Livestock Waste Management in East Asia
LWMEA (GCP/RAS/215/WBG)

The World Bank | Global Environment Facility | The Food and Agriculture Organization

Decision support tools for managing nutrient fluxes and for selecting manure treatment technologies

Technical support

Consultants report on the joint project mission held in SE Asia from 13th to 24th April 2007

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SUMMARY

Together with delegations of the World Bank and FAO, who carried out a project supervision mission the two consultants Colin Burton and Harald Menzi carried out a technical support mission to Vietnam, Thailand and Guangdong from April 13 to 24 2007. In each country the mission comprised

1. a workshop with invited experts on the possibilities and needs of a Decision Support Tool (DST) in the form of a computer model.
2. Backstopping the LWMEA project activities concerning the design of manure treatment facilities and environmental monitoring.
3. Expert consultations about potential collaborations.

Important conclusions from the workshops can be summarized as follows:

- There is a keen interest for such a DST in all the countries. However it will have to take into account the needs of different users. The DST should be a management tool as well as a capacity building instrument.
- The DST must not only contain calculation modules but also decision aids in the form of a decision tree approach, recommendations and possible case study examples. In addition to computer model guidelines, recommendations and decision support aids should also be disseminated in printed form to farmers.
- For the user the nutrient balance/Flux part and the treatment part of the model must be one comprehensive and user-friendly and flexible package.
- The existing model NuFlux can not meet all the requirements of the LWMEA project; a new programming will be necessary. The manure treatment part of the DST must be newly developed.

The progress since the last mission in the design and implementation of the new manure management technology has been variable. There was no construction yet in all three countries but it might start in the near future. While the monitoring activities have already progressed well in Thailand, they are still in the recruitment phase in Vietnam and Guangdong. The mission allowed valuable discussions with the project teams on the upcoming activities.

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1. INTRODUCTION

1.1 Report objectives

This report represents a record of activities carried out by the consultants Colin Burton and Harald Menzi contracted by the FAO to fulfill a series of activities during a joint mission to SE Asia 13 to 24th April 2007. In addition it presents, as required, the specific views and advice of the consultants in response to a series of tasks related to the implementation of the Livestock Waste Management in East Asia (LWMEA) project. As such, it is expected that the content of this report is disseminated amongst other members of the project team as a principle means of communication of key information to enable this part to the project to progress.

1.2 Context of the mission

For the context of this report, the reader is directed to a series of previous reports prepared in the past 2 years as well as the project documentation itself.

BURTON, C.H (2004) Consultants report on manure management technologies for livestock farms in Thailand, Vietnam and Guangdong province, China. Contract report: CR/1594/04/3475 Silsoe Research Institute, Silsoe, Bedford UK. November 2004. This provides an initial overview of the situation of livestock farming in SE Asia and of technologies available for possible installation. In this same report is an evaluation of each of these technologies in terms of effectiveness against the principle concerns of nitrogen, phosphorous and organic matter release to surface water.

Menzi, H (2004) Consultants report on Environmental Baseline Study (EBS): Manure Management and Nutrient Balances in the LWMEA project in Thailand, Vietnam and Guangdong province, China. Swiss College of Agriculture, Zollikofen, Switzerland. November 2004. This provides an overview of the situation of manure and livestock management in the project areas and a list of suggestions of issues to consider in the LWEAM project.

BURTON, C.H (2005) Consultants report on manure management systems required for specific livestock farms in visited in Thailand, Vietnam and Guangdong Province, China. Contract report: CR/1663/05/3689 Silsoe Research Institute, Silsoe, Bedford UK. June 2005. This provides more specific detail of the farms identified in the selected study areas including examples of treatment system and corresponding design information.

BURTON, C.H (2006) Consultants report on manure management systems required for specific livestock farms visited in Thailand, Vietnam and Guangdong Province (China). Contract report, Cemagref, Groupement de Rennes, 17, avenue de Cucillé, Rennes, France. December 2006. This reviewed the manure handling and treatment systems proposed for the first farms to be included in the project. In addition the outline requirements of the DST packages were covered in a joint regional workshop.

Menzi, H (2006) Back to office report on Environmental monitoring in the LWMEA project in Thailand, Vietnam and Guangdong province, China. Swiss College of Agriculture, Zollikofen, Switzerland. December 2006. This provides an overview of the activities and issues addressed during the mission in October 2006.

Menzi, H. and Burton, C. (2007) Summary BTOR of the technical mission to the LWMEAP project in Vietnam, Thailand and Guangdong in April 2007. April 2007. Bullet-point summary of the activities and issues addressed during the mission in April 2007.

The 5-year project formally commenced in August 2006. Amongst its objectives, are three which are relevant to this report: (a) the provision of technical support for the initial farms participating in the project and (b) the support of the national LWMEAP project teams in establishing and carrying out a monitoring scheme for the farms participating in the project, (c) the specification of an information package and calculation model (referred to as DST or decision support tool) to be made available to project participants by the end of 2008 to enable wider dissemination of the assessment of nutrient fluxes and balances in conection with livestock production and manure management, the specification and design of waste management schemes for livestock farms and correct manure management strategies. At the time of this mission, the preparations for the first group of farms was expected to be near completion.

1.3 Itinerary of this mission and DST workshops

The preliminary mission schedule is given in Annexe 1. Some minor modifications were made but the structure remained the same, *i.e.* visits in turn to the three participating countries of Vietnam, Thailand and China. In each case, the pattern was similar the visit comprising three elements: (a) jointly running a workshop to discuss and develop the planned DST package; (b) subsequent meetings with key people interested in the DST; (c) field visits to view the on-going developments at participating farms – providing technical support on proposed designs and monitoring. The latter would include both aspects related to environmental and system monitoring and the design of a waste management system.

2. DST WORKSHOPS AND TECHNICAL DISCUSSIONS

2.1 Outline of function of workshops

In the original project documentation, a series of 4 DST packages were to be developed to enable the fulfillment of the project including:

- Nutrient flux model for the calculation of nutrient balances on agricultural land at farm, watershed and regional levels (Nuflux DST) – responsible: Harald Menzi

- Decision support tool for the selection and technical validation of on-farm manure management options for confined pig raising (Technology DST) – responsible: Colin Burton.

These two DST's form a close pair and it was thus decided by the FAO management to present a combined workshop in which the scope of each would be explored. Thus a single workshop was put together comprising elements from both DST's each being handled by the respective "responsible" with combined sessions on the common factors between the two packages. The outline of the workshop is given in Annexe 2 with the principle presentations for each DST given in Annexes 3 and 4.

The workshops objectives were threefold:

- to review and discuss the country-specific needs for decision support tools to aid in the specification, planning and monitoring of manure management strategies. This was to cover both technical and policy aspects;
- to identify the specific local requirements of the DST and the basic components that will make up the package;
- to discuss the practical arrangements to be made for developing the tool (operational users, target groups, technical capacity, data requirement and data supply).

Later in 2007, both Harald Menzi and Colin Burton will prepare separate reports detailed specifications of the DST required in each case and including "Terms of Reference" details to enable contractual negotiations. Preliminary versions of each of these two reports had been completed prior to the Mission and were thus available to be circulated to participants as preparation material.

The subsequent contract alluded to will cover the construction, delivery and training related to a pair of compatible DSTs that can be operated together or a joint DST package.

2.2 Vietnam

2.2.1 Workshop introduction and participants

The morning sessions started with introductions and an over view of the DST. Then a pair of presentations were given by Harald Menzi and Colin Burton on the two parts of the DST (reproduced in Annexes 3 and 4). The related draft reports on the preparation of the DST that had been prepared prior to the mission had not been distributed thus some reference was made to these - copies were subsequently distributed electronically.

Partners present

At the opening session the following delegates were present in addition to the interpreter (Dr To Long Thanh) who also had an interest in the subject representing the NCVD at the Dept of Animal Health.

1. Mr. Tai – PMO director for Vietnam
2. Dr Phan Long – Institute of Ecology
3. Dr Hai – University of Natural Science
4. Dr Minh Hung Nguyen – Soil and Fertilizer Institute
5. Mrs Phau – CTC (Centre for Technology and Consultancy)
6. Mrs Ngo Kim Chi – PMO project team
7. Mr Ong Lui – Dept of Agriculture; Ha Tay Province
8. Mrs Dao Thi – Dept of Environment: Ha Tay Province
9. Mrs Nguyen – CTC
10. Dr Trinh Duc Tuan – CTC
11. Mr Vong Duc – Administration - Ha Tay Province
12. Dr Pham Van Duy – Dept of Animal Production, MARD

2.1.2 Discussion in workshop

Anaerobic digestion is clearly the preferred technique because of the benefit of biogas and (in the larger installations) of electricity as well. Energy is clearly prized in the region but the value of the nutrients in the manure is less understood. It is noted that alone, AD will make no difference to the N and P content although the implied breakdown of reactive organic matter will leave an effluent relatively more stable, lower in offensive odour and in terms of risk for certain pathogens. Furthermore, it is noted that the phosphorous for the most part will accumulated in deposited sludge within the digester and thus not present such an impact on the environment in the short term. AD can thus be an important part of the manure management strategy in enabling better land application which is the crucial part of the solution of returning to a balanced farming system.

