Environmental footprint of agricultural practices with respect to surface water pollution

(Nutrients and pesticides)

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OUTLINE

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5. Results from irrigation water quality: nutrients analysis
6. Conclusion and further workplan

Introduction

River network, canal, drainages system, water regime are complicated, land use and soil types are diverse

The biggest hub for rice production, and exporting in the country

Pesticide use is commonly in intensive rice systems

Some where in rural area, surface water is still used for drinking, cooking, bathing and animals,

-lack of mitigation and surface water quality monitoring (pesticides analysis)

GLOBALG.A.P.
Global Partnership for Good Agricultural Practice

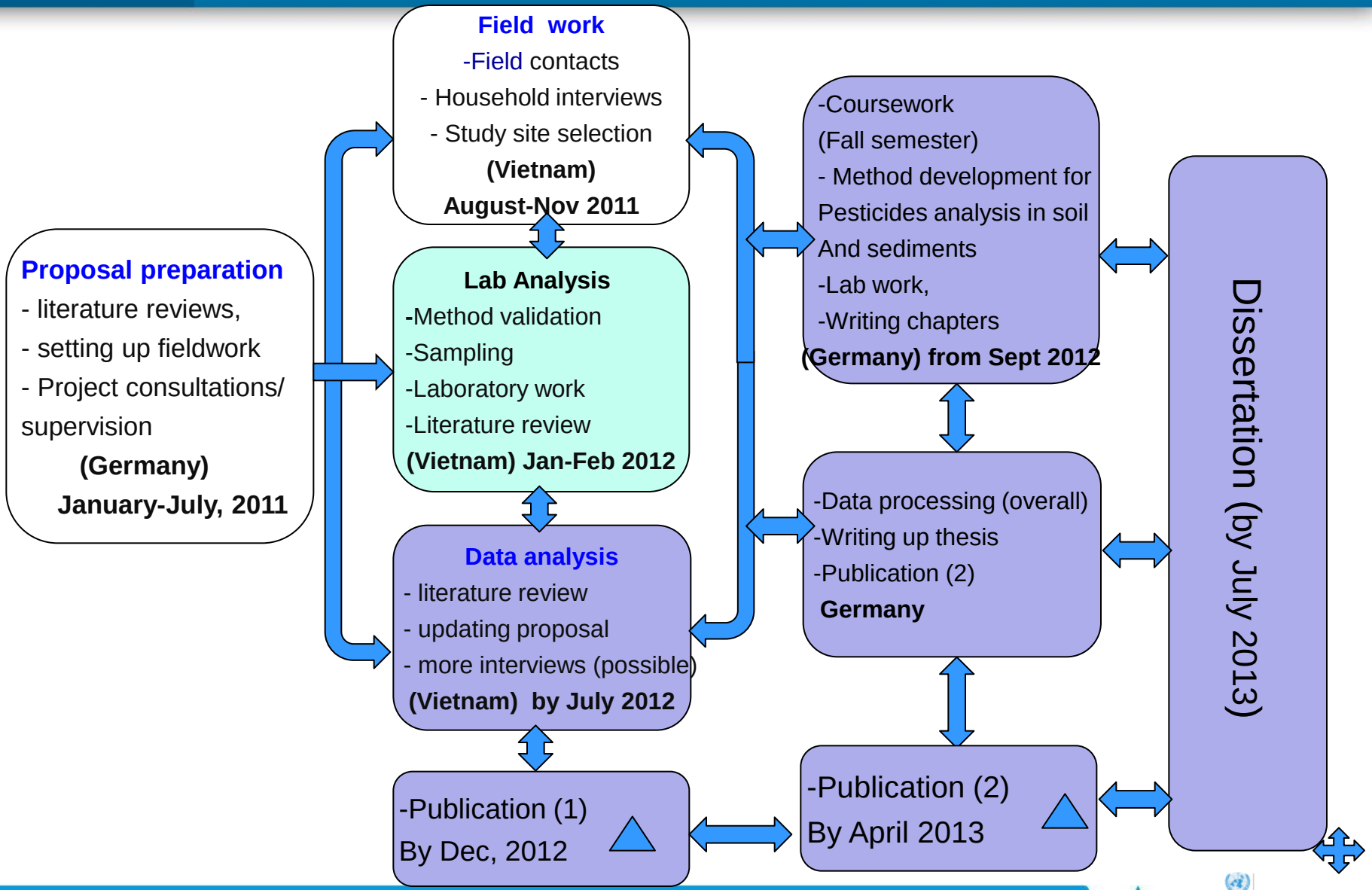
There are “good practices” application in rice production in the Mekong delta

HYPOTHESIS, OBJECTIVES

Different agricultural production systems differentially affect the amount /rate and spatial –temporal dynamics nutrients/ pesticides discharges into surface water bodies (hypothesis)

- To **classify rice-based systems** in order to understand the runoff characteristics and management practices (1)
- To **monitor concentrations of nutrients and pesticides** in surface water (soils and sediment s) (2)
- To link the **relationship** between **management practice** of rice systems and **surface water quality** (3), and
- To **differentiate agricultural areas** with regards to their environmental footprint (4)

