**Project Title: Climate change and impacts on rice production in Vietnam: Pilot testing of potential adaptation and mitigation measures**

**Deliverable 2.0**
**Implementation plan for field demonstration of selected potential adaptation measures in the three study areas**

**A project funded by the Ministry of Foreign Affairs/The Royal Norwegian Embassy, Hanoi**

## Introduction

As part of the project planning, VAAS and Bioforsk teams jointly organized meetings in August 2013 in Hanoi. The meetings provided an opportunity to get a common understanding of the project goal, objectives and outputs. The teams discussed the activities within the four different work packages and prepared a detailed work plan. During the same month, the teams visited all the three provinces namely Nam Dinh, Tra Vinh and Soc Trang and held detailed discussions with the provincial officials, farmers and other stakeholders.

The project and the main objectives and expected outputs were presented to stakeholders in the respective provinces during the meetings and their feedback was sought. Priorities for field demonstrations were identified and based on the discussions a field implementation plan was prepared for the project. The plan outlines the main activities to be taken up in Work Package Two (WP 2.0).

## PART A: Nam Dinh Province (Northern Vietnam)

### Summary of Stakeholder meeting (*held on Friday 15 November 2013)* in Nam Dinh province.

A meeting was held in Nam Dinh Province at Thinh Long Commune with various stakeholders, including research directors, scientists, farmers and community leaders. Mr Do Hai Dien, Deputy Director, DARD in Nam Dinh province chaired the meeting. At the meeting the Mr.Dien assured that ClimaViet project will get support from all levels of government within the province. Stakeholders at the meeting felt that there is a need to address impacts and risks from climate change in Nam Dinh province and improve rice production in the face of climate change. It was agreed that the ClimaViet project will conduct field trials in two districts within Nam Dinh province (see details below). The priority at the meeting was to identify and test some salt tolerant rice cultivars and management practises to address salinity and drought problems in the province. At the meeting, it was mentioned that it is also vital to improve the income of farmers and hence adaptation measures that will be developed should also contribute to increasing farmers' income.

*Meeting with stakeholders in Nam Dinh Province, (Photo:Trond Rafoss)*

*Dr Nagothu Udaya Sekhar* from Bioforsk addressed the group and mentioned that since it is the start of project, key issues around climate change relevant to the province need to be identified. The main questions to be addressed are: What are the climate predictions? Is there a climate adaptation plan at the provincial level? What can the project contribute to the process? How can the project help in the adaptation plan and implementation?

One-day workshops for stakeholders in 2014 and 2015, especially farmers and women groups will be planned in the project to improve knowledge and competence in climate and adaptation/technology areas. The stakeholder workshops will provide adaptation and policy inputs. Results from field demonstrations would also be presented and discussed at these workshops. Research can be up-scaled by DARD and other agencies if results from the field demonstration are promising. The project would provide recommendations to local scientific community, women and farmers, increase awareness through farmers field days as well. The ClimaViet project will also emphasize on the need for multidisciplinary and integrated approach, by integrating relevant disciplinary scientists and sectors into the project.

*Dr Trond Rafoss, from Bioforsk* introduced the methodology of collecting and analysing agro-meteorological data across Norway and how this information is used by farmers to respond to pests & diseases and the relevance to Vietnam. In ClimaViet, Bioforsk will train Vietnam scientists on VIPS model and its use for risk assessment of one important pest (leaf hopper) and disease (paddy blast) in rice.

*Dr Andrew Borrell from the University of Queensland* explained his long-term experience (20 years) in rice-based cropping systems in Asia, particularly in the areas of water-saving technologies and the efficiency of fertiliser use. He will be contributing to drought adaptation measures in rice crop, another key area of interest for the project, including the interaction between genetics, management and the environment.

*Mr Do Hai Dien, Deputy Director of Nam Dinh DARD* shared his concerns about the impacts of climate change in the province. There are 80,000 ha of rice land in the Nam Dinh Province. The main challenges are irrigation water, as there is a shortage of fresh water for flushing out salts. Fresh water has to be brought from upstream and there is no certainty of fresh water availability due to droughts in some years. About 12,000 ha are affected by salinity. New rice varieties and improved management are important to address these dual constraints. Policies on how to manage irrigation water for climate change are required. There are no projects on addressing salinity problems at present. ClimaViet project is relevant and the results from the project can be useful to the province. The Vietnamese government has invested in irrigation infrastructure and dams, building sluice gates/walls to prevent sea water intrusion. However, this involves heavy costs in the establishment and maintenance.

*General Discussion*

Stakeholders at the meeting agreed that selecting varieties that adapt to climate change should be a high priority. Some hybrid rice varieties from China have good tolerance to salinity. Local wild rices could also be a useful source of resistance to salinity and drought. While scientists in the Nam Dinh province can evaluate these introductions, there is no rice breeding capacity within the project team. Private companies can play an important role in the breeding and development and release of new varieties. The local rice varieties can tolerate up to 2.5 ppt of salt but salinity is >4 ppt in this area. Salinity is too high in some areas, so farmers are shifting to brackish water aquaculture. In Nam Dinh province, three crops can be grown per year: spring rice (Jan-Jun), summer rice (Jun-Oct) and winter crop (vegetables, sweet potato, maize & potato). Farmers use flood water to flush the salt from the soil profile before sowing. If water was not limiting, farmers would prefer to grow rice under flooding condition. Pest and diseases have become less predictable with climate change according to the stakeholders. The main problems in the spring rice crop are rice blast, bacterial leaf blight and brown leafhopper. The soil is heavy clay and farmers apply chemical fertilisers to supplement nutrients where needed. Irrigation is a challenge as already mentioned. Sluice gates are used to prevent saltwater intrusion with the extent of intrusion varying from year to year.