Solar drying of solid dung is clearly suitable for the hot conditions in Vietnam: in most cases, the product is sold for a small fee and used either to nourish fish ponds or to fertilize orchards. Hygiene is not seen to be a major issue in this respect (in contrast to the idea of using liquid manure on fields). Drying if done completely will both reduce the disease risk and the offensive odour but much of the ammonia N contained will be lost by volatilization.

Fish farmers aside, the preference for farmers adding nutrient to their crops is chemical fertilizer. Concerns with manure go beyond fears of contamination - questions of quality assurance are also raised. There is also the belief that the nutrient content of liquid manure is less than that of solid manures. In reality, virtually all nitrogen stays with the liquid phase and the phosphorous content per unit dry matter or N of pig slurry is higher than that of cattle manure.

The preferred format of the DST was as a software but an accompanying written document would also be appreciated. An illustrated book or leaflets would be especially useful when dealing with farmers directly. The operator of the software would invariably be technical/advisory staff - the running of software and analysis of the data produced would not

fall to the farmer. It was noted that farmers themselves are most comfortable implementing new ideas by copying successful examples that they can see on their neighbours farms. Investors of new larger farms would be more likely to seek external consultancy in connection with technical issues including manure management.

Mr Duy gave a resume of pig farming in Vietnam. The industry is already huge with animal numbers equal (or greater) than many European countries of comparable size and population. However, much of this production is in small farms and the link with arable agriculture is poor. He suggested that the problem was especially with the larger farms but that small scale accounts for 60% of production. (It is more likely that the problem is more visible with the larger farm - the impact would remain closely linked to overall pig numbers).

Discussion on the users of the DST remained fixed on technical people from the relevant ministries (especially MARD and MONRE) but this would be both on the national and district level. The level of competence of the individual would be typically university degree level especially in Agriculture, Engineering and related disciplines. Those with a great experience in the subject area may also be candidates to take and run the package. In any case, training would be an important feature of any delivered software.

Some concerns over the software led to a preference for information to be made available in tabular form within paper copies. However, a user-friendly software may allay many of these fears. The idea was put forward that the farmer himself may be interested to make use of the proposed package - especially for large units where increasingly the farmer has been through higher education. This may be for a more general information-based purpose.

The uptake of the DST, especially beyond the domain of the project was not clear - the feeling was that unless there is some pressure on farmers (eg: from legislation), then enthusiasm would be limited. However, with some help from government, farmers wishing to expand production would be interested. Then there were practical issues such as treatment that might allow safe direct use of manure to nourish fish ponds - it was noted that storage would remain the cheaper option. Overall, it is increasingly recognized at all levels that the growth of the industry is and will remain constrained unless manure can be managed in a more satisfactory way.

The idea of a single package for all countries in the region was met with some skepticism; there might be a common structure and common elements but the model would need to be customized for each country in turn.

The "Nuflux model" as developed by Menzi and others in the previous AWI (area wide integration) project was presented. This was met with positive interest and provoked a series of constructive comments:

- Would it be possible to generate data on relationships (function A versus function B) to enable farm systems to be investigate different options (eg; sensitivity analysis).
- How could optimization be included?
- Should rainfall (and other climate data) be inputs?
- There was concern to avoid the need to operate in an "iterative way". The preference was to supply data and obtain the answers directly.
- It would be important to include checks on input data: there would be sensible ranges set and warning messages in the event of unusual output values being generated.

- Testing of the software would be of crucial importance.
- Some concerns were raised over the excessive use of defaults - perhaps warning messages should be included if input data was lacking?
- Errors and accuracy were of special concern. These could originate from the data entered (either by the user or the default values used), errors from the programme assumptions and simplification; errors from the model strategy used. It is assumed that calculations will be themselves accurate but poor data will inevitably mean poor results.
- Should details on feed regime be included? There was also some discussion on the permitted heavy metals in pig feed: in addition to copper and zinc supplements, the suggestion was that levels of chromium, arsenic and cadmium may also be present. However, it was not clear whether such elements are deliberately added, if permitted and indeed, for what purpose!
- Clarification of pigs produced as opposed to the standing population at a farm (which may vary in size distribution and numbers).
- Lastly, there was some discussion on the layout of the input data file: the sequential approach seemed lengthy should there be repeated use of the model: perhaps input data could be arranged with the most important on a single page and detail on connecting pages accessed only if there was a need to modify?

2.2.3 Summarized feedback from the workshop

- The project members will be the first users of the DST. Later it will also be used by advisors and technical staff at the provincial level. Most of these can be expected to have a technical degree.
- The workshop participants were quite enthusiastic about the scope of the proposed DST. The majority of them will personally use it, especially for scenario calculation and as an advisory and teaching tool.
- Farmers will be important end users. For them advice and printed illustrated guidelines will be more appropriate than a model. The tools should be in a form that farmers understand and can use themselves. At first, probably only larger farms will make direct use of the DST. Stepwise capacity building will be important for a wider dissemination.
- For strategy and technology selection farmers will have to rely on the support of a specially trained expert. Nevertheless, small farmers seldom ask for advice from extension services but rather rely on what they see in other villages. The pilot farm approach of the project therefore is a promising approach.
- Both a flexible computer application and printed recommendations and guidelines should be provided.
- One common tool for al three countries appears feasible if the user interface (inputs and outputs) can be flexibly arranged according to different user needs and local conditions.
- If the same tool is officially propagated as planning aid for farmers and as monitoring instrument which has an effect on farming permits, this could create conflict.
- The DST should both be a management tool and a capacity building instrument (in this order of priority).

2.2.4 Discussion at separate meeting with MARD

Two people were met: Dr Hoang Kim GIAO, (Deputy Director - Department of Livestock Production) and Mrs Hoang Huong GIANG, his senior researcher in animal feed. It became quickly clear that the DST tool proposed was of great interest and there was enthusiasm to support this and related aspects of the LWMEA project.
An introduction was provided giving a brief overview of the project and the role of the DST tool. Dr Giao gave an overview of the problem of pig production in Vietnam adding that numbers were also significant for poultry (now 220 million), buffalo and goats. Common methods for manure disposal include: some composting schemes and some drying of dung applications of solids to certain crops. Manure can and is applied to rice fields before and after planting during flower when the excess N would reduce the amount of grain yield in favour of extra leaf growth. Other crops receiving manure (or manure products) include fruit, coffee and other permanent crops. It is the solid products that receive most interest, some being sold. Some liquid manure is effectively turned to solid product by drying, composting and/or blending. Some farmers restrict the amount of water used thus avoiding excessive volumes of liquid effluents. Liquid manures are often transferred to a common local store where it is allowed to dry up in the hot season; there is some use of EM products in this process. The final solid material is dug out for composting and export. There appeared to be no method for dealing with liquid manure as liquid and no consistent plan to use such material on crops.

CHB gave a brief resume of the project strategy which is to move towards bringing the farm and farming region into nutrient balance. This requires measures to deal with the nutrient excess in a consistent and sustainable way; eg;

- Local field applications to meet crop needs
- Modification of diet to reduce nutrient excreted
- Export of manure and manure products
- Treatment for the removal of N and for the enabling of the above
- Note is made of the inevitable losses, especially N as ammonia

In response, Dr Giao commented that livestock farmers do have some experience in balancing manure and crop requirement (but presumably not including liquid manures). There remain questions on how much and when fertilizers should be applied. Public health remains a common concern. The involvement of MARD might be in carrying out measurements in (selected) villages and in the provision of specific data on livestock and crop production. There would be a need to balance nutrients from manure with those supplied from chemical fertilizers. Lacking was the development of a "manure market" and the related assurances of quality and nutrient content. The easiest way forward would be to convert all manure to solid form. *[NB: The practicality of this remains unclear as there is evidence that many farmers in Vietnam use as much as 50 litres of water per pig per day directing most (over 80%) of the nutrients in streams that can not easily be dried. There remains a general belief that most nutrients are contained in the solid fraction which is certainly not the case.]*

The role of MARD in the project could include:

- Testing of the developed DST tool
- Development of parallel policy (especially that relating to spatial planning)
- Advising the farmer
- Providing data
- Information relating to feed (including poultry)
- Statistics
- Further contacts within the ministry

It was agreed to keep the MARD team informed by means of inclusion in e-mail circulars and reports generated.

