
Total nutrient uptake (kg nutrient/ t grain yield)	18.0	2.56	17.4
Nutrient content in grain (kg nutrient/ t grain yield)	10.6 (59%)	1.93 (75%)	3.0 (17%)
Nutrient content in stover (kg nutrient/ t grain yield)	7.4 (41%)	0.63 (25%)	14.4 (83%)

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## Estimating fertilizer requirements

1. Identify a **yield target** (i.e. attainable yield)
  - Depends on climate, variety, and season
  - Yield achieved with best management practices and ample supply of nutrients
  - Indicates the **total amount of nutrients** needed by the crop
2. Estimate **indigenous nutrient supply**
  - Can be determined through use of nutrient omission plots: ON (PK), OP (NK), OK (NP)
  - **Yield in nutrient omission plot** indicates amount of nutrient from indigenous sources
3. Estimate amount of nutrient to be supplied as fertilizer
  - Fertilizer requirement = total requirement – indigenous supply
  - **(Yield target – yield in omission plot)/nutrient requirement**
  - Taking into account nutrient efficiencies and nutrient balance



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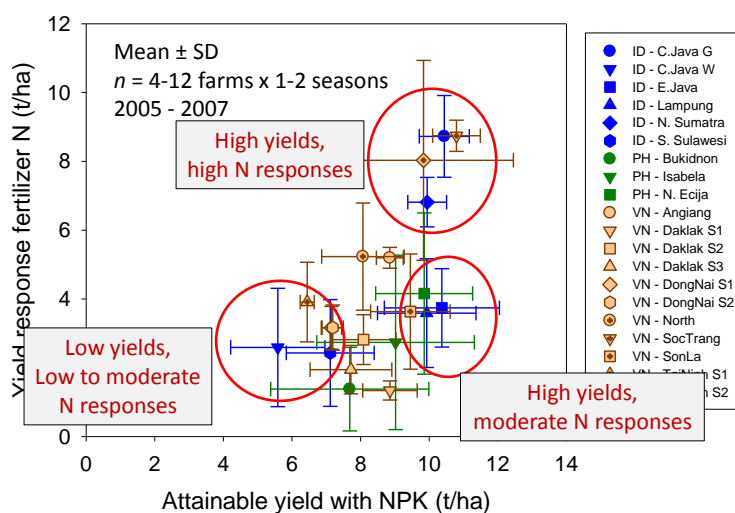
## Attainable maize yield in Southeast Asia

Site	Average farmers' yield (t/ha)	Average attainable yield (t/ha)	Maximum attainable yield (t/ha)	Simulated potential yield (t/ha)
Wonogiri, C Java, Indonesia	4.9	5.7	7.3	12-14
Lampung, Indonesia	7.2	9.2	13.7	12-14
Nueva Ecija, Philippines	7.9	9.0	14.2	12-15
An Giang, Vietnam	8.3	8.8	10.3	11-14
CuM'gar, Dak Lak, Vietnam	6.2	7.8	12.0	12-15

Data are the average of 5 farms per site in at least three seasons, 2004-2007. Potential yield was estimated using the model HybridMaize (Yang et al 2006).

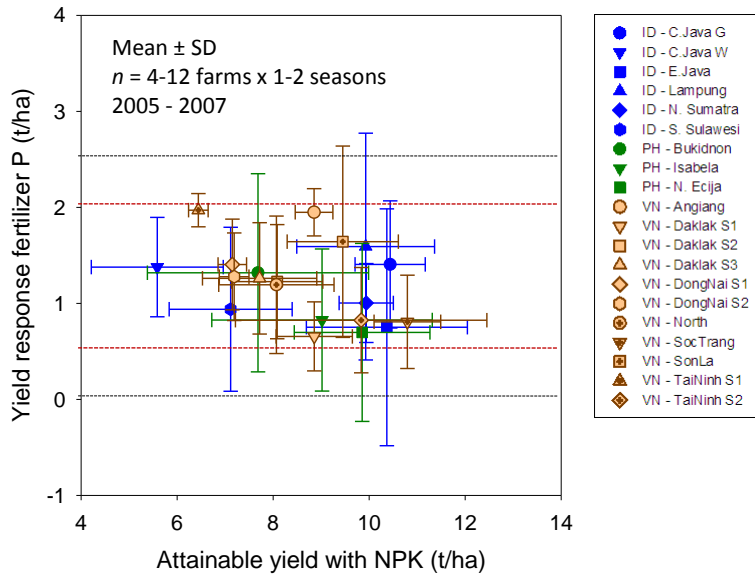
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## Yield response to fertilizer N