Field visit in Nam Dinh province (15 Nov 2013)

Four key areas were identified by stakeholders. Interestingly, water-saving technologies were not listed in this province as a key issue.

*1. Identifying and testing salt tolerant rice varieties*

Since there is no rice breeding program in the north, this would involve testing introduced varieties from China, IRRI and other sources for salt tolerance. Varieties would need to be tolerant to >2.5 ppt salinity. The quality of the grain also needs to be preferable to consumers and market (taste etc). Therefore, salt tolerance, yield and quality need to be considered while selecting the new varieties. TX111 is a well-adapted Chinese hybrid with some level of salt tolerance. This is the benchmark which new lines will be evaluated against.

*2. Low input sustainable cropping (no tillage and no chemicals)*

There was a desire to test low input sustainable cropping systems featuring no tillage and no chemical inputs. One challenge was how to decompose the rice roots faster to prepare for planting the next crop. Some farmers flood fields to decompose rice roots.

*3. Nutritional aspects*
Fertiliser application was listed as another high priority. Farmers often apply more N fertiliser than necessary. Experiments to test lower N rates were considered important. Slow-release fertilisers may enable N to be used more effectively.

*4. Cropping systems*
Three crops are grown per year, however, there is a need to optimise combinations of crops to maximise yield potential of the system. Some farmers grow a rice-peanut-rice-vegetable combination. But there may be better combinations. Cropping systems also need to be tested for soil types and environments. There is a market for maize for 'beach' tourists.

Other issues
*Uptake of technology*
It is difficult to get farmers to adopt new ideas. Farmers need more training. Current training has focused on 'training the trainers'. It would be good to get farmers participating in capacity building workshops, field visits, farmer to farmer learning. Policy support is also very important in the adoption of new technologies.

*Marketing*
Rice is sold directly from farmer to market. Farmers keep 60% of their rice and sell 40% for cash. Vegetables are the converse. To some extent, farmers use mobile phones to get information. Timely information is important to farmers and mobile services can be used to provide market information to farmers.

*Farm size*
The average farm size is 500 $m^2$ per person or 2000 $m^2$ per household. These are very small farm sizes, even compared to southern Vietnam.

*Role of women in agriculture*
Women do most of the agriculture at the field level, while men do other off-farm work to generate income. Women generally manage the household finances. Women should play an important role in future adaptation programs. The project will map the role of gender in agriculture, risks due to climate change and their role in adaptation to climate change.

*Land ownership*
There is no private ownership of land, although farmers can get long-term leases for land (called red papers). These leases can also be transferred from one generation to the next through inheritance documents. Government policy states that rice must be grown on rice land. However, farmers can grow whatever vegetables they want.

**Partners meeting at the Vietnam Academy of Agricultural Science (VAAS)**
**Nam Dinh Province (Northern Vietnam) -*Saturday 16 November 2013***


Figure 2: Visit to VAAS and meeting of partners

*Introduction (Dr Nagothu Udaya Sekhar, Bioforsk)*

The second meeting of ClimaViet partners was organized to discuss the WP1 progress and finalize the WP2 implementation plan (field trials, plot designs, surveys etc.) The partners discussed the 6-month/half yearly progress report (July to Dec 2013) and the work plan (Jan to June 2014) that has to be submitted in January 2014 to the embassy. To date, most activities have been in WP1. In WP1, one of main issues discussed was the purchase of climate data in each province, and the budget needed for that. This is causing delays as this was not estimated in the original proposal and the purchase of data from MARD will also involve some procedures that can be time consuming. Embassy has been informed about this and additional budget requested. We will need to consider the climate change scenarios for three provinces (one in the north and two in the south). Hydrology modelling will also be a component. IAE (Dr.Trinh) who is responsible for WP1 will follow up and support will be given to him to implement the tasks 1.1 and 1.3.

A benchmark report (task 1.2) will include a literature review (grey literature – provincial documents converted into English, stakeholder workshop summary (15$^{th}$ Nov meeting), and household survey results from three provinces). Data from the survey will go into an excel spreadsheet for analysis. The survey will cover a wide range of issues including socio-economic vulnerability to climate change, farmers' adaptation capacity, income, agriculture and gender data.

A number of ideas for pilot demonstrations that were suggested at the 15$^{th}$ Nov stakeholder meeting:

1. Testing some introduced rice varieties for salt tolerance, including hybrids
2. Evaluating 'no tillage' and 'no chemical' options
3. Assessing nutritional aspects of bio-char
4. Comparing a range of rice-based cropping systems

Seed requirements for pilot demonstrations 1 ha = 30 kg of seed

- 2 ha site on-farm = 60 kg of seed

On-farm pilot demonstrations and criteria to be considered:
- Collaborate with farmers that are interested and will actively involve
- Select uniform sites
- Make sure soil types are representative of area
- Determine number of replications and treatments
- Should water management be a treatment in Nam Dinh province?

The group worked together to design five pilot demonstrations for Nam Dinh Province.


**Figure 3: Partners meeting at VAAS, 16th Nov, 2013**

**Field Demonstration 1 (Salinity tolerance of rice varieties in the field)**

**Objective**
To evaluate the performance of five rice varieties under saline conditions in the field during the implementation period of 2014 and 2015.

**Background**
Salt water intrusion is a major problem in this province. While fresh water is available early in the growing season, the irrigation water becomes more saline during the season, particularly from the booting stage onwards.