2.3 Thailand

2.3.1 Workshop introduction and participants

The second of the series of three national workshops was held in Thailand and enjoyed the support of a large and enthusiastic group of attendees:

1. Dr. Nappadol Kongricharoern – Thai Environmental and Energy Co Ltd
2. Mrs. Konnkanok Niamrit – Thai Environmental and Energy Co Ltd
3. Dr. Thanmarat Koottatep – Asian Institute of Technology
4. Dr. Nintaphan Kulpredarat – DLD
5. Prof. Chalermraj Wantawin – King Mongkut's University of Technology
6. Dr. Uthai Kanto – Kasetsart University
7. Mrs Pennapa Kanchana – Asian Institute of Technology
8. Dr Oleg Shipin – Asian Institute of Technology
9. Dr Chanuntorn Katasaenee – Transcend Co. Ltd.
10. Dr Linchong Borhirunratana – Ministry of Public Health

The structure of the workshop followed that of the first meeting in which presentations were given by H Menzi and C Burton followed by a discussion prompted in part by a series of questions and some reference to the approach necessary to specific farm examples. A separate session was put together on the following day for Drs Arux and Sommai from the DLD who could not be present for the main workshop because of the project review meeting.

2.3.2 Comments arising from discussion

The presentations themselves initially led to a series of questions related to clarification issues especially on the expected scope of the DST's and the likely users. There were a series of concerns raised related to the more general deployment of manure management technology especially from the point of view of the farmer who would not necessarily see any personal benefit from the likely investment. The broad strategy of increasing the proportion of nutrients in the manure that is constructively used in crop growth was re-iterated. It was noted that complete treatment may not be achievable but a substantial improvement could be a worthwhile short term goal. These last two comments were linked with a general desire to increase the uptake of nutrient from manure from well below 50% to a target of nearer 80%. It was noted that unused nutrients would ultimately end up as pollution. Some participants

clearly welcomed the promotion of using manure as an organic fertilizer, a practice which is still uncommon in Thailand.

Other comments included:

- A major obstacle for manure recycling as fertilizer is the lack of reliable data on the content and fertilizer value of manure, especially liquid manure. To provide such information and generally information on nutrient fluxes is therefore a priority need for the DST.
- The tools developed in the project should contribute towards a reduction of pollution and health risks while keeping in mind the economic consequences and the capabilities of the farmers.
- The main beneficiaries of a detailed DST will be livestock officers (veterinarians and technicians) of the central and local government. They will disseminate the project results to the farmers. For the large majority of farmers simple and illustrated printed guidelines will be more appropriate.
- It will be important to keep the inputs and outputs of the model as simple as possible.
- The LWMEAP DST on treatment should be coordinated with the decision tree tool of PCD.
- A common approach for all three countries should be feasible, if the specific needs of each country are considered in the design of the inputs and outputs. A final decision can only be taken when the first version of the DST is available.
- It will be important that the DST is also supported beyond the lifetime of the LWEAMP.

What are the priority needs for a DST in Thailand ?
Promotion of manure as a fertilizer; reduction in consumption of chemical fertilizers; promoting public health; need for better data on manures; management of point source pollution; risk analysis.

Who will be the potential users?
Broad application sought – farmers; extension officers; local government; academia. Benefits of a concise version as a booklet; trade association involvement (eg; Pig Breeders Association). The output would give detailed information but it was clarified that this is not expected to be appropriate for a small farmer to construct their own facilities; however, it was noted that some larger farmers may have passed through university training enabling them to work directly with the package. It was added that a teaching role for the DST was expected.

What could be the motivation for the farmers to use the DST?
Importance of initial seminars using simple models to demonstrate the principles. Regulation was not seen as a primary factor strangely enough. Transportation and handling problems might be a bigger factor. There is some interest to move manure to fields but a lack of technology to achieve this.

What is the best delivery format for the DST?
Whilst the printed form has advantages when disseminating to farmers in more remote areas, the computer based option remained the clear favorite. In addition, this would be best prepared and sent out by an internet site: or at least upgrades should be available by this means if the main package is to be distributed as CD-ROMS.

What is the preferred structure for the model?
Although local customizing is likely, the core of the model could be common for all three countries. Many of the features that define special local conditions (such as differences in manure composition) could be covered in the model inputs.

Who remains to be consulted?
A wide number of people could be yet included but probably not before the preparation of the model has started. It is important to involve people both at policy and technical levels. It was noted that the Department of Pollution Control (PCD) in Bangkok was already looking at a similar decision tool and clearly some join discussions could be mutually beneficial.

2.2.3 Expert consultations at the Asian Institute of Technology (AIT)

AIT is starting a phD project on nutrient fluxes on pig farms to support the validation of NuFlux. Measurements will be carried out on farms belonging to a cluster of pig/fish farms near AIT. They will comprise the nutrient excretions, the amount and composition of fresh liquid and solid manure, input and output of the liquid waste lagoon (possibly also sludge), input and output (if applicable) of the fishpond, fish production, fishpond sludge. AIT will approach FAO for some support for these activities and DLD for coordination with the project.

Prof. Uthai Kanto of KS University has performed a large number of demonstration experiments with manure application on a wide range of crops. The results are very positive and he has had good success in convincing crop farmers of the benefits of such practice. Apart from solid and liquid manure he has also widely used "pig manure extract" (sun-dried pig manure soaked in water at a ratio of 1 : 10-20 for 24 h) as foliar fertilizer.

Prof. Uthai Kanto of KS University will review the default values in NuFlux on pig production. Major changes are expected because of the change the NRC feeding standards to the European system. His suggestions will also be submitted to DLD.

2.4 China

2.4.1 Workshop i participants

The final workshop in the series of three was held in China – it was not well supported with just four participants plus the translator plus Harald Menzi and Colin Burton.

1. Dr Liao Xin Di – South China Agricultural University
2. Mr Zhou Chao Xian – Guangdong Rural Energy
3. Dr Li Jingming – Centre of Science and Technology Development, Ministry of Agriculture
4. Mr Jo– Guangdong Rural Energy Station

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2.4.2 Discussions during workshop

Decision support tools will be needed to achieve the goal of a balanced nutrient situation. The DST should provide guidance for the selection of appropriate livestock waste management strategies, including the recycling of the waste. This is also in line with the Governments perspective to define feasible farming plans which take into account the carrying capacity of the land, the soil and the environment.

It was recommended that the DST should consider the following aspects: N and P, recycling on land and in fish ponds, local resources (soil and water), nutrient requirements for different seasons, public health, soil and water pollution and possibly emissions to the atmosphere, recommendations for technical options and proper management (e.g. manure application). The tool should be applicable for different regions, taking into account the respective situation (soil, climate etc.).

The major obstacle will be the lacking motivation from livestock farmers to use such a tool. For them the price they receive for solid manure and the benefits of biogas are the driving force. They do not care about the nutrients in the manure and are not ready to invest money into liquid waste management. They will therefore only adopt simple and economically feasible solutions.

On the side of crop production the ongoing intensification and the reduction of crop land make it increasingly difficult to find appropriate land for manure recycling, because farmers prefer to rely on chemical fertilizers. The average fertilizer use per hectare is 640 kg in Guangdong and thus much higher than in other regions.

The small size of most livestock and crop farms is a further obstacle for the launch of a DST. However, the small farms usually recycle their own manure.

A model will be appropriate for farm advisors and public offices. For farmers specific recommendations (e.g. kg of manure to apply per hectare of per mu) will be necessary.

For the Government a DST could help to achieve a comprehensive view of pig farms. It might also be useful to include a database to collect information on the pig farms.

2.4.3 Other technical discussions

On the following day, a separate session was held with Mr Rao, the head of the provincial PMO who had not been available for the workshop due to the project review meeting. The translator and Mr Chan were also present. Following a brief presentation of the DST material, there was a period of some general discussion. Mr Rao, indicated that the farmers in the project were getting impatient, because no clear advance had been achieved in spite of the continual discussions and the numerous visits on the farms since over three years. He fears that farmers might not be ready to continue with costly manure treatment measures (labour and electricity intensive) after the lifetime of the project.

Guangdong Province in 2007 expects to meet the aim of 60'000 operating biogas systems on small and medium sized farms. The systems cost about RMB 1800, of which the farmer has to pay RMB 1000 himself. The investment of Guangdong Province in biogas systems will reach RMB 50 million in 2007.

Mr Chan had recently visited Shandong Province to seek collaboration in biogas activities.

2.5 Overall impacts on future development of DST

Important conclusions from the workshops can be summarized as follows:

- There is a keen interest for such a DST in all the countries.
- The DST must take into account the needs of different users. One common tool for all three countries and different user groups would be desirable but there were some doubts if this was realistic.
- The DST should both be a management tool and a capacity building instrument.
- If the same tool is officially propagated as planning aid for farmers and as monitoring instrument which has an effect on farming permits, this could create conflict.
- The DST must not only contain calculation modules but also decision aids in the form of a decision tree approach, recommendations and possible case study examples.
- It will be important that the DST is not only available as computer model but that guidelines, recommendations and decision support aids are also disseminated in printed form to farmers. For the computer model the users can be expected to have an academic background.
- For the user the nutrient balance/Flux part and the treatment part of the model must be one comprehensive and user-friendly and flexible package.
- The existing model NuFlux can not meet all the requirements of the LWMEA project. A new programming will be necessary to take into account the expectations identified during the workshop and to link and harmonize the calculations with those in the treatment part.The manure treatment part of the DST must be newly developed.