WORKPLAN

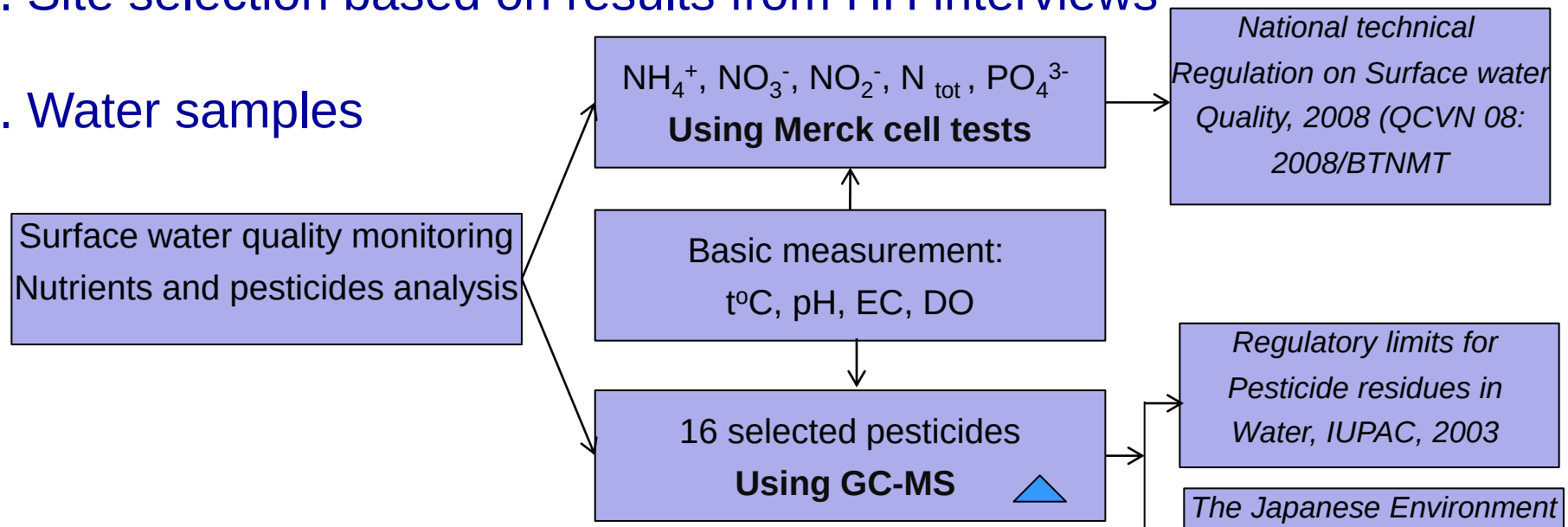

Field work
-Field contacts
- Household interviews
- Study site selection
(Vietnam)
August-Nov 2011
Proposal preparation
- literature reviews,
- setting up fieldwork
- Project consultations/ supervision
(Germany)
January-July, 2011
Lab Analysis
-Method validation
-Sampling
-Laboratory work
-Literature review
(Vietnam) Jan-Feb 2012
Data analysis
- literature review
- updating proposal
- more interviews (possible)
(Vietnam) by July 2012
-Publication (1)
By Dec, 2012
-Coursework
(Fall semester)
- Method development for Pesticides analysis in soil And sediments
-Lab work,
-Writing chapters
(Germany) from Sept 2012
-Data processing (overall)
-Writing up thesis
-Publication (2)
Germany
-Publication (2)
By April 2013
Dissertation (by July 2013)

Study contents and Methods

1. Household interviews

2. Site selection based on results from HH interviews

3. Water samples



4. Soils and sediments (basic characteristics)

- pH
- CEC (cation exchange capacity)
- Soil texture
- Nutrients (N_{tot}, C_{tot}, P_{tot})
- pesticide pollutants

Criteria to select study sites

- Soil type: Alluvial and slight acid sulfate soil
- Rice system: triple, double rice
- No other contamination influence on selected sites (irrigation source)

- There are available comparative systems (technology targeting) in each site
- good practice and typical practice: global gap/Non-Global Gap, Vietgap/Non-Vietgap, IPM/non-IPM
- Farmers are willing to cooperate

Household interviews

Methodology

- Using the participatory rural appraisal (PRA) conduct formal survey , Questionnaires , asking questions

Important information

- Cultivation techniques/practices on rice
- Fertilizer and pesticide use
- Irrigation regime (tide effect, pumping, close dyke)
- Rice productivity
- Field observation

Agricultural systems in the Mekong delta, and study focus

Crop based systems:

- Rice-aquaculture (rice-wild fish, rice-saline water shrimp, rice-fish)
- Fruit trees
- Rice-livestock farming system
- **Intensive rice systems**

  - double rice crop-upland crop/year

  - Triple rice crop/year

  - double rice crop/year

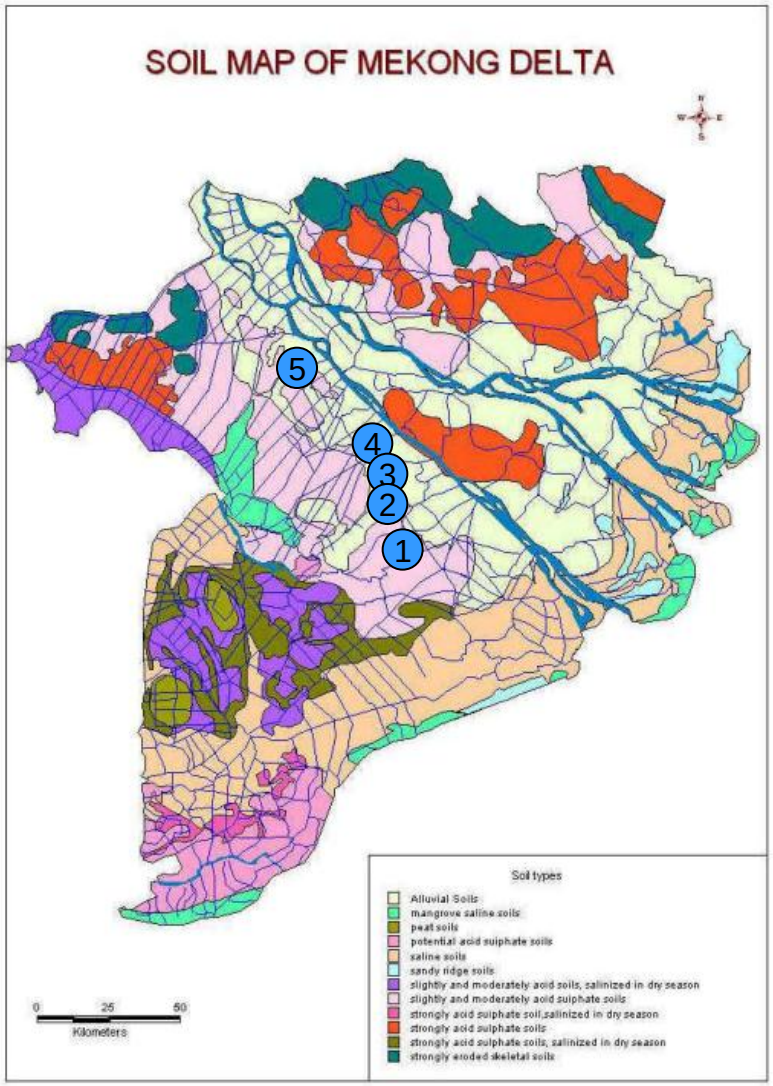
Animals based systems:

- Livestock production (pig, poultry)
- Fish production (mostly in coastal area)
- Livestock and fish

(Vo-Tong Xuan, Shigeo Mattsui, 1998)

Study sites: Household interviews

- **1. Phung Hiep, Hau Giang**
  -Double rice, slight acid sulfate soil
  -Vietgap and non-Vietgap (2nd year)
  - Inside dykes, pumping
- **2. Truong Lac, Omon, Can Tho**
  -Triple rice, alluvial soil
  -IPM and Non IPM (years)
  - Outside dykes, tidal water (velocity)
- **3. Thoi Long, Omon, CT**
  -Double rice-upland, alluvial soil
  - IPM and Non IPM (years)
  - Outside dykes, tidal water
- **4. Vinh Thanh, Can Tho**
  - double rice, alluvial soil
  -Global gap and non-global gap (1st year)
  - Inside dykes, pumping
- **5. Chau Phu, An Giang**
  - double rice, alluvial soil
  -Global gap and non-global gap (3rd year)
  - Inside dykes, pumping



Household interviews: Result

∑171 household interviews

(4 pre-tests & 20 interviews were conducted together with Kajo, - a master study)