**Sites**
- Commune 1 (heavy soils): Thinh Long commune, Hai Hau district
- Commune 2 (light soils): Rang Dong farm, Nghia Hung district

**Implementation period:**
- 2014 Spring cropping season (sowing time: Feb. 2014)
- 2014 Summer cropping season (sowing time: around June)
- 2015 Spring cropping season

**Varieties**
- BT7 (inbred- current local variety) – the control treatment
- Tx111 (hybrid – new certified line)
- M14
- M15

- LTH134

**Experimental design**

- 2 sites x 4 reps x 5 varieties = 40 plots
- Plot size: $10m^2$/plot
- Space between plots: 0.3m

Map of the experimental area:

<table>
<tr><td rowspan="6">Protected line</td><td colspan="6">Protection line</td><td rowspan="6">Protected line</td></tr>
<tr><td>Rep. 1</td><td>BT7 (control)</td><td>TX111</td><td>M14</td><td>M15</td><td>LTH134</td></tr>
<tr><td>Rep. 2</td><td>TX111</td><td>M14</td><td>LTH134</td><td>BT7 (control)</td><td>M15</td></tr>
<tr><td>Rep. 3</td><td>M14</td><td>BT7 (control)</td><td>M15</td><td>LTH134</td><td>TX111</td></tr>
<tr><td>Rep. 4</td><td>M15</td><td>LTH134</td><td>BT7 (control)</td><td>TX111</td><td>M14</td></tr>
<tr><td colspan="6">Protected line</td></tr>
</table>

**The application of rice cultivation measures:**

+ Method for planting rice: transplanting with straight-row
+ Space between plants: 12x12cm
+ Space between rows: 20x20cm
+ Density of plant: 40-45plants/$m^2$
+ Rate of fertilisers:
  - Spring rice season: 110kgN-60kgP-80kgK
  - Summer rice season: 100kgN-60kgP-80kgK
+ Fertilisers: Urea (Nitrogen) fertiliser, Lam Thao NPK (5/10/3), potassium chloride

**Measurements**

- Measure the salt in the irrigation water at both sites. This could be done weekly using a salt meter. Then plot water salinity over time and relate to crop growth.
- Apply standard management practices i.e. land preparation, transplanting, flood irrigation, fertilisers, weed control, disease & pest control
- Record all management throughout the season
- Measure grain yield, biomass and HI at maturity
- Also measure biomass at PI and flowering if plot size is large enough
- Components of yield
- A scale for measuring salinity damage (see table 1,2 and 3):

Table 1. Standard evaluation score of morphological symptoms of rice leaf dying affected by salinity

| Score | Symptom |
|---|---|
| 0 | No leaf symptom |
| 1 | Less leaf tip drying |

| | |
|---|---|
| 3 | ¼ leaf dry |
| 5 | ¼ - ½ of all of observed leaves dry |
| 7 | Up to 2/3 of all of observed leaves dry completely |
| 9 | Almost all leaves dead or dying |

Table 2. Standard evaluation score of morphological symptoms of rice leaf rolling affected by salinity

| Score | Symptom |
|---|---|
| 0 | Normal leaf growth |
| 1 | Leaves start rolling (shallow) |
| 3 | Leaves rolling in V-shape (deep V-shape) |
| 5 | Leaves rolling in U-shape |
| 7 | Leaves rolling in 0-shape |
| 9 | Completely leaf rolling (V-shape) |

Table 3. General standard evaluation score for measuring salinity damage

| Score | Observation | Tolerance |
|---|---|---|
| 1 | Normal growth, no leaf symptom | Highly tolerant |
| 3 | Nearly normal growth, but leaf tips of few leaves whitish and rolled | Tolerant |
| 5 | Growth severely retarded; most leaves rolled; only a few are elongating | Moderately tolerant |
| 7 | Complete cessation of growth; most leaves dry; some plants dying | Susceptible |
| 9 | Almost all plants dead or dying | Highly susceptible |

**<u>Demonstration/Experiment 2 (Salinity tolerance of rice varieties in pots)</u>**

**Objective**

Determine the response of five rice cultivars to increased salinity rates and evaluate genetic variation for salinity tolerance.

**Background**

High levels of salinity in irrigation water constrain rice production in the Nam Dinh Province of Vietnam. The extent of genetic variation in the response of rice varieties to increasing rates of salinity needs to be determined, including the critical levels of salinity that cause significant reductions in yield.

**Varieties**
- BT7 – the control treatment
- Tx111 (hybrid var.)
- M14
- M15
- LTH134

**Sites:** Glasshouse at Centre of Technology Development and Agricultural Extension

**Implementation period:**
- 2014 Summer cropping season (sowing time: around June)
- 2015 Spring cropping season
- 2015 Summer crop season

**Salinity treatments**
- Pot experiment (pot size to be determined)
- Five salinity rates (to be determined)
- Method of application (to be determined)
- Freshwater should be used until PI, followed by salinity treatments

**Experimental design**
- Pot experiment in a glasshouse at VAAS
- 4 reps x 5 varieties x 5 salinity rates = 100 pots
- Complete randomised design (use spatial analysis)
- Grow one plant per plot
- Pot size: 25cm in diameter x 35cm high
- Salinity rates: 0‰ (the control), 2‰, 3‰, 4‰ and 5‰

**Method of application:**
+ Rice transplanting
+ 1 plant/pot
+ Space between pots: 20cm
+ Fertiliser application:
  - Urea (white N) fertiliser
  - Lam Thao NPK fertiliser
  - Potassium chloride KCl
+ Soil used in pots: collected from Nam Dinh province

**Materials & Methods**
- Apply fresh water until PI, then impose salinity treatments thereafter

**Measurements**
- Above-ground biomass, grain yield and harvest index
- Components of yield
- Weekly salinity ratings (leaf colour, leaf size, leaf markings, leaf rolling, tillering)
- Salinity level of irrigation water (weekly).

The experiment will start in the beginning of June, 2014. One Master student will be involved.

**<u>Experiment 3 (Slow-release N fertilser)</u>**

**Objective**
To evaluate the impact of slow-release N fertiliser on rice yield and assess the impact of two slow-release N fertilisers on the emission of nitrous oxide.