3. TECHNICAL SUPPORT DUTIES

3.1 Discussion in relation to sites in Vietnam

3.1.1 Treatment facility design and installation

Two Farms previously identified in the south of the country were withdrawn last year. At the start of the mission, a group of 7 new candidate farms were visited by members of the international team - (see separate report by Dr W Zhou).

The village in Ha Tay in the north remains in the project and this was visited again. At the moment, there is no progress on the ground but a comprehensive set of engineering drawings had been prepared for the mission held last October. These were considered technically acceptable then but modifications were advised and further modifications were suggested by Dr Choi during his mission in January 2007.

The revised drawings were available during the current mission. Concerns by the WB engineer were raised on (a) the size of the covered lagoon (considered 2.5 times to small), (b) the means of gas transportation and metering to the local homes.

The volume of the digester was confirmed as 800 m3 for a collection of 120 homes with a combined 900 pigs. The amount of wash water per pig was given by Dr Chinh as 25 to 30 litres per pig per day - this implies a retention time of 27 to 32 days which was considered adequate with current recommendation of a value over 20 days.

Mr Chinh explained that houses connected into the system would each pay a fixed amount per year - equivalent to 33 to 50% of their current bill for bottled gas. Similar consumption was assumed and the need for expensive meters avoided.

The pressure of the collected gas under the cover is assumed enough to deliver sufficient quantities to each home. In the event of a combined demand using up line pressure, provisions for a blower will be included for deployment if the problem arises.

The suggestion of bottle traps to prevent the lines filling with condensate was made; there will be further feedback from CHB on the pipeline size. The pipe is likely to be flexible plastic and of reducing size to the home.

3.1.2 Monitoring activities

No measurements have been conducted so far. Different labs were contacted and the PMO will soon decide who will be contracted. Most probably it will be labs of the Ministry of Agriculture (irrigation). The head of this lab has visited the project site.

We urgently advised to start measurements in the very near future to have at least some results for before the rainy season. In principle the baseline monitoring activities can rely on the suggestions made in the BTOR of Harald Menzi and Hong Lim for the visit in October 2006 and the sampling plan discussed with Hong Lim in January 2007.

A detailed sampling and sample handling plan should be established. It can rely on the guidelines prepared by Hong Lim. The sampling plan should be established by an experienced

expert who should also take responsibility for the sampling (at least for training and supervision of sampling staff).

As most wells are 20-30 m or 30-45 m deep, it will be necessary to establish special shallow bore-holes slightly deeper then the lowest level of the ground water table to be able to really show the effect of the project (unless the water in the deep well is also already polluted). The depth of the sampling points is more important than the well type (traditional vs. modern).

In addition to the sampling points for later monitoring of the ground water, the quality of the drinking water of different households (20) should be analyzed for the baseline.

As advised in October it would be useful to analyze the water quality of some surface water ponds.

The data on the present farming practice, the number of animals during the last year etc. should be collected. Furthermore, social aspects and the health status of the nearby population should also be assessed.

3.1.3 State of affairs on first project (Tu Duong village)

The land for the project activities has been allocated and the understanding of the households on the aims of the project and their obligation has considerably increased. The District officials and the village leaders hope that the project can be implemented soon.

The community leaders would welcome a more intensive involvement in the project (e.g. study tour and participation in project meetings).

3.1.3 Discussion at separate meeting with MONRE

This session involved CHB, HM, Dr Chinh, the local project engineer (who could not be present for the DST workshop) and the translator at the workshop, To Long Thanh, from the Dept of Health at the National Centre for Veterinary Diagnosis.

There were two areas of discussion, monitoring of the site and technical issues relating to the design of the first system to be installed in Ha Tay province. A very brief note was made on the DST but there was no discussion made on this subject.

HM raised concerns that there had been no monitoring of the proposed site (the village of Tu Duong in the commune of To Hieu) and that now the rainy season was imminent. The plan was to monitor the site before the manure system was installed and running such that the benefit in reduced impact could be clearly demonstrated. Dr Chinh confirmed that a laboratory had been identified to fulfill the task. A sampling plan was to be finalized. Concerning health issues, it was clarified that fecal indicators would only be useful as a broad indicator of contamination of groundwater from organic matter from a livestock (or human) source. This measurement would not be useful to monitor the system itself; in this latter case, total coliforms would be one (of several options) to establish the broad benefit of the system in reducing bacteria including potential pathogens.

Concerning the proposed design for the village system (see also notes under section 3.1) the following were confirmed by Dr Chinh:

- The estimate of the number of pigs in the communal catchment area had been revised from 1200 down to 900.

- The covered lagoon was designed to provide a minimum of 27 to 32 days retention time. The volume of the digester was confirmed as 800 m3 and the expected mean flow of water as 25 to 30 litres per pig per day. Thus exceeding the various recommendations of between 18 and 30 days retention time.

- The proposed gas distribution to the participating homes was to be by flexible pipe. In the event of insufficient supplies, priority would go to the participants. Those connecting to the scheme would pay an annual fixed charge; no metering was included as impractical. The level of charge would be set as equivalent to 33 to 50% of the current cost of providing the same cooking/heating services by bottled gas.

The diameter of pipe is yet to be decided: this had been suggested as 100mm pipe reducing down to smaller pipe to each home but this seems excessive in the light of the modest amounts of gas to be transported. However, it was noted that there would be a peak demand at meal times. There would be no gas storage other than that provided by the lagoon cover.

CHB suggested traps to remove the inevitable condensate that would otherwise collect in the system. There was not removal of hydrogen sulphide. Concerning pipe size, CHB promised to make inquiries and to advise in due course. This was subsequently prepared in the form of a small spreadsheet programme which will be delivered separately.

3.2 Discussion in relation to sites in Thailand

3.2.1 Field visits

Two farms remain in the project - KOS and Saard - both were visited as part of the field visit.

At the visit to KOS Farm, Dr Sommai took the opportunity to report on the environmental monitoring already carried out at both KOS and Saard (see below).

A third farm called “Pig Family Farm” was briefly visited out of more of general interest. This was a large unit of 4000 sows with a large AD digester under construction. The investment was clearly substantial (possibly over 200,000 USD) but also apparent was the believe that much of this would be recovered from the anticipated energy production. There appeared to be no provision beyond digestion to deal with nutrient excesses although in the short term phosphorous might be expected to collect in the digester.

3.2.2 Monitoring activities

The monitoring activities for surface and ground water have progressed well. Three groundwater wells have been established on each of the two farms for the groundwater monitoring. Two samplings have already been performed (beginning and end of March) on

the two project farms. Results of the first sampling were presented during the mission. They look plausible. A third sampling is planned for July (during rainy season).

It would be advisable to have more than three baseline measurements. Especially during the rainy season one measurement will not be very significant. If at least one additional measurement should also be made before the rainy season should be decided when the results of second sampling are available. The team is also advised to analyze the variability between the duplicate samples. If it is large, more than two samples would be advisable.

Because a flow measurement is not possible at the outflow of Sa-ar farm, it would be advisable to gather detailed information on the water use of the farm to calculate the flow per day. If possible this could be done best by installing water meters.
The data on the present farming practice, the number of animals during the last year etc. should be collected. Furthermore, social aspects and the health status of the nearby population should also be assessed.

A mass balance calculation for waste water performed on KOS farm (as suggested by Hong Lim in January) showed that there should really be no discharge from the lagoon (Dr Somai will provide the data), except maybe after very strong rains (as before the visit in October 2007). Should such strong rains happen again in the coming rainy season a specific measurement at the point of outlet would be advisable.

So far the costs of the monitoring activities have already reached approximately $ 40'000 (including the groundwater wells, sampling, analysis etc). It will have to be discussed how far the same monitoring program will be possible on further farms.

3.2.3 Treatment facility design and installation

No additional design data was available beyond that seen and reported in the October mission. This included a schematic and costing but no engineering drawings which are still awaited.

At KOS, there seems to be every reason why the installation should proceed. The large size of the farm and farmer interest along with the generation of electricity adds up to a system that should be installed and used.

The only concern is that the preoccupation with biogas/electricity may overlook the problem of properly utilizing the N and P content - biogas alone has no real effect on either nutrient.

The crucial test of the scheme at KOS will be the reasoned and disciplined implementation of a land spreading plus solid export plan for the digestate and solid manure products produced.

At Saard farm, there is also a lack of progress on the ground but the enthusiasm of the farmer remains unabated. Here, the production of biogas is less easily accompanied by the production of electricity due to the smaller scale - however, a revenue from the investment will be essential for the farmer.

The concern that ammonia emission from the second and third lagoon may prove a nuisance to the school alongside seems excessive in the light of the years of exposure to the farm in its current poor state of maintenance. Nonetheless, a provision for a floating cover may be left in the design budget to be used if this fear is realized.