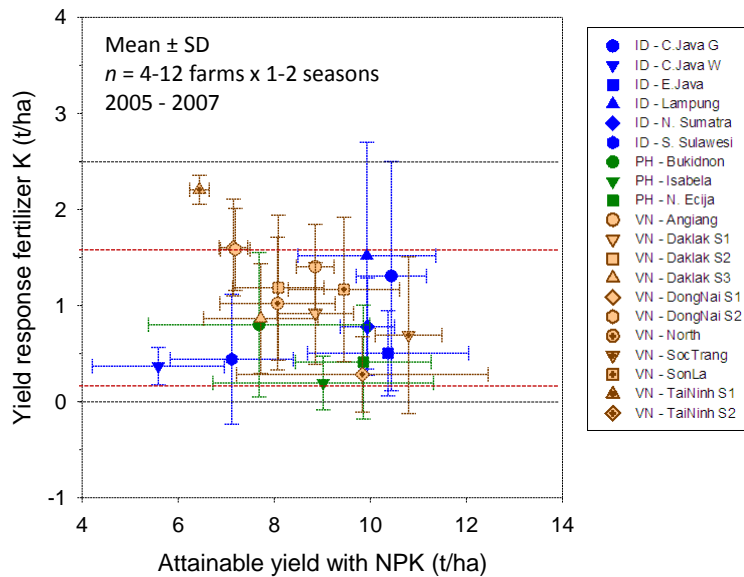
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## Yield response to fertilizer P



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## Yield response to fertilizer K



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## Agronomic and economic performance

Parameter	Unit	FFP	SSNM	SSNM – FFP	%
Yield	t/ha	7.2	8.3	<b>1.2</b>	<b>16%</b>
AEN	kg/kg	16.4	25.1	8.7	<b>53%</b>
Fertilizer N	kg/ha	167	151	-16	-10%
Fertilizer P <sub>2</sub> O <sub>5</sub>	kg/ha	71	83	11	16%
Fertilizer K <sub>2</sub> O	kg/ha	77	95	18	23%
Revenue	US\$/ha	1275	1480	205	16%
Fertilizer cost	US\$/ha	244.8	258.4	13.6	6%
Gross benefit over seed & fertilizer costs	US\$/ha	971	1155	<b>184</b>	<b>19%</b>

4-13 farms x 19 sites x 1-2 seasons in Indonesia, Philippines, and Vietnam, 2005-2008.  
 Farm gate prices (average regional prices, 2004-2007): 0.18 US\$/kg grain; 0.93 US\$/1000 seeds;  
 0.71 US\$/kg fertilizer N; 0.88 US\$/kg fertilizer P<sub>2</sub>O<sub>5</sub>; 0.81 US\$/kg fertilizer K<sub>2</sub>O