**Background**
Urea is currently used to fertilise rice crops in the Nam Dinh Province of northern Vietnam. However, the NUE of urea appears to be relatively low in this system. Preliminary studies indicate that slow-release N fertilisers could increase NUE. It is also hypothesized that nitrous oxide emissions may be reduced by using slow-release fertilisers since nitrification, and consequently denitrification, would be reduced.
**Sites**
- Commune 1 (heavy soils): **Thinh Long commune, Hai Hau district**
- Commune 2 (light soils): **Rang Dong farm, Nghia Hung district**

**Implementation period:**
- 2014 Spring cropping season (sowing time: Feb. 2014)
- 2014 Summer cropping season (sowing time: around June)
- 2015 Spring cropping season

**Treatments**
- T1: Standard urea (30/40/30 split at sowing, tillering and PI)
- T2: Slow release fertiliser 1 (green)
- T3: Slow release fertiliser 2 (orange)

Table 4: The fertiliser rates used in the experiment

| Crop season | Treatment | Fertiliser rate per 1ha (kg) | | | Fertiliser rate per 20m$^2$ (g) | | |
|---|---|---|---|---|---|---|---|
| | | N | P (Lam Thao fertiliser) | KCl | N | P (Lam Thao fertiliser) | KCl |
| Spring | T1 | 235.5 | 363,6 | 133.3 | 471.1 | 727.3 | 266.7 |
| | T2 | 117,8 | 363.6 | 133.3 | 235.5 | 727.3 | 266.7 |
| | T3 | 176,7 | 363.6 | 133.3 | 353.3 | 727.3 | 266.7 |
| Summer | T1 | 214.1 | 363.6 | 133.3 | 428.3 | 727.3 | 266.7 |
| | T2 | 107.1 | 363.6 | 133.3 | 214.1 | 727.3 | 266.7 |
| | T3 | 160.6 | 363.6 | 133.3 | 321.2 | 727.3 | 266.7 |

**Experimental design**
- 2 sites x 4 reps x 3 treatments = 24 plots
- Rice variety: Tx111

- Plot size: $20m^2$

**Map of the experimental area:**

<table>
<tr><td rowspan="9">Protection line</td><td colspan="4">Protection line</td><td rowspan="9">Protection line</td></tr>
<tr><td>Rep. 1</td><td>T1 (control)</td><td>T2</td><td>T3</td></tr>
<tr><td colspan="4">Irrigation line 1</td></tr>
<tr><td>Rep. 2</td><td>T3</td><td>T1 (control)</td><td>T2</td></tr>
<tr><td>Rep. 3</td><td>T2</td><td>T3</td><td>T1 (control)</td></tr>
<tr><td colspan="4">Irrigation line 2</td></tr>
<tr><td>Rep. 4</td><td>T1 (control)</td><td>T3</td><td>T2</td></tr>
<tr><td colspan="4">Protection line</td></tr>
</table>

**Method of application:**
+ Rice transplanting
+ Row space: 20x20cm
+ Rice density:
  - Space between plants: 12x12cm
  - Density: 40-45plants/$m^2$
+ Application of fertilisers:
  - White urea Ninh Binh (46.7% of N)
  - Urea NEB26 (50% of N)
  - Urea (orange) Dau Trau 46A+ (25% of N)
  - NPL Lam Thao fertiliser (with 16.5% of $P_2O_5$)
  - Potassium chloride KCl (with 60% of $K_2O$)

**Measurements**
- Measure the salt in the irrigation water at both sites. This should be done weekly using a salt meter. Then plot water salinity over time and relate to crop growth.
- Apply standard management practices i.e. land preparation, transplanting, flood irrigation, fertilisers, weed control, disease & pest control
- Record all management throughout the season
- Measure grain yield, biomass and HI
- Components of yield
- Measure effects of salinity on phenotype (use appropriate scales)
- Measure biomass at PI and flowering (as well as maturity) if plot size permits
- Nitrous oxide emissions will be measured by scientists at VAAS

**<u>Experiment 4 (organic fertilisers)</u>**

**Objective**

To evaluate the impact of two forms of organic fertiliser, compost and biochar, on rice production, and to assess the effect of these fertilisers on methane gas emissions.

**Background**

The high cost of inorganic fertiliser prevents many farmers from applying fertiliser to rice crops in northern Vietnam. The application of compost and/or biochar could be a cheaper and more sustainable alternative to inorganic fertilisers. In addition, biochar should reduce greenhouse gas emissions compared with nitrogen fertiliser.

**Sites**

- Commune 1 (heavy soils): Thinh Long commune, Hai Hau district
- Commune 2 (light soils): Rang Dong farm, Nghia Hung district

**Implementation period:**

- 2014 Spring cropping season (sowing time: Feb. 2014)
- 2014 Summer cropping season (sowing time: around June)
- 2015 Spring cropping season

**Treatments**

- T1: Control (no fertiliser)
- T2: Half standard NPK rate
- T3: Standard NPK (farmer practice)
- T4: Compost alone
- T5: Half standard NPK rate + compost
- T6: Standard NPK + compost
- T7: Biochar alone
- T8: Half standard NPK rate + biochar
- T9: Standard NPK + biochar
- T10: Standard NPK + compost + biochar

Initially, only three treatments were proposed: a) control, b) Standard NPK + compost, and c) standard NPK + biochar. These treatments do not provide an adequate evaluation. For example, if the standard NPK rate provides sufficient nutrients, then the addition of compost or biochar will not further increase yields. Further treatments are needed to assess compost and biochar. The comparisons of compost and biochar with the control and two NPK rates will provide an estimate of fertiliser equivalence for these treatments.