The release of digestate after the final lagoon to the local stream is far from ideal - however this will represent an improvement on the current situation where the release of untreated raw manure is normal practice. The disposal of the accumulated phosphorous-rich sludge from the lagoons to meet crop needs will be crucial.

3.3 Discussion in relation to sites in China

3.3.1 Monitoring activities

The general monitoring concept was agreed on by WB and FAO and should not be re-discussed. The public bid is now running. The selection of the candidate and the signing of the contract for the monitoring activities is expected in approximately two weeks.

3.3.2 Field visits

The number of farms in the first group in Bolou County has progressively fallen and is now just two - Ma-Shigang (3000 pigs) and Folling (around 600 pigs).

A field visit was made which included teams from Thailand and Vietnam as well as the international group and the PMO group for China. However, the schedule did not include either of the two remaining partner farms; instead, two examples of model farms were chosen to provide information for the international audience.

Farm 1

The first farm was a large pig fattening/breeding centre - around 3000pigs and a parallel fish production facility in a 5 hectare pond alongside. The farmer had installed a biogas unit to treat livestock effluent prior to discharge to the pond. The digester comprised 21 fibreglass vessels each 10m3 and buried underground arranged in 7 groups in parallel each of three in series. The total volume was thus 210 m3 - this would handle 10 to 20 % of the anticipated manure output from the farm.

Beyond the digester was a three stage settlement chamber - each around 2-300 m3 - clarified effluent from the third was pumped to the fish lagoon. During the visit, the contents of these settlement chambers were clearly active giving the impression that the treatment was not completed in the digesters.

Biogas from the digesters was piped to local buildings and being used for cooking. It was hard to see how the volumes produced could be fully. Buildings were being washed during the visit with removed effluent going direct to the pond.

Comment was made of electricity production but no detail of existing or planned facilities were seen; in any case, the size of the digesters would seem too small to justify such an investment.

Farm 2

The second farm was at the Guangdong Province Breeding Farm with in excess of 7000 pigs. Alongside was an impressive treatment facility in which the manure was separated then the flow was divided between an aerobic and anaerobic digestion systems. The aerator was not in operation during the visit.

Biogas was transferred by pipeline to a 50 m^3 store located 600 m away from where the gas was supplied to a dozen or so homes. This facility was also built to a high standard. The consumption of biogas was presumably for more than cooking on the basis that 5-10 pigs would be enough for one home; 7000 pigs could supply 1000 homes just for cooking needs.

The digester, although impressive, at 500 m3 seemed far to small to treat other than a small part of the expected effluent from the farm - the rule of 1 m3 pig would suggest that a unit about 10 times bigger would be needed. The investment was given as over a million RMB; this would be reasonable for 7000 pigs but not for the manure of the 500 to 700 pigs probably treated by the plant.

3.3.3 Treatment facility design and installation

Near the end of the mission, engineering drawings were provided of the two systems planned for Ma-Shshingang and Folling Farms. These fitted into a general schematic for the process in each farm circulated at the previous mission held in October 2007. However, the designs were in both cases limited to the AD units and related biogas handling equipment. In the brief appraisal session - greatly limited by the time available - the following comments were made:

The design flowrates and volumes seemed reasonable but the digesters in both cases were based on a residence time of 10 days which was below that recommended of 20 days.

The drawings for the unit at the **Ma-Shigang Farm** looked very credible with facilities for biogas production, storage and electricity production. However, there was little detail on the associated oxidation pond although this would be a relatively easy facility to build.

The unit at **Foling Farm** split the flow with half going to an underground digester and half to an aeration pond. The effluent from both would go to the fish pond. The design of the digester seemed reasonable but a bit small. The use of the biogas produced was not evident.

In both cases, discharge values were included for water release to local rivers; it seems likely that the low values would be partly the result of anticipated subsequent treatment activity from the fish pond. The monitoring of the installed process would be crucial to confirm the claimed performance of the final system.

4. DISCUSSION

4.1 The development of the DST tools

The level of interest of most those attending the workshop was sufficient to enable some shaping of the structure of the package to meet local needs (as reported). However, the numbers attending the workshop (especially in China) raises concerns of the wider interest in the exercise. To some extent, interest may be expected to increase as versions of a product become available albeit in an early form. It would therefore be an important milestone in the project to organize a workshop as soon as a first rough structure of the model is available to enable objective feedback. This is especially important in view of the existence of at least one similar exercise in Thailand (run by the PCD department). In this way, the final shaping of an appropriate product can be established at an early stage. It remains likely that a DST package so developed to reflect local needs will be used in due course even if there remains some doubts at present. The crucial challenge is to get this as near "right" as possible as early as possible to avoid wasted effort in developing features that are either not needed or not usable.

4.2 The preparation for the first installed facilities at the selected farms

At the time of the Mission, there were five schemes well advanced in terms of prepared drawings and specification: one in Vietnam (comprising three installations at a single village), two in Thailand and two in China. With encouragement, the installation of all could be done before the end of 2007 allowing performance monitoring and evaluation to commence early in 2008. Clearly many more than 5 systems are expected and it is important that information from the first phase of operating systems is available to benefit the design and implementation of the larger phases to follow.

Some reduction in the reliance on anaerobic digestion alone (a central feature in all designs so far) would be desirable. Whilst AD is one option it is not unique (there being composting, aerobic treatment, land spreading strategies, lagooning and separation - drying processes as well). Some diversification would be prudent as AD alone has little effect on the nutrient excess which in many cases is the target of this project. Nonetheless, most important at this stage is to ensure that the first phase of installations proceeds and is completed quickly - and thus providing the basis to evaluate and stimulate the greater interest needed in the subsequent development of the project.

Appendices

A1 Mission schedule

A2 Agenda for the workshops

A3 Powerpoint presentation used for the description of the nutrient management component of the workshop

A4 Powerpoint presentation used for the description of the manure treatment component of the workshop

A5 Sizing of gas distribution pipes for use in village scheme in northern Vietnam (will be delivered separately)

Annex A1: Mission schedule

Agenda of consultants mission to LWMEA project in April 2007

Vietnam				
			Colin Burton (CB)	**Harald Menzi (HM)**
Date	**Day**			
12.04.2007	Thursday	Morning		arrival Hanoi
		Afternoon	arrival Hanoi	workshop preparation; discussion with Pierre Gerber
13.04.2007	Friday	Morning	DST worshop	
		Afternoon		
14.04.2007	Saturday	Morning	field visit to Ha Tay Province; Tu Duong Village	
		Afternoon	co-ordination with HM	co-ordination with CB
15.04.2007	Sunday	Morning	meeting with World Bank and FAO	
		Afternoon		
16.04.2007	Monday	Morning	consultation with MARD	
		Afternoon	consultation with MONRE; travel to Bangkok	
Thailand				
17.04.2007	Tuesday	Morning	field visit to project farms: KOS (Rachaburi) and Saard farm (Cholburi)	
		Afternoon		
18.04.2007	Wednesday	Morning	DST worshop	
		Afternoon		
19.04.2007	Thursday	Morning	reporting	technical disussion at AIT
		Afternoon		technical discussion at KS University (Prof. Uthai Kanto)
20.04.2007	Friday*	Morning	consultation with DLD	
		Afternoon	travel to Guangzhou	
China				
21.04.2007	Saturday	Morning	reporting; internal consultations	
		Afternoon		
22.04.2007	Sunday	Morning	field visit to two model frams (together with delegations from Vietnam and Thailand	
		Afternoon		
23.04.2007	Monday	Morning	DST worshop	
		Afternoon		
24.04.2007	Tuesday	Morning	meeting with Dr Rao, viece director provincial PMO	
		Afternoon	reporting; discussion with LEAD evaluation mission	

Annex A2: Agenda for the workshops

LWMEA project April Mission
Nutrient Fluxes and Manure Treatment Technology
Decision Support Tool (DST) - Combined Workshop

Programme

Objectives of the Workshop

- to review and discuss the country-specific needs for decision support tools to aid in the specification, planning and monitoring of manure management strategies. This will cover both technical and policy aspects;
- to identify the specific local requirements of the DST and the basic components that will make up the package;
- to discuss the practical arrangements to be made for developing the tool (operational users, target groups, technical capacity, data requirement and data supply).

Invited participants

Two broad types of participants should be involved in this project workshop: (1) policy and decision makers who set out the manure management strategies and targets, and (2), technical experts from the national and provincial governments and from extension services. Crucially, some end users of the proposed DST package need to be present and to be involved in the preparation process.

Expected results

By the end of this workshop there should be:

1. The identification and listing of the (country specific) objectives and needs of the nutrient fluxes and manure treatment technology.
2. A clear summary of the policy and decision making context and the related issues (relevant laws, regulations, incentives, enforcement structures etc.),
3. The required outputs of the tool at the individual farm level and also additional requirements at the local (area-wide) and provincial levels.
4. The identification of the sort of people who will operational users of the tools (eg: what institutions, which professions and grades)
5. A clear specification of the decision making procedure in which the tools should be used.