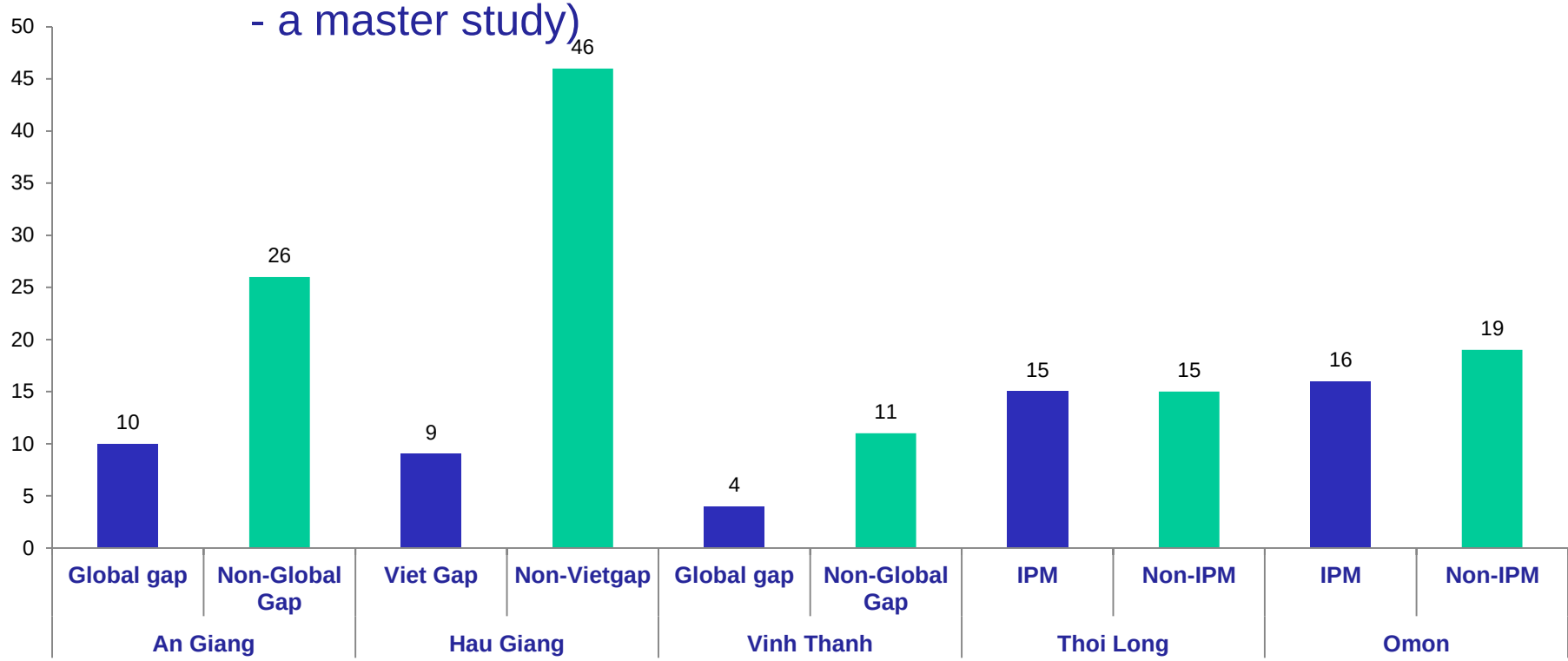


Fig.1 Number of interviews by locations and practice

Good practices/technology targeting in the MD

- **Good practices**: are **methods/techniques** to apply **on- farm** production to promote agricultural productivity of **safe and healthy food**, while taking into account **farm labor safety, economic viability, social and environmental sustainability** (FAO, 2003, 2004)

- **The available good practices in the MD:**
  - **Integrated Pest management** (IPM)
  - **3R3G** (3Rs: seeds, inorganic fertilizers, pesticides; 3Gs: yield, quality, profits
  - **1 must do, 5 reductions** (right cultivar, can reduce seed, fertilizers, pesticides, water use and loss at post harvest)
  - **Vietgap** (promoted by the Government of Vietnam since 2008)
  - **Global gap**, has been launched in 2009, evaluated and monitored by the international company (TÜV SÜD Group) on agricultural environment, product quality
  - **The trial farm or "**cánh đồng mẫu lớn", Thoai Son, An Giang, promoted by the An Giang Plant protection company
  - **Ecological Engineering (EE)**, new and mostly in Tien Giang, based on IPM approaches, etc

Difference in fertilizer use in different groups: HH Interview results

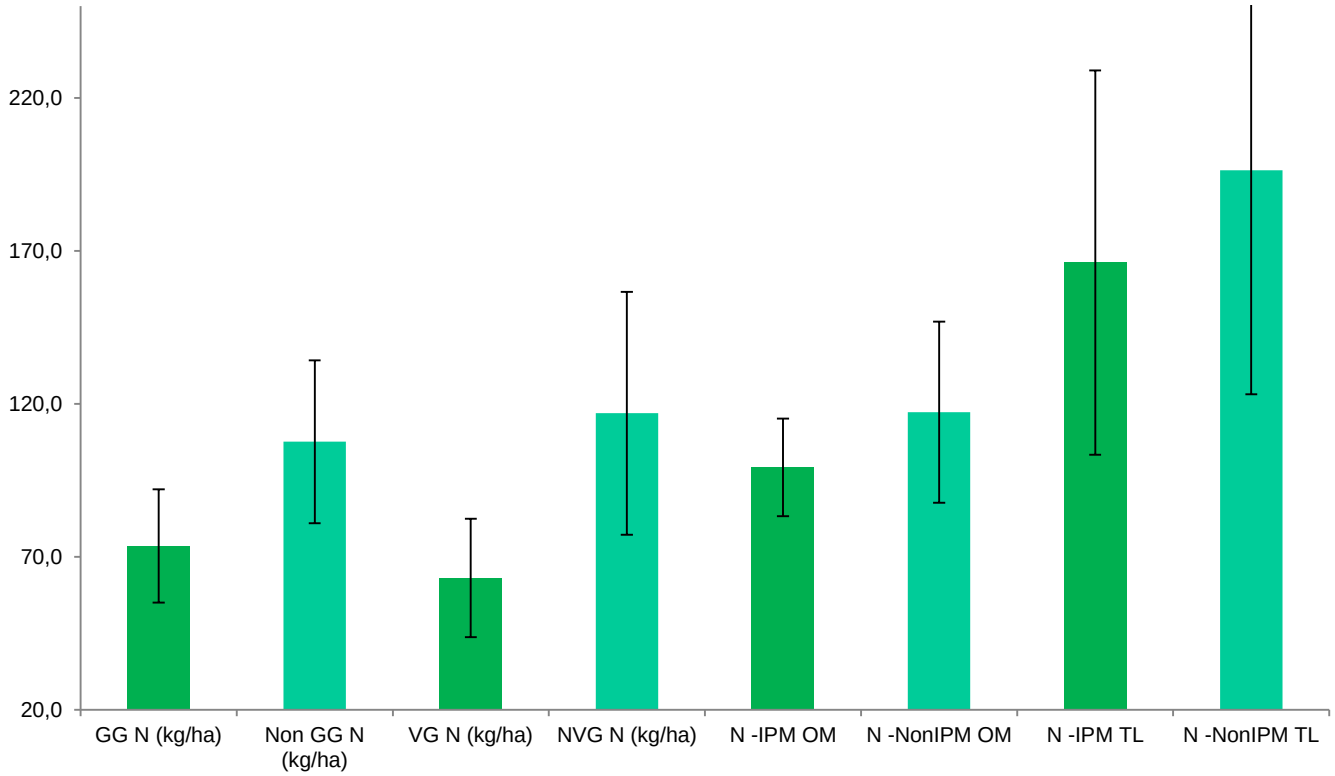


Fig. 2 Difference in Nitrogen use (kg/ha)