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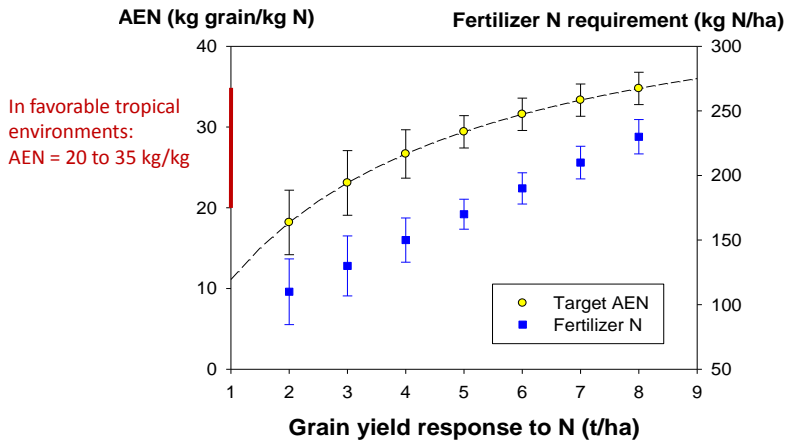
## SSNM for Maize

2009 updated recommendations

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# Fertilizer N requirements for maize

- Based on yield response to fertilizer N and agronomic efficiencies



AEN is most likely linked to the yield response to fertilizer N application depending on climatic conditions and yield level in an average season.

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# Fertilizer P<sub>2</sub>O<sub>5</sub> requirements for maize

Non-P fixing soils

Fertilizer P = f (yield response, P removal)

Yield target (t/ha) →	4 – 6 t/ha	7 – 9 t/ha	10 – 12 t/ha
Expected yield response to fertilizer P over 0P plot (t/ha) ↓	Fertilizer P <sub>2</sub> O <sub>5</sub> rate (kg/ha)		
0	10 – 20	20 – 30	30 – 40
0.5	20 – 30	30 – 40	40 – 50
1.0	30 – 40	40 – 50	50 – 60
1.5	40 – 50	50 – 60	60 – 70
2.0	50 – 60	60 – 70	70 – 80
2.5	60 – 70	70 – 80	80 – 90

- Based on a P requirement of 20 kg P<sub>2</sub>O<sub>5</sub>/t of yield response (i.e. AEP of 112 kg grain/kg P) plus a 75% return of P removal with grain (i.e. 3.3 kg P<sub>2</sub>O<sub>5</sub>/t grain yield)
- Apply 100% of fertilizer P with basal application.

Yet to be considered:

P fixation, available P, other soil properties, cropping system

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## Fertilizer K<sub>2</sub>O requirements for maize

Fertilizer K = f (yield response, K removal)

Yield target (t/ha) →	4 – 6 t/ha	7 – 9 t/ha	10 – 12 t/ha
Expected yield response to fertilizer K over 0K plot (t/ha) ↓	Fertilizer K <sub>2</sub> O rate (kg/ha)		
0	15 – 25	25 – 35	35 – 45
0.5	30 – 40	40 – 50	50 – 60
1.0	45 – 55	55 – 65	65 – 75
1.5	60 – 70	70 – 80	80 – 90
2.0	75 – 85	85 – 95	95 – 105
2.5	90 – 100	100 – 110	110 – 120

- Based on a K requirement of **30 kg K<sub>2</sub>O/t yield response** (i.e. AEK of 40 kg grain/kg K) plus a 100% return of K removal with grain (i.e. **3.6 kg K<sub>2</sub>O/ t grain yield**)
- Apply 100% of fertilizer K<sub>2</sub>O with basal application, if ≤ 60 kg K<sub>2</sub>O/ha.
- Apply each 50% of fertilizer K<sub>2</sub>O basal and mid-season, if > 60 kg K<sub>2</sub>O/ha.

Yet to be considered:

- 15 Exchangeable K, other soil properties, cropping system

## Tools and products

- Software – *Nutrient Expert for Hybrid Maize* (will be available for download soon at ><http://seap.ipni.net><)
- Film on best management practices for maize (under preparation, targeted for 2010)
- Maize pocket guide (2010)
- Manuals (participatory evaluation, development of Quick Guides)



# Nutrient Expert for Hybrid Maize

Settings Help Exit

## Nutrient Expert for Hybrid Maize

Version 1.0 (December 2009)

First time user? Working in a new location? Make sure to have the 'Settings' right!