Table 5: Rates of fertilisers, compost and biochar for each treatment

| **Treatment** | **Fertiliser rate per 1ha (kg)** | | | | | **Fertiliser rate per 20m$^2$ (g)** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **NPK** | **Urea** | **KCl** | **Compost** | **Biochar** | **NPK** | **Urea** | **KCl** | **Compost** | **Biochar** |
| **Spring season** | | | | | | | | | | |
| **T1** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **T2** | 298.5 | 86 | 59 | 0 | 0 | 597 | 172 | 118 | 0 | 0 |
| **T3** | 597 | 172 | 118 | 0 | 0 | 1194 | 344 | 236 | 0 | 0 |
| **T4** | 0 | 0 | 0 | 10,000 | 0 | | | | 20,000 | 0 |
| **T5** | 298.5 | 86 | 59 | 10,000 | 0 | 597 | 172 | 118 | 20,000 | 0 |
| **T6** | 597 | 172 | 118 | 10,000 | 0 | 1194 | 344 | 236 | 20,000 | 0 |
| **T7** | 0 | 0 | 0 | 0 | 4,150 | 0 | 0 | 0 | 0 | 8,300 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **T8** | 298.5 | 86 | 59 | 0 | 4,150 | 597 | 172 | 118 | 0 | 8,300 |
| **T9** | 597 | 172 | 118 | 0 | 4,150 | 1194 | 344 | 236 | 0 | 8,300 |
| **T10** | 597 | 172 | 118 | 10,000 | 4,150 | 1194 | 344 | 236 | 20,000 | 8,300 |
| **Summer season** | | | | | | | | | | |
| **T1** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **T2** | 298.5 | 75 | 59 | 0 | 0 | 597 | 150 | 118 | 0 | 0 |
| **T3** | 597 | 150 | 118 | 0 | 0 | 1194 | 300 | 236 | 0 | 0 |
| **T4** | 0 | 0 | 0 | 10,000 | 0 | 0 | 0 | 0 | 20,000 | 0 |
| **T5** | 298.5 | 75 | 59 | 10,000 | 0 | 597 | 150 | 118 | 20,000 | 0 |
| **T6** | 597 | 150 | 118 | 10.000 | 0 | 1194 | 300 | 236 | 20,000 | 0 |
| **T7** | 0 | 0 | 0 | 0 | 4,150 | 0 | 0 | 0 | 0 | 8,300 |
| **T8** | 298.5 | 75 | 59 | 0 | 4,150 | 597 | 150 | 118 | 0 | 8,300 |
| **T9** | 597 | 150 | 118 | 0 | 4,150 | 1194 | 300 | 236 | 0 | 8,300 |
| **T10** | 597 | 150 | 118 | 10, 000 | 4,150 | 1194 | 300 | 236 | 20,000 | 8,300 |

*Note: Fertiliser rates per ha that farmers often apply in project sites are:*

- *Spring cropping season: 110kgN-60kg$P_2O_5$-80kg$K_2O$*
- *Summer-Autumn cropping season: 100kgN-60kg$P_2O_5$-80kg$K_2O$*

**Experimental design**

- 2 sites x 4 reps x 10 treatments = 80 plots
- Rice variety: Tx111
- Plot size: 20m$^2$

**Map of experimental area:**

| Protection line | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Rep. 1 | T1[1] | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 | T10 |
| **Irrigation line 1** | | | | | | | | | | |
| Rep. 2 | T10 | T5 | T6 | T4 | T8 | T7 | T9 | T1* | T3 | T2 |
| Rep. 3 | T7 | T6 | T1* | T8 | T10 | T5 | T2 | T9 | T3 | T4 |
| **Irrigation line 2** | | | | | | | | | | |
| Rep. 4 | T4 | T8 | T10 | T5 | T3 | T1* | T9 | T2 | T6 | T7 |

[1] Control treatment

**Measurements**

- Measure the salt in the irrigation water at both sites. This should be done weekly using a salt meter. Then plot water salinity over time and relate to crop growth. It will be important to know the extent of salinity since severe salinity could confound the experiment. Hence knowledge of salinity levels will assist in correct interpretation of data.
- Apply standard management practices i.e. land preparation, transplanting, flood irrigation, fertilisers, weed control, disease & pest control
- Record all management throughout the season
- Measure grain yield, biomass and HI at maturity
- Components of yield
- Measure effects of salinity on phenotype (use appropriate scales).
- Measure biomass at PI and flowering (as well as maturity) if plot size permits
- Methane emissions will be measured by scientists at VAAS

**Experiment 5 (Cropping Systems)**

**Objective**

To optimise the components of the rice-based cropping system in northern Vietnam, including evaluating options for the spring, summer and winter crops on two soil types.

**Background**

Three crops can be grown in one year. The spring crop (Jan-Jun) is followed by a summer (Jun-Oct) and winter (Oct-Dec) crop. Winter crops include sweet potato, maize, potato and other vegetables.

**Sites:** Thinh Long commune, Hai Hau district

**Experimental period:**

- 2014 spring season; 2014 summer season; 2014 winter season
- 2015 spring season; 2015 summer season; 2015 winter season

**Treatments**

- T1: Spring rice/summer rice/fallow **(control treatment)**
- T2: Spring rice/summer rice/winter crop (maize, or soyabean or cucurbit)
- T3: Spring rice/ratoon summer rice crop/early winter crop (maize, or soyabean or cucurbit)

**Experimental design**

- 2 sites x 4 reps x 4 treatments = 32 plots per season (x 3 seasons)
- One variety (Tx111)
- Plot size: $20m^2$

**Method of Application**
Rice transplanting
Row space: 20x20cm
Rice density:
Space between plants: 12x12cm
Density: 40-45plants/$m^2$
Application of fertilisers:

- White urea Ninh Binh (46.7% of N)
- NPL Lam Thao fertiliser (5/10/3)
- Potassium chloride KCl (with 60% of $K_2O$)

+ Rates of fertilisers:

- Spring rice season: 110kgN-60kgP-80kgK
- Summer rice season: 100kgN-60kgP-80kgK

**Measurements**

- Measure the salt in the irrigation water at both sites. This should be done weekly using a salt meter. Then plot water salinity over time and relate to crop growth. It will be important to know the extent of salinity since severe salinity could confound the experiment. Hence knowledge of salinity levels will assist in correct interpretation of data.
- Apply standard management practices i.e. land preparation, transplanting, flood irrigation, fertilisers, weed control, disease & pest control
- Record all management throughout the season
- Measure grain yield, biomass and HI at maturity
- Components of yield
- Measure effects of salinity on phenotype (use appropriate scales).
- Measure biomass at PI and flowering (as well as maturity) if plot size permits

**Surveys**

- Household surveys will be carried out (80 household surveys to map the gender and socio-economic vulnerability, impacts and adaptation )
- Two Focus Group meetings (Women and Farmers) to be held
- One stakeholder workshop

**PART B: Soc Trang Province (Southern Vietnam)**

*Sunday 17 November 2013*

**Meeting with DARD staff at Regional Headquarters**

At the meeting main problems in rice cultivation in particular and agriculture in particular due to climate change impacts were discussed with scientists and some local technical staff.

*Introduction*
Genetics (salt tolerance and drought adaptation) and management (fertilisers, pest & diseases) will be critical to solving the problems in this area. Farmers have even tried maize but crops were constrained by salinity and flooding. Salt tolerant rice is the preference.

*Crops*
Rice, the main crop, is grown on 343,000 ha over all seasons, accounting for 90% of the total cropped area. Sugarcane is grown on 12,000 ha (5%) and onions are grown on 2% of the cropped area.

*Farm size*
Average farm size is approximately one hectare.


*Soil types*

In general, the soils are heavy (clay), saline and acidic. Farmers flush the soil to remove acid from the profile. Heavy rain is required to wash acid from the soil at depth.

*Seasons*

There are three main seasons each year. Dry season crops (Nov-Mar) average grain yields of 6 t/ha. The spring/summer season (Mar-Jun) produces yields of 5-7 t/ha with a short-season variety. The wet season crop (Jun-Sep) averages yields of 4-5 t/ha, including IR504 which is good for processing. Water can be limiting before flowering in the spring/summer season rice crop due to the late arrival of the wet season.


*Land preparation and pre-plant herbicides*

Land levelling and puddling are common practices. A small manual type of rotary hoe is often used for puddling. Overall, weeds are not much of a problem. Farmers apply pre-plant herbicides (e.g. Sofit).

*Seed treatment*
About 46% of farmers use certified rice seed. There are 9-10 rice breeders in the province.

*Sowing*
80% of farmers use broadcast seeding and the remaining 20% use drum seeding. Direct seeding is popular with very few farmers transplanting. Seed are treated with an acid solution to increase germination. An insecticide seed coat of Cruiser or Oshin is also used.

*Varieties*
The salt tolerant line OM6976 tolerates up to 4000 ppm of salt, but is yet to be tested by growers? OM4900 is the current salt tolerant line, with relatively high yield and quality.

*Fertilisers*

Inorganic fertilisers (NPK) are used by farmers at rates of >100 kg N/ha. Granular fertilisers are applied at the seedling, tillering and PI stages. Foliar fertilisers are applied post-flowering. Farmers don't use organic manure in this province because it's too time consuming to apply. Fertiliser (urea + agrotin) containing Ca is used to increase drought adaptation since the Ca combats acidity. Another additive, Avail, increases P efficiency.

*Pest and diseases*

The main pests are leaf-folders, caseworms and snails. Snails are controlled with molluscicides and/or hand-picking. Sticks are also placed in the field on which snails accumulate (the sticks plus snails are then removed). The main diseases are blast, leaf blight and seed blight. There is a strong plant protection system at the state and provincial levels. Forecasting over the mass media has been effective in the past (e.g. brown planthopper campaign).

*Water management*

There is too little water in the dry season and too much water in the wet season. AWD should be applicable for the dry season.

*Harvesting*

Most rice crops are hand-harvested, although some fields are machine-harvested.

*Post-harvest*

After harvesting, rice grain is sun-dried on roads or roadsides. The rice straw remaining in the field after harvesting is burnt, or flooded to break down, then incorporated into the soil.

*Climate-related constraints to production*
The intrusion of saline water into rice cropping areas is increasing.

**Discussion on treatments/pilot demonstrations**

- Dec-Mar
- Saline & drought tolerant line
- OM6976
- Combine with fertiliser management
- Reduce urea by 30%
- Urea + agrotin (slow release)
- DAP + avil (increases P uptake)
- CAO + bio-organic fertiliser
- AWD treatment
- Best management
- Control: farmer practices
- 5 farmers

**Soc Trang pilot demonstrations in Southern Vietnam/Mekong River Delta**
**Objectives**

To a) compare the alternate-wet-dry (AWD) irrigation method with permanent flood (control), and b) evaluate a new fertiliser regime under both irrigation methods.

**Background**
Drought and salinity both limit rice yield in the Mekong Delta region of southern Vietnam. Water saving strategies are required in both the wet and dry seasons to conserve water resources. Rates of nitrogen (N) fertiliser currently applied to rice fields by farmers are thought to be too high. It is proposed that a number of new technologies (slow-release N fertiliser, Cao placement) will be combined to improve efficiency of nutrient use.