Difference in No. of sprays/season and mode of using

HH interview results:

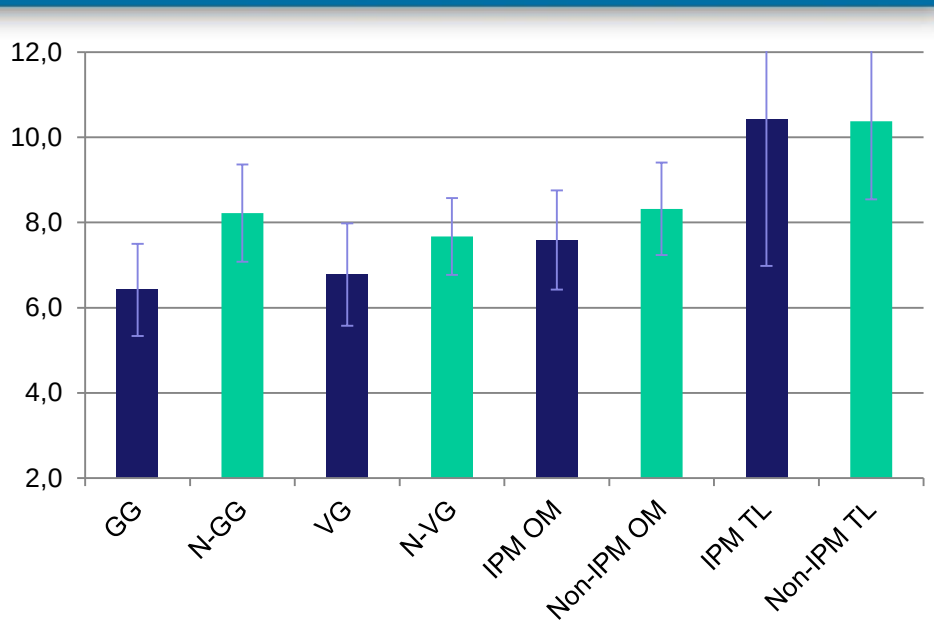


Fig.3 Number of sprays in Summer-Autumn 2011

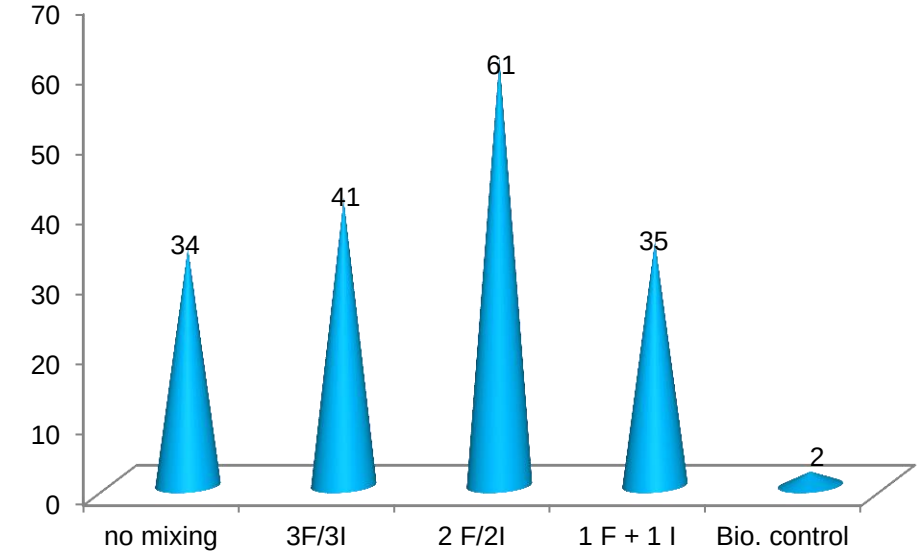
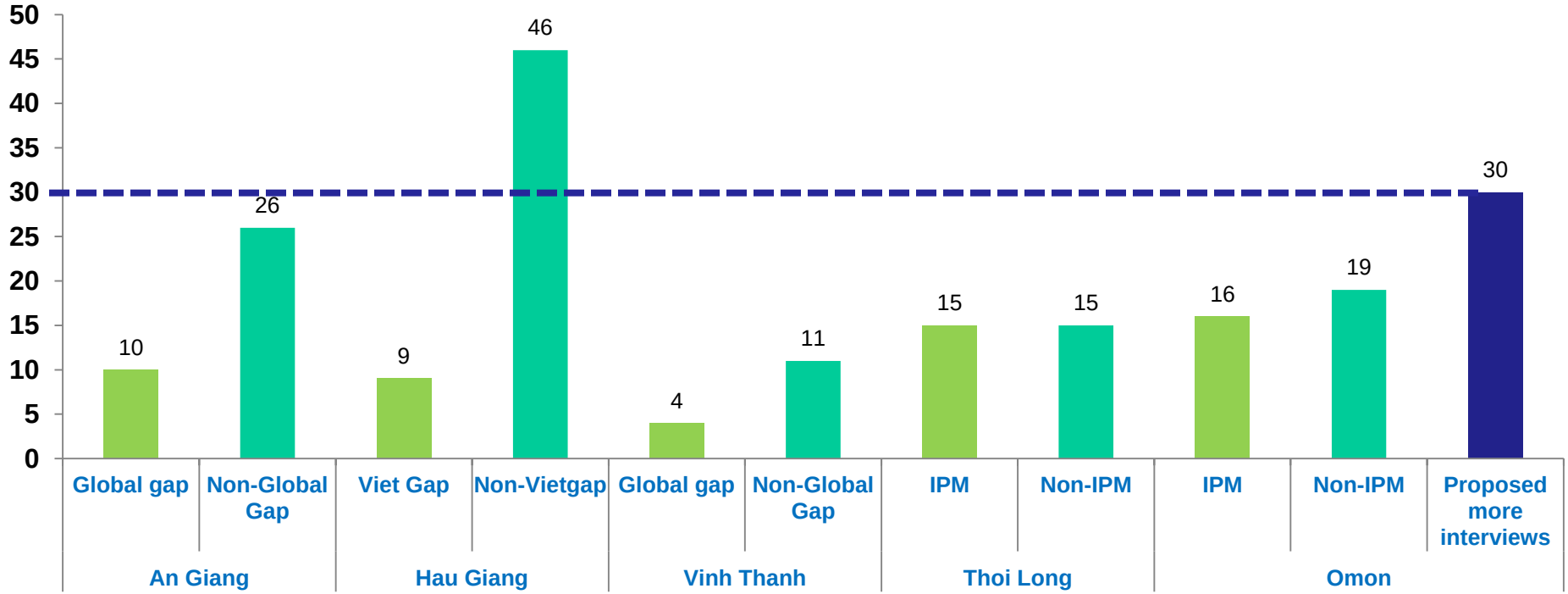