**Nutrient Expert for Hybrid Maize helps you to:**

- develop an optimal planting density for your location
- evaluate current nutrient management practices
- determine a meaningful yield goal based on attainable yield
- estimate fertilizer NPK rates required for the selected yield goal
- translate fertilizer NPK rates into fertilizer sources
- develop an application strategy for fertilizers (right rate, right source, right location, right time), and
- compare the expected or actual benefit of current and improved practices.

To start, click a button

Current  
NM  
Practice

➔

Planting  
Density

➔

SSNM  
Rates

➔

Sources &  
Splitting

➔

Profit  
Analysis

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Home Settings Help

## Nutrient Expert for Hybrid Maize

Current NM Practice
Planting Density
SSNM Rates
Sources and Splitting
Profit Analysis

Name and/or location:

Field size:  ha

1. What is the yield of hybrid maize for a typical season in the past 3 to 5 years for the growing season you wish a guideline for? Provide total amount of harvested grain from your field (measured at shelling).

Fresh weight (50 kg/cavan):  cavan

Moisture content (if known):  %

Yield at 15.5% moisture:  t/ha

2. How much fertilizer do you apply to your maize field? Click the fertilizer type to see list of fertilizer materials and enter amount.

Inorganic fertilizers

Organic fertilizers

N:  kg/ha

P<sub>2</sub>O<sub>5</sub>:  kg/ha

K<sub>2</sub>O:  kg/ha

N:  kg/ha

P<sub>2</sub>O<sub>5</sub>:  kg/ha

K<sub>2</sub>O:  kg/ha

Report
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Next >
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**1<sup>st</sup> application at 15 DAP**

Source	No. of bags	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
kg/ha				
14-14-14	3	21	21	21

**2<sup>nd</sup> application at 30 DAP**

Source	No. of bags	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
kg/ha				
Urea	2	46	0	0

## Nutrient Expert for Hybrid Maize

Home Settings Help

Current NM Practice **Planting Density** SSIM Rates Sources and Splitting Profit Analysis

**Analyze farmer's current planting density:**

- What is the distance between rows?  cm
- What is the distance between plants in a row?  cm
- How many plants per hill?  one  two

The current plant density: **71,429** plants/ha.

**Develop an improved planting density:**

- What is your preference for row spacing structure? 
  - single-row spacing  double-row spacing
- What is the best distance between rows? 
  - 70 cm  50 cm
  - 60 cm
- Choose distance between plants in a row: 
  - 20 cm  23 cm  26 cm  29 cm
  - 21 cm  24 cm  27 cm  30 cm
  - 22 cm  25 cm  28 cm

Your new plant density: **69,444** plants/ha.

Row spacing (cm)

plants/ha

- ◆ 55,000
- ▼ 60,000
- 65,000
- ◇ 70,000
- ▲ 75,000
- ▽ 80,000

○ Farmer ○ Nutrient Expert

- The optimal planting density at seeding is: 65,000 to 75,000 plants/ha
- The white center area shows the optimal planting density

## Nutrient Expert for Hybrid Maize

Home Settings Help

Current NM Practice **Planting Density** **SSIM Rates** Sources and Splitting Profit Analysis

Name and/or location:  Field size:  ha

Fertilizer N, P, and K requirements are based on yield goal (i.e. attainable yield) and expected yield responses to fertilizer application.