**Experimental design**

- 2 seasons x 3 sites x 4 reps x 2 water x 2 fertiliser = 96 plots
- 16 plots per site
- Randomised split block design with 4 replications

Experimental area

- Total area = 480 m2
- Water main plots = 240 m2
- Treatment subplots = 30 m2

**Seasons**

- Dry season (Jan-May) OM5451 (short duration variety)
- Wet season (May-Sep) OM6976 (short duration variety)

**Sites**

- 3 field demonstration sites
  -Tan Qui A
  - Tan Qui B
  - KoKo

**Treatments**

*Water treatments*

- Permanent Flood (control)
- Alternate-Wet-Dry (AWD)

*Fertiliser treatments*

Control

- 120 kg N/ha split at three times (40/40/40)
- 100 kg/ha DAP
- 75 kg/ha $K_2O$

New fertiliser mix (with 25% less N but slow release)

- 90 kg N/ha + Agrotin
- 70 kg N/ha + Avail

**Pest and disease risk assessment and forecasting model/Trond and CLRRI team**

**Measurements**

Biomass harvests

- PI (2 x 0.25m$^2$ quadrats)
- Flowering (2 x 0.25m$^2$ quadrats)
- Maturity (5 m$^2$)

Measurements at PI & flowering harvests (2 x 0.25 m$^2$)

- Plant number per 0.25 m$^2$
- Tillers per plant (10 plant sub-sample)
- Above-ground biomass of rice
- Above-ground biomass of weeds (this may not be possible since most weeds will be removed by hand)

Measurements at maturity harvest (5 m$^2$)

- Plant number (1 m$^2$ sub-sample)
- Tillers per plant (1 m$^2$ sub-sample)

- Panicles per plant (1 $m^2$ sub-sample)
- Grains per panicle (1 $m^2$ sub-sample)
- Above-ground rice biomass (5 $m^2$)
- Above-ground weed biomass (5 $m^2$)
- Grain yield (5 $m^2$)
- Calculate harvest index

Phenotyping scales

- Check with local VAAS breeders first
- Then with IRRI and/or Chinese breeders

**Management**

- Hand broadcast at a rate of 80-100 kg/ha of seed
- Apply herbicides, insecticides etc as required (but record all applications)

**Surveys**

Socio-economic vulnerability/ HH surveys will be carried out (80 HH in each province together with gender survey and other data needed)

- Exposure (climate risk, market risk, income diversity etc) Outside household
- Sensitivity (within household)
- Adaptive capacity (within household)

Two Focus Group meetings
One stakeholder workshop

**PART C: Tra Vinh Province (Southern Vietnam)**

*Monday 18 November 2013*

**Meeting at DARD/Tra Vinh province**

**Discussion**

*Climate change*

There is a big problem with climate change in this province due to typhoons and drought. It is a high priority of the government to address impacts from climate change. Each province has a disaster prevention committee run by the Department of Rural Development (DARD).

Until recently, saline water only intruded upto 20 km into rice cropping areas in the dry season. The intrusion of saline water is now more than 40-60 km inland. Sluice gates are used to prevent the salt water intrusion. However, less water from upstream during the dry season cannot stop sea water intrusion. Hence drought and salinity are related problems. Heavy rain with high tides results in flooding. Vegetables grown on raised beds are also affected. Usually there is no rain in November, but heavy rains were observed this year. Squash, watermelon and onion have all been damaged by flooding.

 

Are the climate change events becoming more extreme? According to stakeholders, frequency is higher in the last three years (15 typhoons already this year). Four extreme events this year (category 4 or 5 typhoons) have been recorded. Good weather data has only been collected since 1975, including temperature, rainfall and humidity data.

*Disaster plans*

Does the province have a disaster action plan? Dykes are checked and maintained regularly to protect rice fields from typhoons. There is an early warning system in the form of a car and loudspeaker. Farmers are provided help to re-build their houses, seed supplies and food, although support varies between provinces. Local people report damage and the government responds. The organisational structure in Vietnam operates at the province, district, commune and village levels. Self-management people groups support each other locally. More vulnerable people get more funding.

**Commune Headquarters**

**Discussion**

Irrigation infrastructure is poor. Pumping is a problem and costs are high for farmers. Salinity is also a problem. In this province, >60% of the people are Cambodian (Khmer) and the population is poor. Average farm size is 0.5 ha and 50% of the area is affected by salinity, with 20 ppm salinity in the irrigation water.


The commune is divided into two land-use areas:

- 53% of the area has very high salinity and is used for shrimp culture and rainfed rice; and
- 47% of the area has two rice crops per year.

Drought is the number one problem and salinity number two. Drought affects crop production mainly before flowering. The fields are more elevated here, so hard to get water to fields. Farmers need to pump a lot and it is expensive. The most severe drought occurs between mid-November and May. Irrigation infrastructure is high compared with the rice fields, creating further problems.

Average grain yields are 4.5 t/ha in Wet Season 1 (May-Aug) and 5 t/ha in Wet Season 2 (Aug-Nov). No dry season rice is grown between November and May due to severe drought. Rice variety OM576 is tolerant to salinity levels up to 4 ppm, but low in quality. All crops are hand-sown by broadcasting the pre-germinated seed. After harvest, some of the crop is kept for consumption, some as seed for the next crop, and anything left over is sold for cash.

Water management is difficult. The commune has a water-release schedule and farmers plan their crop activities in line with the release of water by the commune. Therefore the management of water at the individual farm level depends on the commune's decision to open sluice gates. This commune is located far from the water source, so it's hard to get good quality water. The commune leader has not yet heard of the AWD water-saving irrigation technology.

Is the biggest constraint to rice production a) limited irrigation infrastructure, or b) lack of salt and drought tolerant varieties? The highest priority, according to the commune leader, is to get drought and salt tolerant varieties. Perhaps this is because at least they can address the issue of crop genetics, while improvement in irrigation infrastructure may be much harder (and more expensive) to achieve. They cannot even flush the soil to reduce soil acidity because there is not enough water. Farmers do not have electricity, so they have to use petrol for pumping. Poor transportation also limits capacity to move rice from field to market. Farmers receive no special help from the government in times of severe drought.