Fig.4 Mode of using pesticides

Conclusion on household interviews, proposed more interviews

- Differences in fertilizer use, number of sprays/season between Global Gap and Non-Global gap group, Viet Gap group and Non-Viet Gap group (t-test, SPSS ver. 13)
- No significant different between IPM and Non-IPM group in terms of fertilizer use and number of sprays
- **Proposed more household interviews**: **30 household interviews/ group**



Final site selection, site replicates

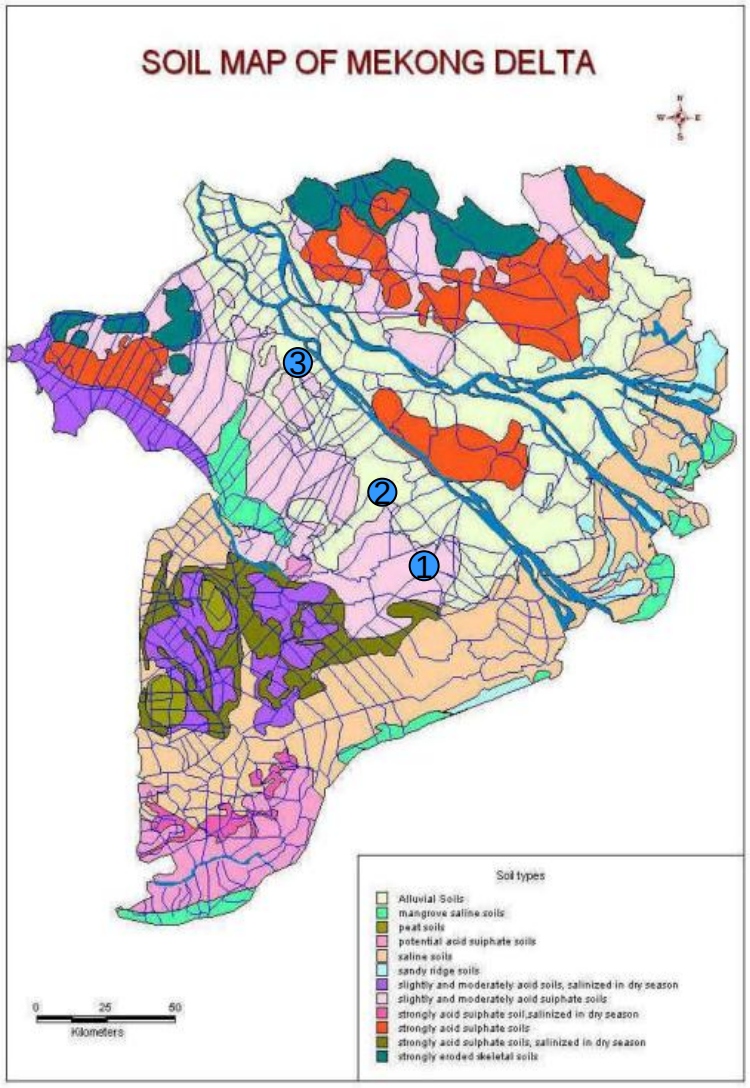


Fig. 5 final study sites

Location	specific practice		Representative/typical practice	
Study site	Field size	coordinate	Field size	coordinate
Chau Phu, An Giang (3)	**Global Gap group**		**Non-Global gap group**	
	3,2 ha	10°27'33.2" N 105°11'76.5"E	5 ha	10°27'61.3" N 105°11'55.5"E
	2,1 ha	10°27'96.5" N 105°11'60.5"E	5 ha	10°27'59.4" N 105°11'56.5"E
	2,7 ha	10°27'57.9" N 105°11'38.5"E	2 ha	10°27'55.1" N 105°11'33.4"E
Vinh Thanh, Can Tho (2)	4 ha	10°12'23.7" N 105°17'09.1"E	3 ha	10°08'29.7" N 105°19'71.8"E
	3 ha	10°12'26.5" N 105°17'06.9"E	2,2 ha	10°08'27.9" N 105°19'73.4"E
	1 ha	10°12'28.3" N 105°17'05.2"E	2,6 ha	10°08'26.3" N 105°19'75.0"E
Phung Hiep, Hau Giang (1)	**Vietgap group**		**Non-Vietgap group**	
	1,5 ha	9°49'37.8" N 105°41'08.2"E	1 ha	9°49'28.7" N 105°41'12.2"E
	1 ha	9°49'48.3" N 105°41'04.3"E	1 ha	9°49'58.6" N 105°41'36.6"E
	1 ha	9°49'55.7" N 105°41'12.4"E	1 ha	9°49'71.2" N 105°41'00.4"E

Replicates: 6 fields/system, 2 seasons

Sampling water samples, number of samples

- Inflow water from selected rice fields (pumping events) at inlets
- Outflow water from selected fields at discharging events at outlets

