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

The World Bank	Global Environment Facility	The Food and Agriculture Organization

MISSION TO DEVELOP A COMPUTOR BASED SOFTWARE PACKAGE (DST) FOR USE IN THAILAND, VIETNAM AND GUANGDONG PROVINCE, CHINA

CONSULTANTS REPORT

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Department of Agriculture Guangdong Province of China | Department of Livestock Development Thailand | Ministry of Natural Resource and Environment Viet Nam

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Work carried out for:

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Viale delle Terme di Caracalla,
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Livestock Waste Management in East Asia Project
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SUMMARY

This report sets out the work carried out by consultants, Harald Menzi (Swiss Agricultural College), Peter Thorne (Stirling Thorne Associates) and Colin Burton (Cemagref, Groupement de Rennes) to provide specific inputs to the project - *Livestock Waste Management in East Asia* - during their mission to S.E Asia in June 2008. The mission's objective was to consult national experts on matters relating to the Decision Support Tool (DST) on manure management practices referred to as MAUREEN (provisional name) and on necessary inputs. This DST aims to assist local advisors in the specification of manure management systems (including treatment facilities, land spreading options or exporting manure products as appropriate) at future farms coming into the scheme. The broad principle is one of a balanced farm system in terms of avoiding nutrient excess by calculated application to local crops, export of surpluses as products or the destruction by treatment as possible. The production of biogas is included as a means to enable the above objective by enabling a reward for the implied investments. Other factors included in the decision making procedure include disease concerns and odour.

In each country, three principal meetings were held (i) a workshop to establish information appropriate to the country or region concerning agriculture and manure management; (ii) a session with data co-ordinator(s) to review the collection of specific data (both numerical and descriptive) ; (iii) a de-briefing session with the local PMO to inform about the state of activities and to enable a more general feedback. These meetings were supplemented with internal meetings as necessary.

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1. INTRODUCTION - THE PURPOSE AND BASIS OF THE REPORT

1.1 Report context, structure and content

This report provides details of the work carried out by the consultants, Dr H Menzi (HM; Swiss Agricultural College), Mr C H Burton (CHB; Cemagref, Groupement de Rennes) and Dr P Thorne (PT; Stirling Thorne Associates) during their mission to S.E. Asia from the 16 to 27 June 2008. This represented part of the set task to prepare a software programme known as DST (decision support tool) which will be a principal output of the parent project: known as *Livestock Waste Management in East Asia (LWMEA),* which formally started in August 2006 and will run for five years. This activity is part of component 4 of the LWMEA project which is implemented by the project RFO (Regional Facilitation Office) which is run by FAO in collaboration with the nation PMO's (project management offices) in the project countries Thailand, China (Guangdong Province) and Vietnam. Two other DST software packages will also be produced as tasks of this parent project : to distinguish the DST discussed here which relates to the management and treatment of livestock manures, this package is also known under the acronym, MAUREEN (**MA**nure **U**tilisation for **RE**covery of **E**nergy and **N**utrient) although this may not be the final name for the software package.

The preparation of the MAUREEN DST is subject to a series of sub-contracts jointly describing an activity running from Dec 2007 to the expected conclusion around May 2009 with the launch of the software package produced. The requirements of this task were specified by previous preparation work carried out by Dr Menzi (2007) and Mr Burton (2007) this work being based on two missions carried out in the study regions in 2007 (Burton and Menzi, 2007a and 2007b).

A great deal of the work carried out during the current reported mission was based around a series of meetings with local co-ordinators. In consequence, for the most part, this report provides a series of minutes of these meetings making special note of factors shaping the MAUREEN DST. These are presented in chronological order grouped under the three countries involved in the project, Thailand, China (Guangdong province) and Vietnam.

1.2 Mission objectives

The central objective of this first of two missions under the current contracts describing the task was one of data gathering. "Data" in this sense implies both specific numerical values and a broader description of the farming systems common in each country or region. Consultation was made via (a) workshops involving a selection of local agricultural experts, (b) meetings with data co-ordinators (already contracted to the project) and (c) meetings with the local PMO's. In the case of data collection, the co-ordinators were supplied several month's prior to the meeting with extensive lists of requirements for specific information that describes the current farming systems, the related manure handling and implied costs. Although data collection will continue through to October 2008, a review of interim information amassed formed part of this mission: the opportunity was also taken to clarify any misunderstandings.

A second mission is pencilled in for end-2008 or early 2009 following the completion and circulation of the first complete draft of the software package. This will concentrate on reactions and subsequent modifications deemed necessary ahead of preparing a final version . The current mission also addressed some issues related to the structure and operation of the software although based on a very early version of the package. This was detailed enough to enable some initial reaction but the early draft was not operational and it was too soon to circulate a version to the partners involved in the project.