The project National Steering Committee will have a specific role to stimulate and support the inter-ministerial and inter-departmental cooperation that will be required. This will include motivation of key technical players to make good use the DST in the implementation of manure management technologies within the context of this project (and indeed, beyond the domain of the project). It will be equally important to enable the sharing of data and information.

From 08:00 Registration and coffee from 08:00 for a prompt start at 8:30 am

08.30 – 08:45 Introduction to the workshop – review of the plan for the day

Introduction of participants and their expectations

08.45 – 9.00 Introduction to Livestock Waste Management is East Asia Project (LWMEAP)

9.00 – 9.10 Purpose of the decision support tools (CHB)

9.15 – 10.15 Introduction to nutrient fluxes aspects of the DST (HM)

- Nutrient fluxes and environmental impacts related to intensive livestock farming
- Potential objectives of nutrient fluxes calculations
- Approach in the AWI pilot projects (NuFlux: general aims and structure, strengths and weaknesses etc.)
- Potential components and applications of the nutrient fluxes DST in the policy and manure management context
- *Questions and discussion*

10.15 – 10.45 Optional coffee break

10.45 – 11.45 Introduction to manure treatment technology aspects of the DST (CHB)

- Procedures to characterize the specific farm
- Potential objectives of matter fluxes calculations for manure treatment systems
- Approach in the AWI project and the LWMEA project preparation phase (classification of systems and their efficiency etc.)
- Potential components and applications of the manure treatment technology DST in the policy and farm management context
- *Questions and discussion*

11.45 – 12.15 Discussion and identification of the country specific objectives and needs for nutrient fluxes and manure treatment technology DSTs.

12.15 – 13.15 Lunch break

13.15 – 14.45 Discussion and identification of the country specific operational users of the tool and the involved stakeholders.

14.45 – 16.30 Discussion of <u>case study examples</u> of farms to be used to elaborate on preferred procedures. (including coffee)

- Key parameters in defining the farm and farm situation
- Estimating the farm impact on the local environment – identifying key objectives of the implemented technologies
- Procedure in formulating strategy and system design for collection, treatment and disposal of manures – what is required from the DST
- Methods to monitor the implemented system.

16.30 – 17.00 Conclusions – formation of the key directives of the workshop on the design and operation of the DST in the context of the project.

17.00 Close of formal proceedings

Annex A3: Powerpoint presentation used for the description of the nutrient management component of the workshop

DST

GEF – World Bank –FAO

Livestock Waste Management in East Asia: 2006 to 2011

DST Tools - what are they for?

DST

The problem

Excess manure not efficiently used becomes pollution

DST

Approach to a solution

- To bring a nutrient balance to a farm system
- What to do with the **surplus?**
  - Balanced use with local crops
  - Exporting excesses as products
  - Diet optimisation
  - Treatment options to (i) enable the above and (ii) to remove/destroy certain nutrients and pathogens
  - Benefits such as biogas production

  Allowance for inevitable losses (especially N)

CHE/DST - 3

DST

Case study 1

- Medium pig farms centred around production village
- Village population 5.000
- 10.000 pigs in total plus other animals
- Size of farms between 500 and 5000 pigs
- 200 hectares local farm land
  - *150 hectares of rice*
  - *20 hectares of vegetables*
  - *30 hectares of other land use*
- Located near river
- Rural location (nearest town over 30 km)
- Poor local roads
- Local concern over odour and public health

CHE/DST - 4

DST

Case study 2

- Small pig farm located on edge of large town
- Town population 50.000
- 500 pigs
- Very little local farmland of any type (1 hectare)
- Located near houses
- Good local roads
- Local complaints of foul odour
- 100 hectares local farm land but 5 km from farm
    - *50 hectares of rice*
    - *20 hectares of vegetables*
    - *30 hectares of orchards and permanent crops*
- Local market for meat very important

CHB/DST - 5

DST

Case study 3

- Large pig farm - 10.000 pigs
- Located away from housing
- Available farmland - 200 hectares
    - 50 hectares of Rice
    - 50 hectares of orchards/permanent crops
    - 50 hectares of fish ponds
    - 50 hectares of other land use
- Moderate local roads
- Other pig farms in area
- Little local housing

CHB/DST - 6

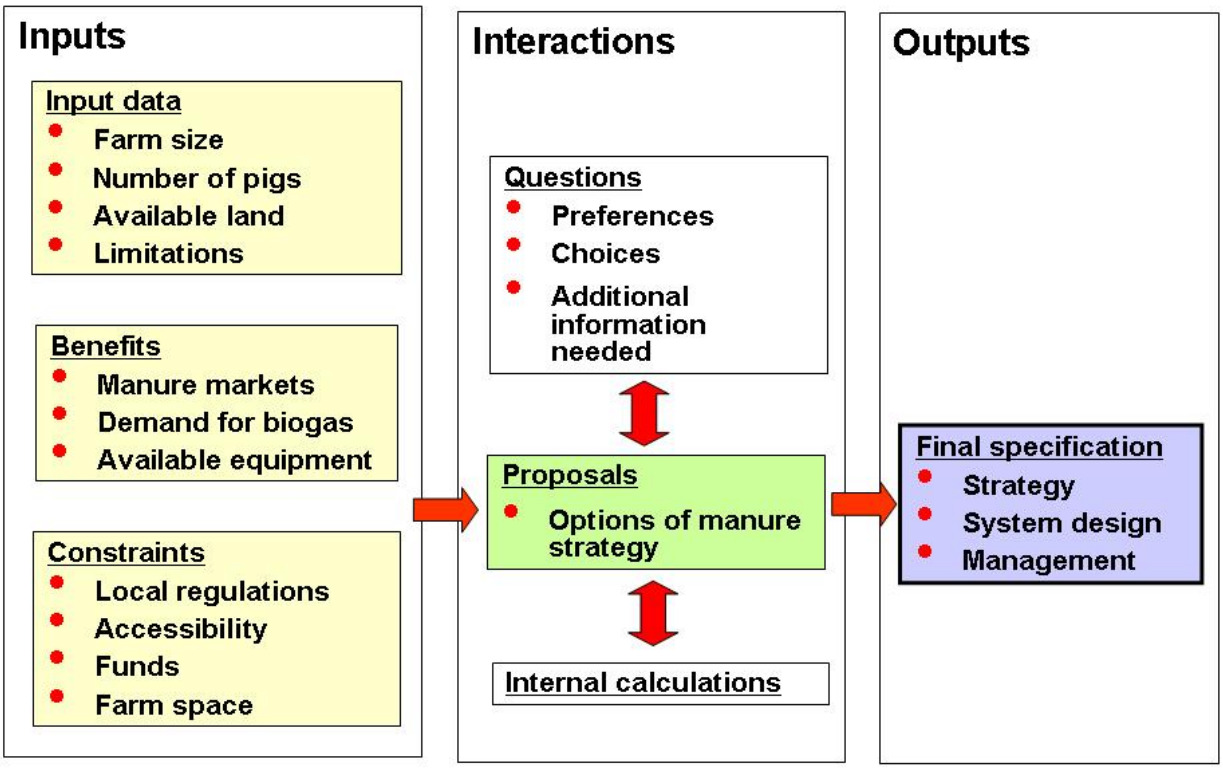
DST

Questions

? How much nutrient is produced
? What do we want to do with the nutrient (mass balance)
? Export options (compost, solid manures)
? Treatment requirements
? Biogas options
? Storage, transfer and handling requirements
? What is the overall strategy?
? What equipment is needed
? Costs - investment, running and maintenance
? What are the benefits

CHB/DST - 7

DST

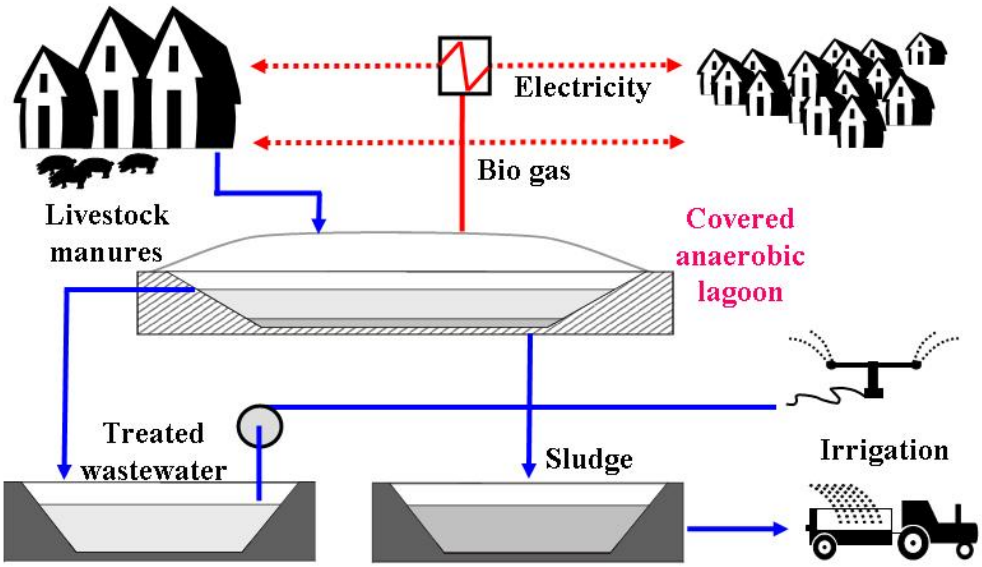


CHB/DST - 8

DST

Ouput - strategies and proposed schemes

Example solution of a medium or large farm near village/town and adequate land available.