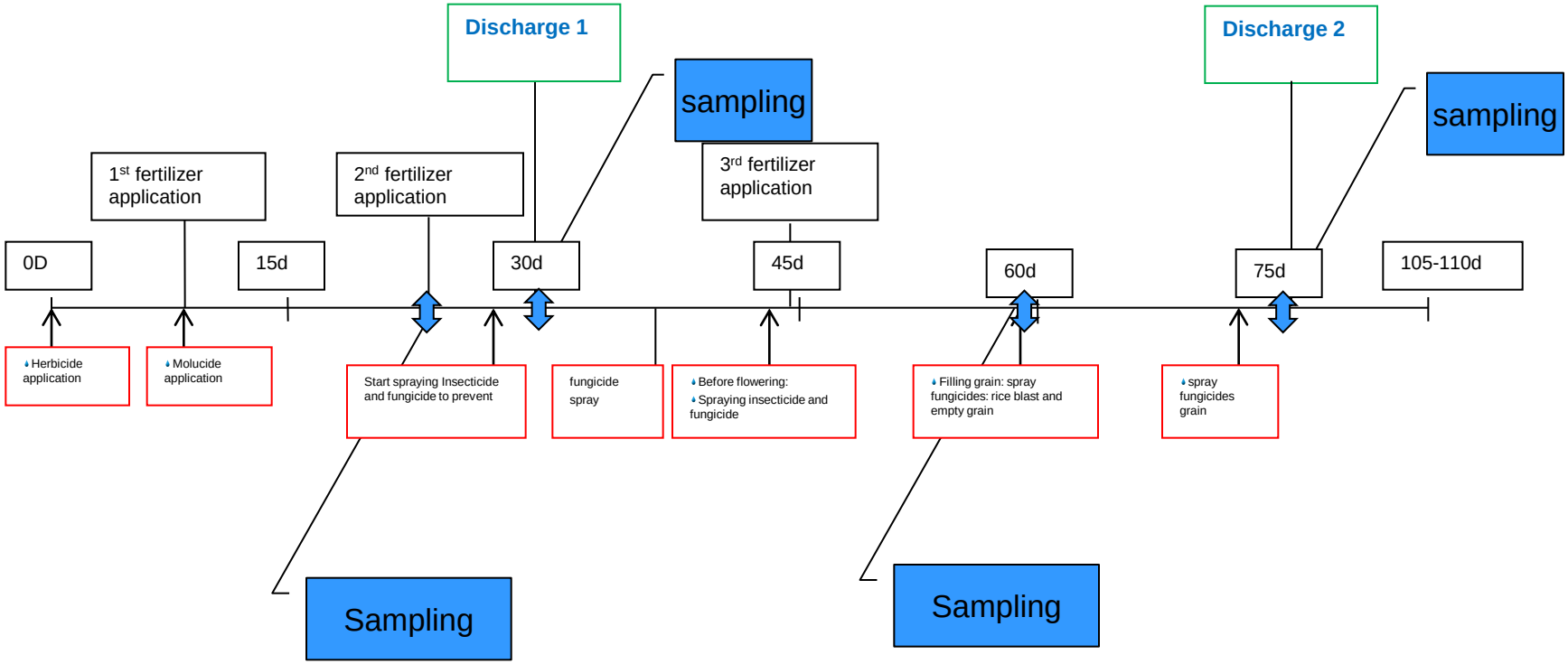


Fig.6 Rice growing period, input applications and water sampling events

(Jasmine 85 rice cultivar)

Sampling and number of samples

No. water samples=

(2 inflows + 2 discharges)x6 fields/area (18) +

(1 high tide +1 low tide)x3 farm canals/sitex3 sites x 4 times/season

= **104 samples/Season**

Composite samples: 5 subsamples to build 1L of sample/rice field

4 sub-samples to build 1L of sample/farm canal

Soils and sediments

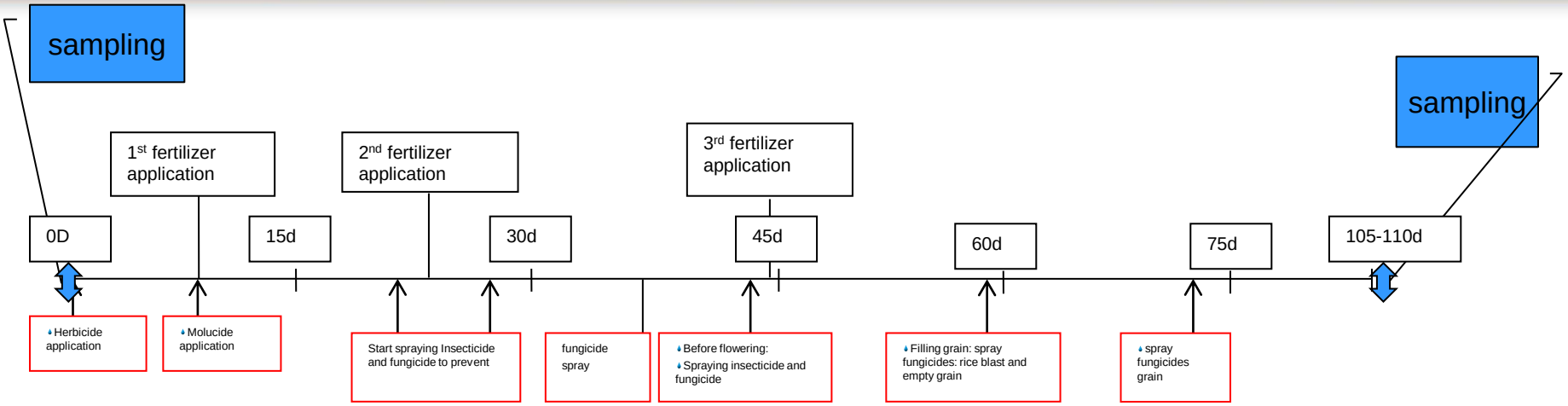


Fig.7 Rice growing period, soil, sediments sampling (Jasmine 85 cultivar)

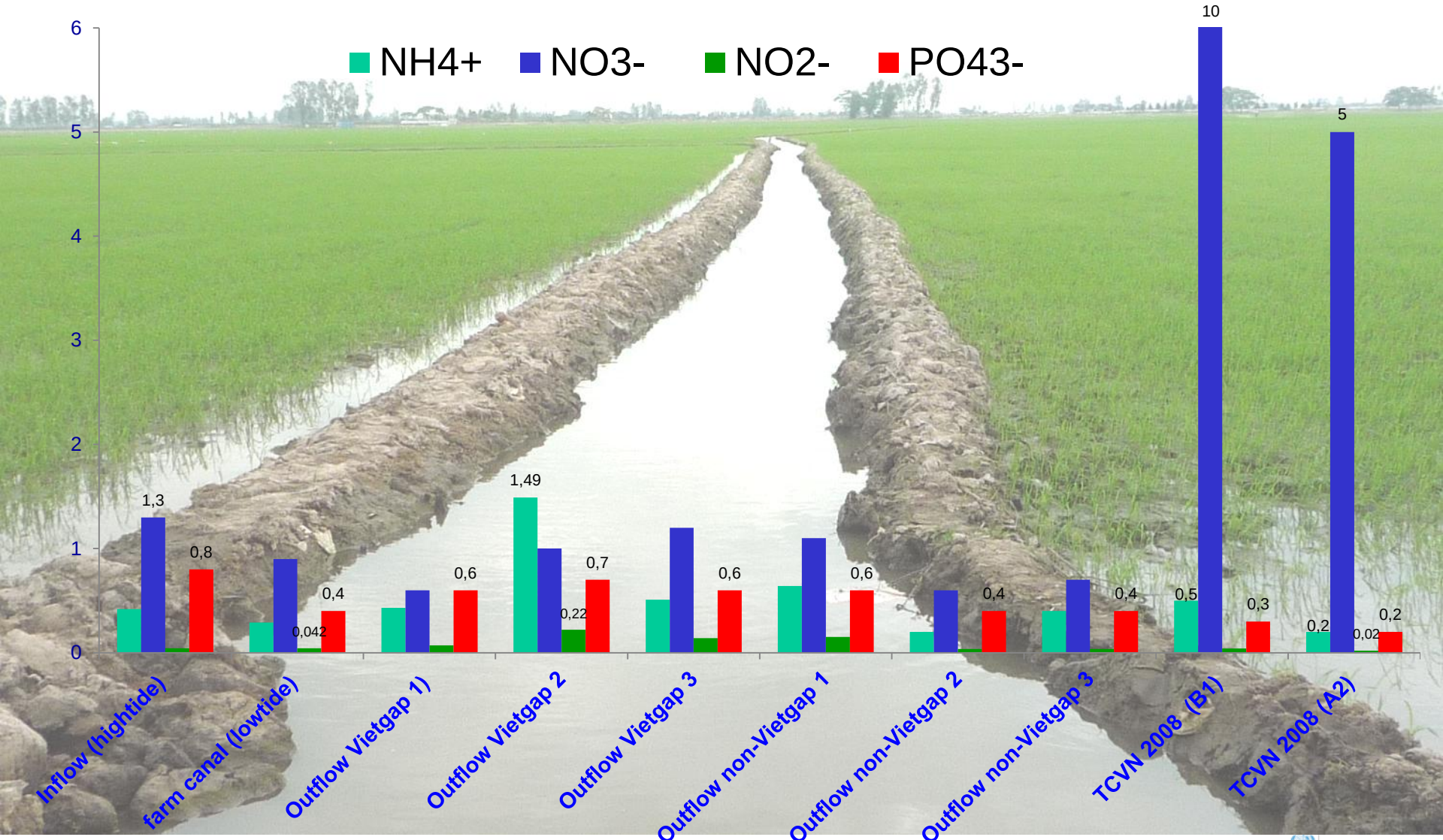
- **Soil samples:** before broadcasting + after harvesting, from selected rice fields (a composite sample from 8 subsamples, zigzag pattern)