- What is the attainable yield for your location?  t/ha
- What do you do with maize residues after harvest?
  - Remove all the above ground residues from the field  Retain stover in the field and burn
  - Retain stover in the field and incorporate  Compost stover for incorporation to next maize crop
- Will you apply organic fertilizers (e.g. manure)?  Yes  No
- Determine residual benefit from your previous crop?  Yes  No
- Do you have results from omission plot trials conducted in a similar field in your municipality or district?   Yes  No
  - N response:  t/ha
  - P response:  t/ha
  - K response:  t/ha
- Will you apply Bio-N?  Yes  No

N response (t/ha)	Fertilizer N (kg/ha)
2	110
3	130
4	150
5	170
6	190
7	210
8	230

Yield (t/ha)	7	8	9
P response (t/ha)	Fertilizer P <sub>2</sub> O <sub>5</sub> (kg/ha)		
0	23	27	30
0.5	33	37	40
1.0	43	47	50
1.5	53	57	60
2.0	63	67	70
2.5	73	77	80

Yield (t/ha)	7	8	9
K response (t/ha)	Fertilizer K <sub>2</sub> O (kg/ha)		
0	25	29	33
0.5	40	44	48
1.0	55	59	63
1.5	70	74	78
2.0	85	89	93
2.5	100	104	108

N credits:  kg N/ha  
Final N rate:  kg N/ha

P credits:  kg P<sub>2</sub>O<sub>5</sub>/ha  
Final P rate:  kg P<sub>2</sub>O<sub>5</sub>/ha

K credits:  kg K<sub>2</sub>O/ha  
Final K rate:  kg K<sub>2</sub>O/ha

## Nutrient Expert for Hybrid Maize

Home Settings Help

Current NM Practice | **Planting Density** | SSIM Rates | Sources and Splitting | Profit Analysis

Name and/or location: Here; Site A Field size: 1 ha

1. Recommended fertilizer N, P, and K rates: N  $P_2O_5$   $K_2O$   
 150 47 59 kg/ha

2. What is your growing environment? ?  
 Irrigated maize  Favorable rainfed  Less favorable rainfed  
 How many times would you like to apply fertilizer? ?  
 Two times  Three times

3. Select fertilizer source(s) for N, P, and K for the 1st application.

4. Additional fertilizer N shortly before tasseling? ? 0 bag urea/ha  
 0 bag urea/ha  1/2 bag urea/ha  1 bag urea/ha

5. Are you using the Leaf Color Chart (LCC)? ?  
 Yes, I use the LCC  No

**1<sup>st</sup> application at 0 DAP** ?

Fertilizer sources	No. of bags	N	$P_2O_5$	$K_2O$
14-14-14	6.5	46	46	46
Urea	0	0	0	0
MOP	0.5	0	0	15

**2<sup>nd</sup> application at V6 around 25 DAP** ?

Fertilizer sources	No. of bags	N	$P_2O_5$	$K_2O$
Urea	2.5	58	-	-

**3<sup>rd</sup> application at V10 around 35 DAP** ?

Fertilizer sources	No. of bags	N	$P_2O_5$	$K_2O$
Urea	2	46	-	-

Fertilizer rates are adjusted to field size

Example of a fertilizer guideline tailored to local conditions and available fertilizer sources

Name and/or location: Here; Site A Field size: 1 ha

Current yield: 110 cavan (FW) 5.3 t/ha (15.5% MC)


Growing environment: Favorable rainfed

**Recommended alternative practice for hybrid maize**

Yield goal: 165 cavan (FW) 8.0 t/ha (15.5% MC)

Planting density: 69,444 plants/ha

Distance between rows: 60 cm Distance between plants: 24 cm



Growth stage	Days after planting	Soil moisture	Fertilizer sources	Weight of full bag (kg)	Amount (bags)
Basal	0	sufficient	14-14-14	50	6.5
			Urea	50	0
			MOP	50	0.5
V6	25	sufficient	Urea	50	2.5
V10	35	sufficient	Urea	50	2

**Other sources of nutrients:** Fertilizer rates are adjusted to field size

Crop residue: high

Organic fertilizer: 0 t

## Nutrient Expert for Hybrid Maize

Home Settings Help

Current NM Practice | **Planting Density** | SSIM Rates | Sources and Splitting | Profit Analysis