CHB/DST - 9

DST

Ouput - details on systems proposed

- Crop application information - when, how much, where, ….
- Treatment sytems - size, equipment, costs, operation ….
- Manure management - collection methods, storage, ….
- System monitoring and control - sampling and analysis, checks and validation

CHB/DST - 10

Annex A4: Powerpoint presentation used for the description of the manure treatment component of the workshop

LIVESTOCK WASTE MANAGEMENT IN EAST ASIA

Decision Support Tool (DST) for Nutrient Balances and Fluxes at the Farm and Area-wide Scale

Harald Menzi

Swiss College of Agriculture, Zollikofen, Switzerland

Decision Support Tool (DST) for Nutrient Balances and Fluxes at the Farm and Area-wide Scale

- Nutrient fluxes from livestock and their implications
- Potential applications of a DST on nutrient fluxes and balances
- Aspects to consider when evaluating a potential nutrient flux DST
- Introduction to NuFlux

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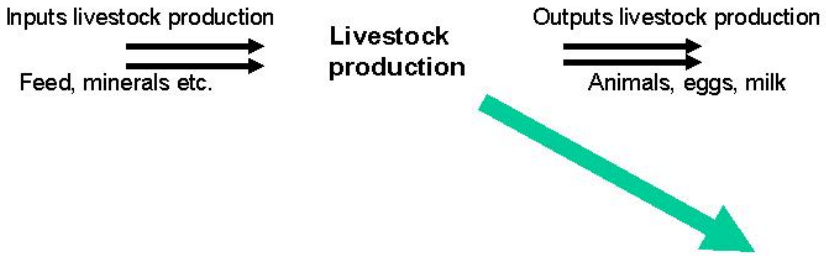
Nutrient and organic matter fluxes resulting from intensive livestock production

- Livestock excretes 60-80% of N and 70->95% of P_2O_5 and K_2O



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Nutrient and organic matter fluxes resulting from intensive livestock production

- Are livestock excreta a waste or a resource?

disposed with or without treatment

→ Waste

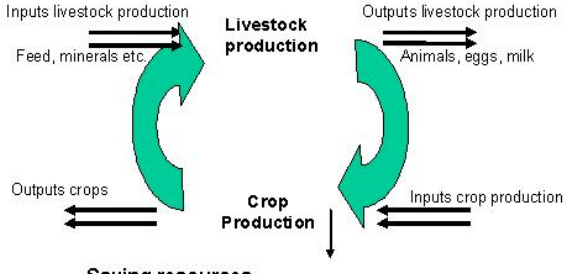
Water pollution
- eutrophication of surface water
- groundwater pollution
- Health problems

Accumulation in the soil (harm to soil fertility)
- nutrients,
- heavy metals

Emissions to atmosphere

Recycled as fertilizer or fish feed

→ resource

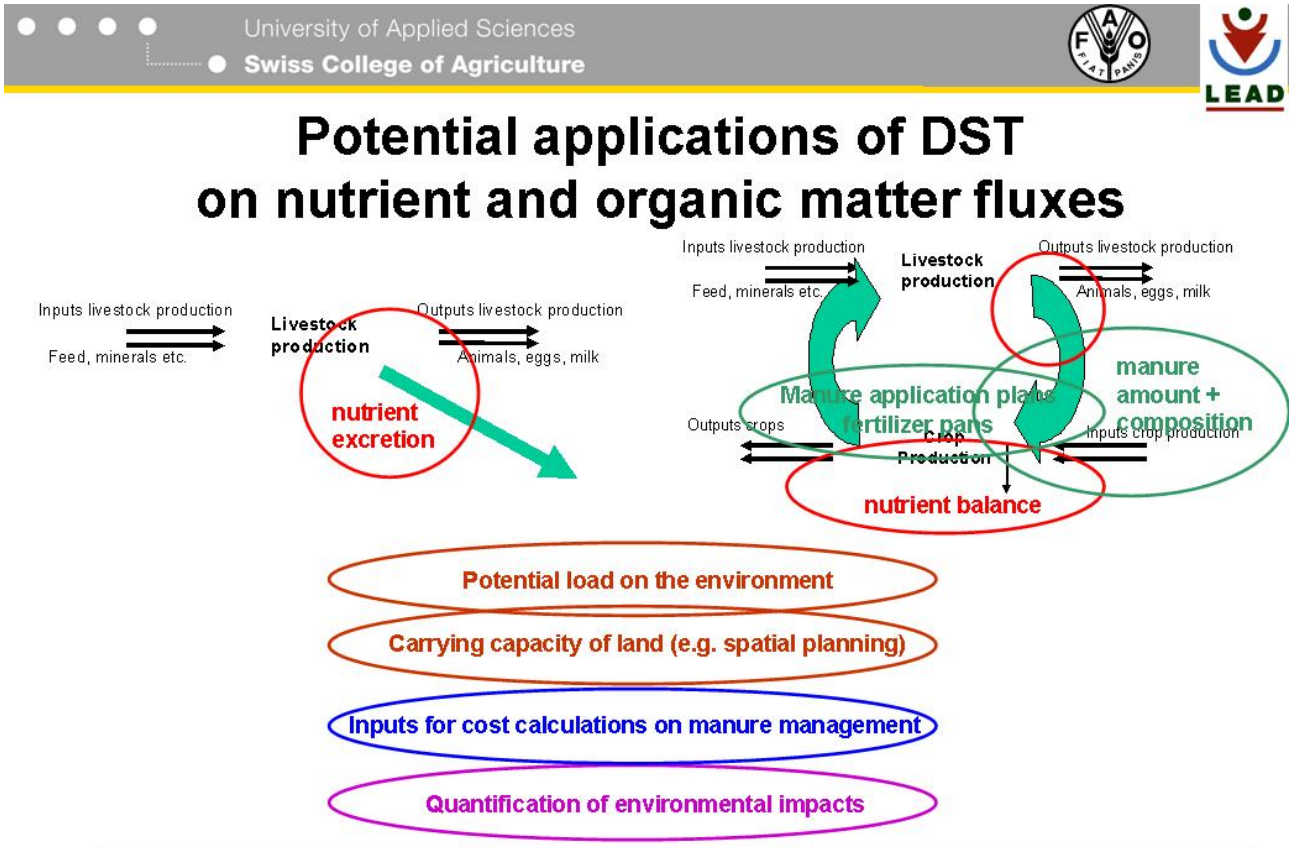


Saving resources

Less environmental impact
- Negative impacts on the environment can be prevented by good management

Questions to address in the discussion

- What are priority needs for a DST in China
- Who will be the potential users of the DST; what is their profile
- What will be the response of farmers, extension officers and teachers to the DST
- Mainly computer based or mainly printed version (recommendations, checklists, tables etc)
- Computer application for local installation or internet application
- Is it feasible to have one common application for all project countries
- Who should still be consulted
- Who could contribute to the development work
- Who could contribute to validation measurements



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Potential elements of nutrient flux DST

Inputs	Calculations (model)	Products
Livestock numbers	Environmental impacts	Calculation model
Livestock production parameters, feeding etc		Model results summary (tables, figures)
Manure treatment effects	Manure distribition tool	Default value tables
Crop surface		Checklists
Mineral fertilizer	Manure amount and composition	Recommendations
		Database for farm information?
		Case study examples
Appropriate templates for different applications	Nutrient balance	Input data manure treatment DST
		Input data for spatial analysis
Automatic interfaces	Crop nutrient requirements	Input data for cost calculations
	Livestock excretions	User-specific presentation

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Aspects to consider when evaluating a potential nutrient flux DST

- Objectives
- Potential users
- Availability of input data
- Reliability of the input data and assumptions
- General form of the model and coordination with other DSTs
- One common model or national models
- Adaptation of NuFlux or a new model

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Objectives of the DST

- Objectives and potential applications must be defined by stakeholders
- Nutrient fluxes and balances not absolutely essential for LWMEAP. Alternatives are:
  - Farmers: recommendations and default values (tables)
  - Carrying capacity: livestock density (e.g. livestock units ha^{-1})

  But, common DST would facilitate procedure and coordination
- Objectives variable for stakeholders
  - Management tool (farmer) vs. evaluation and monitoring tool (policy)
  - Motivation; voluntary or fear of consequences

  Compromise is necessary (challenge for project teams)
- Objectives can vary between countries; but for comparison and exchange of experience general common approach is essential

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Potential users with differing needs and background

- Specialized farmers using DST as planning tool — detailed calculation taking into account wide range of farm-specific variables
- Policy implementation and monitoring — simple and robust to manipulation; controllable
- Users with good and with lacking technical background
- Environment tool has other objectives than a farm management tool

Possibilities to meet wide range of requirements while following same general procedure

- provide different input and output screens which vary in the detail of variables considered
- Possibility to use input data or default values

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General form of model; coordination with other DSTs

- Calculation model based on standard software
- For local installation (wider dissemination) or via internet? (Always newest version; same version for all)

  or

- Tables, recommendation booklet

- Good coordination and harmonization between LWMEAP DSTs is essential

- Nutrient flux DST and treatment DST used together for systems evaluation → good interface necessary; full integration is hardly realistic
- Nutrient balance DST also essential for spatial planning DST (interface?)