- **Sediment samples**: before rice season, and after rice season at farm canals (a composite sample from 4 subsamples in farm canal)

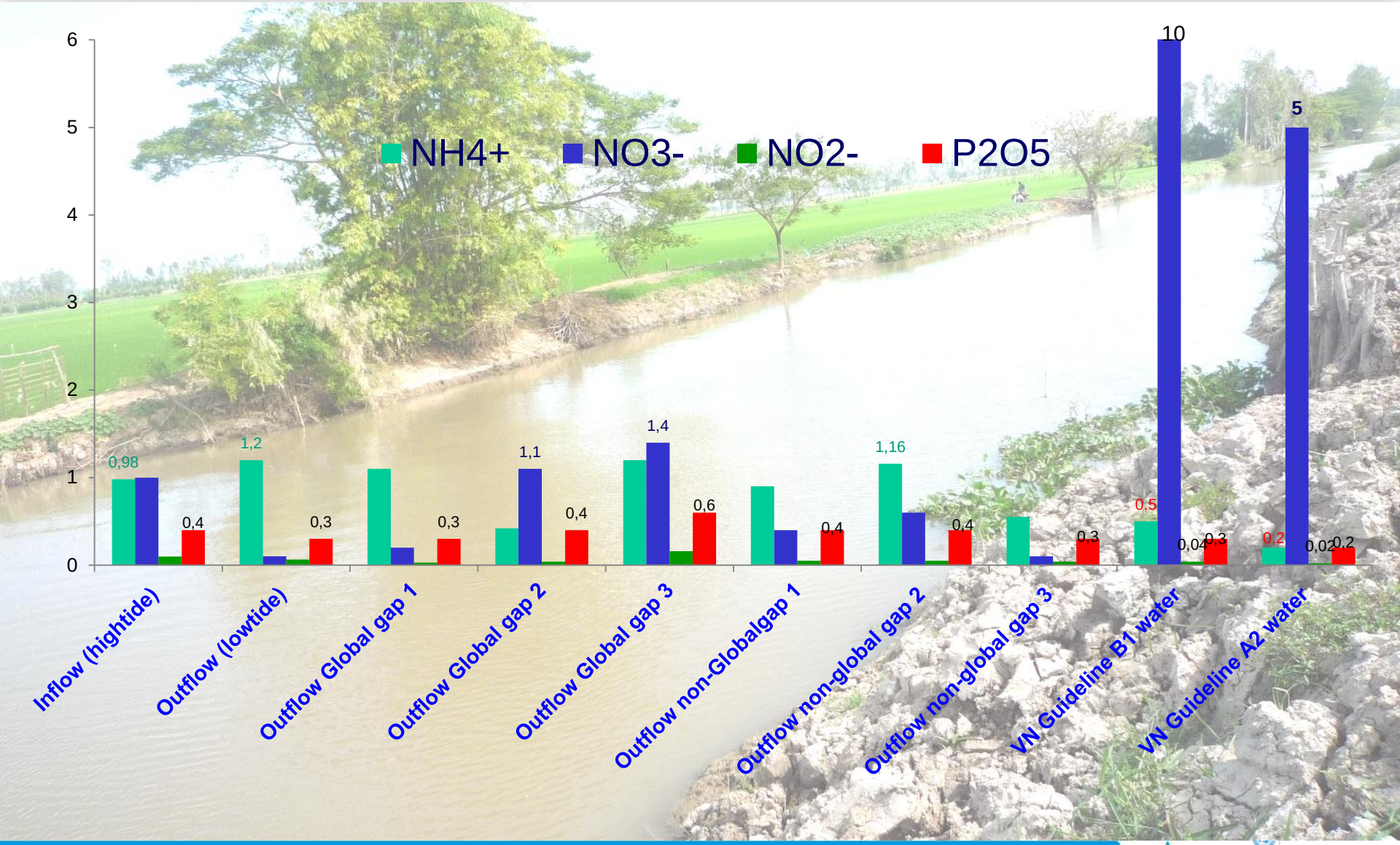
No. Soil samples/season = 18 fields x 2 = 36 samples

No. Sediment samples/season= 3 farm canals/site x 3 sites x 2 times/season = 18 samples

Monitoring results: Nutrients analysis
Phung Hiep, Hau Giang



Monitoring results: Nutrients analysis
Vinh Thanh, Can Tho



Monitoring results: Pesticides analysis

- 33 samples were extracted and sent to run at GC-MS in Hue

•After drying cartridges

•Eluted by ethyl acetate, n-hexane, add toluene (keeper), then evaporation

Run GC

Diluted by toluene,
add internal standard,
Transfer to vial (1ml),
Adjust volume by toluene

Achievements in 1st year

- **Site selection:**

  - the good practices were defined literature, interviews
  - suitable, representative sites were selected for a comparative outputs of selected rice systems

- **Learning approaches and Method development**

  -nutrients analysis and lab training in INRES, C.T.U soil lab (Prof. Guong)
  - pesticide analysis training by Zita in Nov 2011 successfully
  - method development in selected target pesticides together with Chau in Hue

- **Irrigation water quality: monitoring results**

Measurement	Compare to B1	Compare to A2	QCVN B1 (irrigation) mg/l	A2 (public use and need treatment) mg/l
NH4+	100% samples ≤ conc. B1	13% < conc. A2 **87% > conc. A2**	0,5	0,2
NO3-	100% samples ≤ conc. B1	100% < conc. A2	10	5
NO2-	56% < conc. B1 **44% > conc. B1**	**100% > conc. A2**	0,04	0,02
PO43-	**100% > conc. B1**	**100% > conc. A2**	0,3	0,2
DO	≥ 4 (B1)	≤ 5 (A2)	≥ 4	≥5

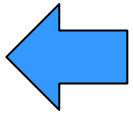
- **Next plan**

Thank you for your attention

Publication 1

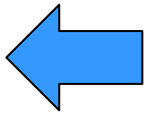
- Rice production characteristics and management in the Mekong delta: The comparative study on current practice and selected technology targeting practices on intensive rice systems at household level

  (by December, 2012)



Publication 2

- Surface water quality (nutrients and pesticide pollution) in intensive rice systems in different cultivation techniques related to soil types and water regime in the Mekong delta (by April, 2013)