Farmer's current practice    Recommended practice

Seed rate:  kg/ha     kg/ha (1 plant/hill)

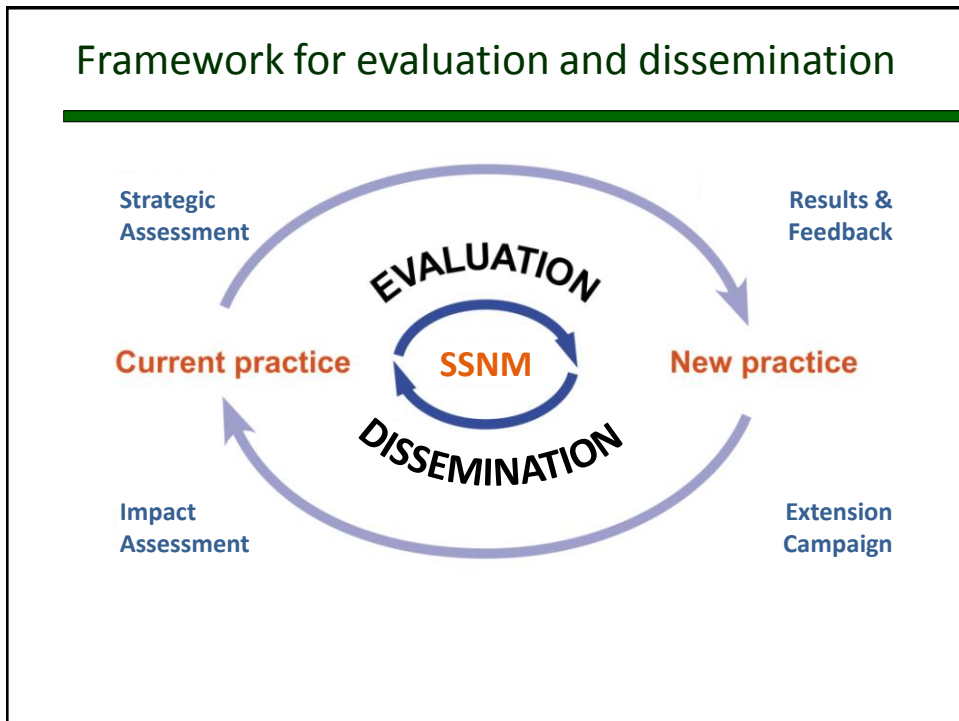
Cost of seeds:  PHP/kg     PHP/kg

Farm gate price of corn:  PHP/kg

Simple profit analysis	Farmer's current practice	Recommended practice
Yield at 15.5% moisture (t/ha)	5.3	8
Farm gate price of corn (PHP/kg)	10.00	10.00
<b>REVENUE (PHP/ha)</b>	<b>53,000</b>	<b>80,000</b>
Seed cost (PHP/ha)	4,800	4,800
Fertilizer cost – inorganic sources (PHP/ha)	5,230	12,235
Fertilizer cost – organic sources (PHP/ha)	0	0
<b>TOTAL COSTS (PHP/ha)</b>	<b>10,030</b>	<b>17,035</b>
Expected benefit above fertilizer costs (PHP/ha)	47,770	67,765
Expected benefit above seed and fertilizer costs (PHP/ha)	42,970	62,965
<b>Change in benefit (PHP/ha)</b>		<b>19,995</b>



## Project outlook

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- Develop refined recommendations for existing areas
- Develop prototype recommendations for evaluation in new areas
  - Involves use of *Nutrient Expert* software
- Prepare tools for dissemination
  - One-page *Quick Guides* for key maize areas
  - Film on SSNM for maize tailored to each of the three countries
- Develop a plan for an impact assessment
- Publish research results
- Other activities
  - Philippines: National initiative on maize project funded by the government (ongoing)
  - Vietnam: SSNM technology approval by national scientific committee
  - Develop a learning alliance with the private sector (seed and fertilizer industry)