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One common model or national models

- Objectives and applications of nutrient flux DST might vary between countries; languages are different
  - → Three national models? Well customized.
  - → One common system? Great advantages for comparability, efficiency and ease of updating

Possibilities to overcome dilemma and provide customized tools for each country without having different calculation procedures:

- Modular approach with customized input and output screens (if necessary) but identical background calculation
- Individual default value sets (national or local)
- Easy mouse-click function for changing language

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Adaptation of NuFlux or a new model

- To build on existing basis (NuFlux developped in AWI project) would considerably reduce work, but there is a risk that weaknesses or peculiarities of NuFlux might impede LWMEAP DST
- If NuFlux is used as basis, it can be whole model or individual moduls

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Introduction to NuFlux

"Terms or reference"

- Assessment tool for nutrient balance situation (indicator of the livestock pressure on the environment) in connection with intensive livestock production in different countries
  - For policy makers, regional planning GIS inputs
  - For extension services and farms as manure management tool
- User-friendly and reliable tool
  - For persons with different background
  - For different countries
  - Functional with available data
- For extension services and farms, ideally also a tool for manure management (to support good practice)
- Special focus on pigs and poultry and recycling of manure

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NuFlux: General principle of the model

- Excel and VBA based
- Country-specific default values and language
  - Can be run without further inputs than animal numbers, crop surface
  - Default values can be changed, if more specific data is available
  - Language can be changed
- Balance: Comparison of nutrients in livestock excreta + mineral fertilizer and crop requirements (recommendations) or up-take
  - Livestock nutrient excretion calculated from feed + production data
- Model extended to estimate manure quantity and composition

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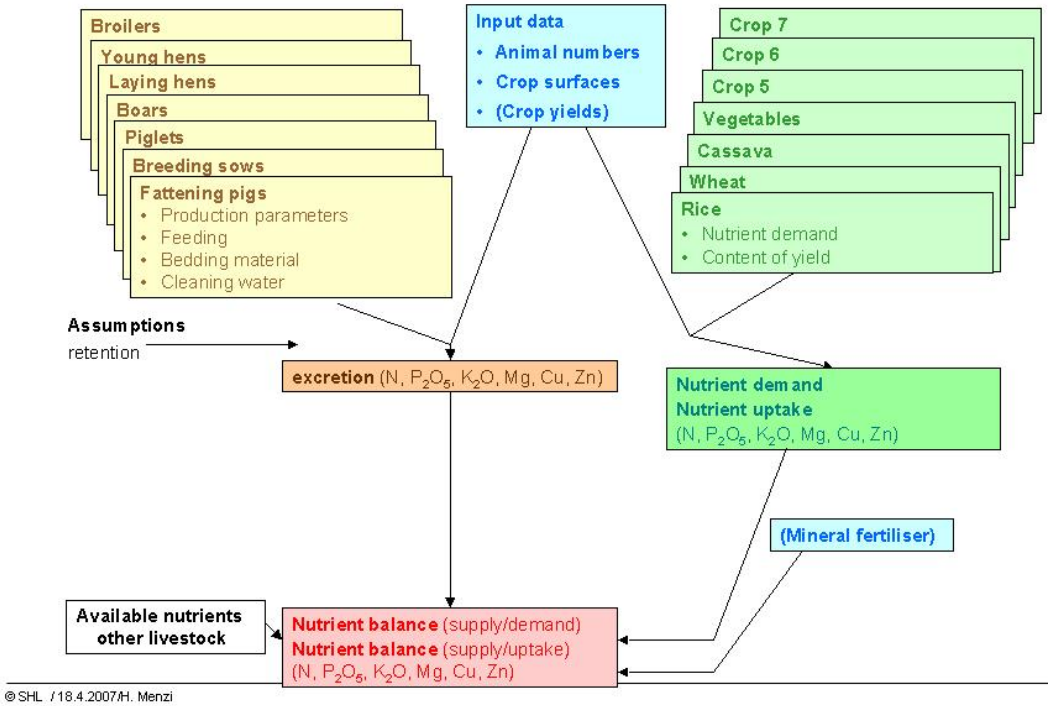
NuFlux-AWI: Schematic structure



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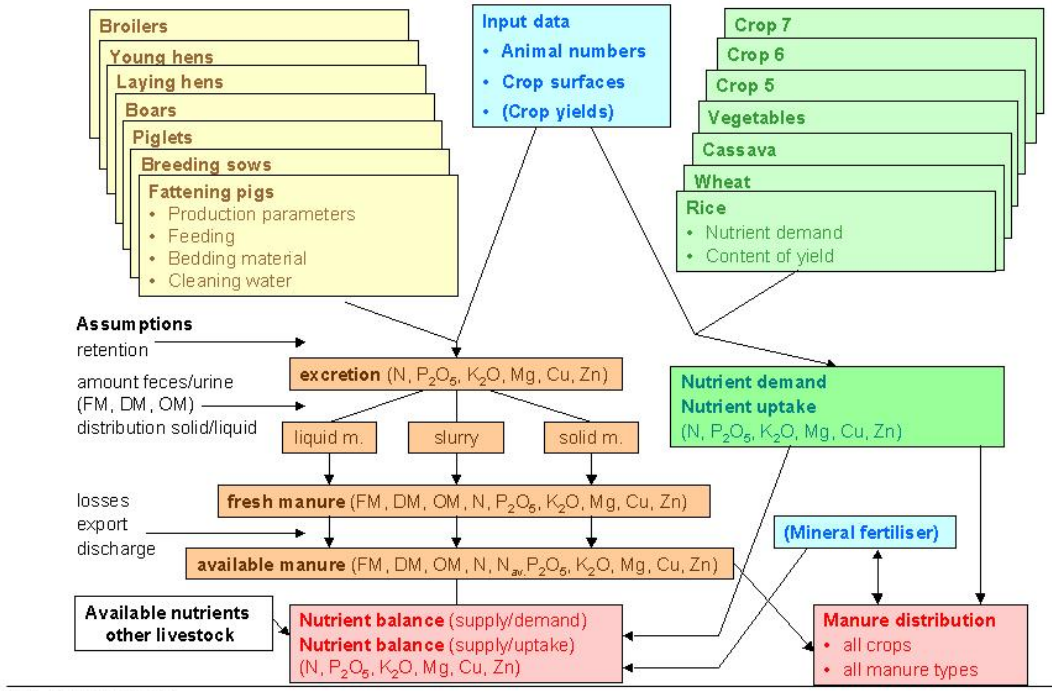
NuFlux-AWI: Schematic structure



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Past applications of NuFlux

- In AWI project for regional nutrient balances and manure quantities and composition for some individual project farms (Thailand, Jiangshu Province (China), HCMC (Vietnam), Mexico
- "Typical" excretions for GIS maps
- For GEF project preparation → typical excretions
- Calculations so far mostly not done by national teams
- No validation for manure amount and composition could be performed yet

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Strenghts and weaknesses of NuFlux

+ Nutrient balance calculation already quite robust and reliable → not much further development necessary
– Calculation of manure amount and composition based on many empirical assumptions → thorough validation needed before dissemination
– Manure distribution module can only be used when amount/composition is validated. Should be more user friendly.
+ Default value sets very useful
+ Different user modes and the "one click" translation have been successful
+ Can be used without great training
– Treatment is not yet considered
– Programming not very professional → difficult to change
– No other losses quantified than ammonia (would need to consider soil, climate etc.)

Questions to address in the discussion

– What are priority needs for a DST in Thailand
– Who will be the potential users of the DST; what is their profile
– What will be the response of farmers, extension officers and teachers to the DST
– Mainly computer based or mainly printed version (recommendations, checklists, tables etc)
– Computer application for local installation or internet application
– Is it feasible to have one common application for all project countries
– Who should still be consulted
– Who could contribute to the development work
– Who could contribute to validation measurements