Cropping patterns/calendar in study areas

Cropping patterns	Jan	Feb	Mar	Apr	May	Jun	Jul.	Aug	Sep	Oct	Nov	Dec
Triple rice- Truong Lac, Omon			S-S (rice)			S-A (rice)			Flooding			W-S (rice)
Double rice-upland Thoi Long, Omon			S-S (sesame/ water melon)			S-A (rice)			Flooding			W-S (rice)
Double rice HG	W-S (rice)					S-A (rice)			Flooding			
Double rice VT	W-S (rice)					S-A (rice)			Flooding			
Double rice A.G	W-S (rice)					S-A (rice)			Flooding			

Samples, measurements and methods

Water samples

- Electrical conductivity
- Dissolved oxygen
- pH
- Nutrients: NH_4^+, NO_3^-, NO_2^-, tot N, PO_4^{3-}
- Pesticide pollutants: 16 selected pesticides

Soil, sediments

(basic characteristics)

- pH
- CEC (cation exchange capacity)
- Soil texture
- Nutrients :total N, total C, total P
- pesticide pollutants: 16 selected pesticides

While sampling, consider the: site conditions,

Crop stage, tide effects/dilution, seasonality

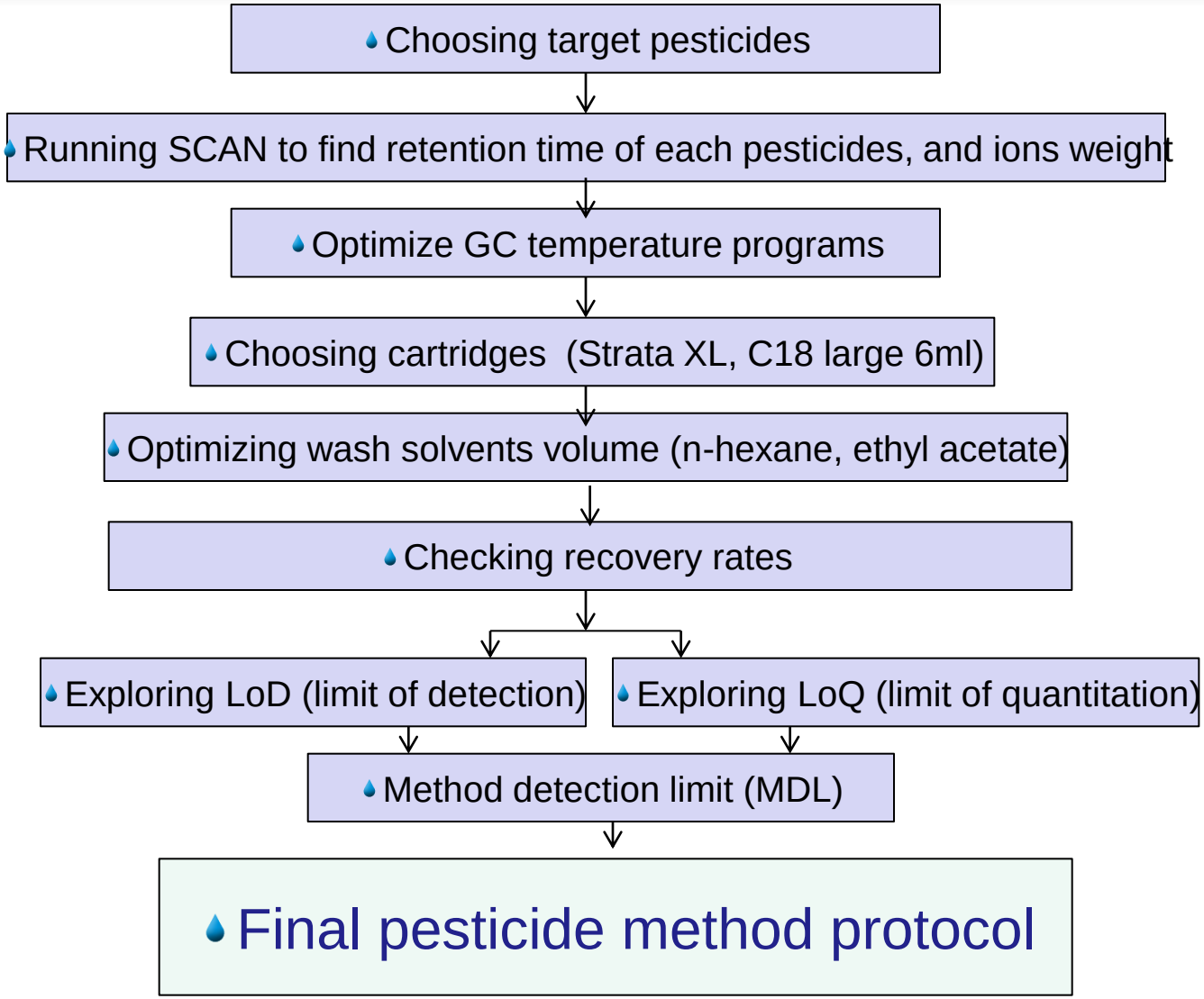
Methods:

- Nutrients analysis in water, soils and sediments: using **cell tests, Merck,** Germany, with suitable range of concentrations (done in Vn)
- Pesticides analysis in water samples by **GC-MS** (done in Vietnam), method was developed in Hue together with Nguyen Dang Giang Chau

List of analyzed pesticides

No	Name	Classification	Pesticide	WHO toxicity
1	Fenoxaprop-P-ethyl	Benzoxazole	Herbicide	III
2	Butachlor	Chloroacetanilide	Herbicide	III
3	Difenoconazole	Azole	Fungicide	II
4	Azoxystrobin	Strobilurin	Fungicide	III
5	Tebuconazole	Azole	Fungicide	III
6	Trifloxystrobin	Strobin	Fungicide	III
7	Hexaconazole	Azole	Fungicide	U
8	Isoprothiolane	Dithiolane	Fungicide	III
9	Pretilachlor	Chloroacetanilide	Herbicide	U
10	Propiconazole	Azole	Fungicide	II
11	Thiamethoxam	Neonicotinoid	Fungicide, Insecticide	III
12	Chlorfluazuron	Benzoylurea	Insecticide	U
13	Quinalphos	Organophosphorus	Insecticide	III
14	Cypermethrin	Pyrethroid	Insecticide	II
15	Fenobucarb	Carbamate	Insecticide	II
16	Fipronil	Pyrazole	Insecticide	II

Pesticide analysis method development (in Hue) with Nguyen Dang Giang Chau



Pesticide Method development

- Cartridge: **C18 (500 mg, 6ml)** is the best option, high recovery rate (82-124%), than Strata XL <60%
- Selecting target compounds: **17 active ingredients** out of from 30 compounds
- Limit of detection (LoD), LoQ (limit of quantitation), MDL (method detection limit)
- Method recovery: **60,1-117,0%** with Relative Standard deviation (RSDs) vary from 4,1- 24,75%
- GC temperature program for analyzed pesticides:

No	Rate	Final temp	Hold time
-		80	2.00
1	10.00	150	5.00
2	5.00	230	0.00
3	2.00	250	0.00
4	20.00	280	10.00
Post temp:	300 C		
Post time:	10.00 min		