The annual rainfall in this area is 1400-1500 mm, but it only rains from May-Oct. Typhoons in central Vietnam supply rainfall in the wet season. Early season drought is a problem in the first rice crop (delay of Wet Season 1) and late season drought is a problem in the second crop (running into end of Wet Season 2). Same rice variety is grown in both crops. Disease is not a major problem because of elevated land and dry conditions. In addition to rice, farmers will try and grow a small area of corn and morning glory (leafy vegetable). The annual income per capita is 3 million Vietnamese dong (AUD 150).

**Tra Vinh pilot demonstrations in Southern Vietnam**

**Objectives**

To a) compare the alternate-wet-dry (AWD) irrigation method with farmer's current irrigation practice (control), and b) evaluate a range of drought-adapted and salt-adapted varieties under both irrigation methods.

**Background**

Drought and salinity both limit rice yield in the Tra Vinh province of southern Vietnam. Water saving strategies are required in both of the wet season crops to conserve water resources (there is too little water for a dry season crop). The control treatment will be farmer's current irrigation practice rather than permanent flood because farmers do not have enough water for permanent flooding.

**Pilot design**

- 2 seasons x 3 sites x 4 reps x 2 water x 5 varieties = 240 plots
- 40 plots per site (480 $m^2$)
- Therefore 12 $m^2$ per plot (e.g. 3m x 4 m)
- Randomised split block design with 4 replications

Experimental area

- Total area = 480 $m^2$
- Water main plots = 240 $m^2$
- Variety subplots = 12 $m^2$

**Seasons**

- Wet season (June-October)
- Dry season (mid- October-Jan.)

**Sites**

- 3 field demonstration sites
  *All three sites located in Don Xuan village, Ba Gia Ma*
- All the 3 sites have same soil types

**Treatments**

*Water treatments*
- Farmer's current irrigation practice (control)
- Alternate-Wet-Dry (AWD)

*Varieties to be tested in the field demonstration*
- OM9921, OM9605, OM178, OM232, OM9577

**Measurements**

Biomass harvests
- PI (2 x 0.25$m^2$ quadrats)
- Flowering (2 x 0.25$m^2$ quadrats)
- Maturity (5 $m^2$)

Measurements at PI & flowering harvests (2 x 0.25 $m^2$)
- Plant number per 0.25 $m^2$
- Tillers per plant (10 plant sub-sample)
- Above-ground biomass of rice
- Above-ground biomass of weeds (this may not be possible since most weeds will be removed by hand)

Measurements at maturity harvest (5 $m^2$)
- Plant number (1 $m^2$ sub-sample)
- Tillers per plant (1 $m^2$ sub-sample)
- Panicles per plant (1 $m^2$ sub-sample)
- Grains per panicle (1 $m^2$ sub-sample)
- Above-ground rice biomass (5 $m^2$)
- Above-ground weed biomass (5 $m^2$)
- Grain yield (5 $m^2$)
- Calculate harvest index

Phenotyping scales
- Check with local VAAS breeders first
- Then with IRRI and/or Chinese breeders

**Management**
- Hand broadcast at standard rate
- Apply herbicides, insecticides etc as required (but record all applications)

**Surveys**
Socio-economic vulnerability/ HH surveys will be carried out (80 HH in each province together with gender survey and other data needed)
- Exposure (climate risk, market risk, income diversity etc) Outside household

- Sensitivity (within household)
- Adaptive capacity (within household)

Two Focus Group meetings
One stakeholder workshop

**References**

Le Hung Linh, Ta Hong Linh, Tran Dang Xuan, Le Huy Ham, Abdelbagi M. Ismail, and Tran Dang Khanh, 2012. Molecular Breeding to Improve Salt Tolerance of Rice (Oryza sativa L.) in the Red River Delta of Vietnam. International Journal of Plant Genomics, Volume 2012, Article ID 949038, 9 pages, doi:10.1155/2012/949038

**Stakeholders meeting, 15th November : Thinh Long Commune, Hai Hau District, Nam Dinh Province, Northern Vietnam**

Participants at the meetings

- Mr Do Hai Dien, Deputy Director of Nam Dinh, DARD
- Mr Tran Duy Nang, Deputy Head of Crop Division, Nam Dinh DARD
- Mr Do Trung Kien, Head of Agriculture Division of Hai Hau district
- Mr Mai Duc Nghia, Agriculture Division of Hai Hau district
- Mr Pham Ngoc Tu, Vice Chairman of People's Committee of Thinh Long commune
- Mr Le Quy Thinh, President of Farmers' Union of Thinh Long commune
- Mr Pham Quang Hau, Head of Thong Nhat Agricultural Cooperative, Thinh Long commune
- Mr Nguyen Xuan Truong, Head of Dai Thanh Agricultural Cooperative, Thinh Long commune
- Mr Nguyen Duc Trung, Thong Nhat Agricultural Cooperative, Thinh Long commune
- Mr Tran Van Hien , Thinh Long commune
- Mr Bui Cong Chinh, Agriculture Division of Hai Hau district
- Dr Nagothu Udaya Sekhar, Bioforsk
- Dr Trond Rafoss, Bioforsk
- Dr Andrew Borrell, The University of Queensland, Australia
- Dr Le Quoc Thanh, Director of CETDAE (VAAS)
- Mr Dam Quang Minh, Secretary of the project
- Ms Nguyen Thu Trang, CETDAE
- Mr Pham Van Vu, CETDAE
- Ms Nguyen Thanh Phuong, CETDAE, interpreter

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