1.3 DST Software application

The target audience for the DST under development has been the subject of much discussion especially during previous missions to the region in April 2007 incorporating related workshops. The outcome from these meetings and of the current mission was that the software should target especially those involved at the technical level including extension officers, local government, livestock advisors and academia. One might expect its direct use by the largest farms but otherwise, it is not expected that the farmers themselves would use the package. They would not be excluded but in the writing of the software, some technical awareness both of computing and manure management will be assumed. It is noted thought that the farmer would be involved in any use of the software concerning his farm both in supplying key data to the advisor/operator and in expressing his preferences in those parts of the programme providing choices. It is noted that a minimal level of training will be necessary even for the target audience to ensure the best use of the software : the likely approach (covered within the current project objectives) will be to “train trainers” although some instructions will be documented.

To further ensure that the principal messages contained in the software package are disseminated further to the farming community, a separate output from the project will be a series of fact sheets. These will not be intended to replace the software package in any way. Rather, the objective of such information sheets will be to make farmers aware of the options available to improve manure management on his farm. The sheets will thus in many cases represent a first step in a review process of farm waste management. In all but the simplest cases, the completion of this process will be achieved by the subsequent application of the software package as described.

1.4 Itinerary of mission

The schedule of the mission is reproduced in Annexe 1. The mission visited Bangkok, Guangzhou and Hanoi in that order. In each location there were four main elements : internal meetings, a workshops with 4 to 6 local experts, a meeting with the appointed co-ordinator and a meeting with the PMO. This last element served mostly as a means of giving a formal de-briefing to ensure that all project partners were aware of the software development but additional feedback was also welcomed. In preparation for the mission, a detailed agenda was prepared and circulated several weeks in advance (Annexe 2). In terms of time, 3-4 days (including travel) was allocated to each country enabling a full day for each workshop and each meeting with the data collection co-ordinators.

2. MEETINGS IN THAILAND

2.1 Preliminary preparation meeting

Held between HM, PT and CHB in a parallel session to the on-going regional policy workshop in an adjoining room. The purpose was to prepare and finalise the content of the workshop sessions and also for the subsequent meetings with the Thai data collection co-ordinator and with the PMO. Beyond clarification of the agenda for the mission and the related organisational matters, the main area of discussion could be divided into two areas, (a) the calendar for the development of the programme and (b) the nature of the workshop to follow. The former was concluded with the identification of the need for a subsequent meeting (already anticipated in earlier planning). The meeting is scheduled for October 10 at the Swiss College of Agriculture, Zollikofen.

There was some difference on opinion on the nature of the workshop - after discussion, it was concluded that the exercise was less of soliciting opinion or even educating those attending (as had been done in the DST workshops in 2007) - rather it was one of gaining specific knowledge and a necessary deeper understanding of the local agricultural situation (and the subsequent appropriate direction of the technical analysis) through the consultation (discussion) of the national experts. As such, we, the development team, would need to be both actively leading the enquiries and pursuing the necessary information to develop the model as a credible tool for local use.

2.2 Software development workshop - Thailand

2.2.1 Introduction

The meeting was attended by the data collection co-ordinator (Dr Thammarat - morning only), the project engineer, Dr Sommai, Dr Pongsak (Silpakom University), Dr U Kanto (Kasetsart University), Dr Napal (KMUTT), Dr N Chalermpao (representing the FAO) and the three members of the visiting group preparing the software package (Dr Menzi, Dr Thorne and Mr Burton). By means of an introduction, CHB gave a brief resume of the agenda and objectives for the day before setting out the broad philosophy of the software which was to enable a nutrient balance in the context of livestock production. With respect to this last point, it was noted that the software was a tool to aid better manure management within and beyond the project study areas. Thus as a consequence, (a) the approach was one of providing farmers and farm advisors with choices in decisions which would ultimately be theirs to make and (b) the approach was one of enabling improvements in the system by coming closer to nutrient balance but not necessarily achieving it in all cases. The supporting overheads used for this introductory presentation is given in Annexe 3.

2.2.2 Software development

PT gave an overview of the current version of the software and its expected operation using a version screened using a data-projector. A number of supporting

overheads are included in the set provided in Annexe 3. Reflecting the current familiarity of most users with Internet browser software, the style of the package will follow that of a website with a series of pages joined by links. The software would be a standalone package (with a separate datafile) which would be operated in the same way as many currently available software programmes. To use optional features linking it to other websites would require the computer to be connected on-line.

On starting the software application, the user will be taken direct to a "home page" where general information on the package is laid out. Navigation around the subsequent pages available that collectively describe the farm system (and indeed that set out the consequences and outputs of the choices made) is via a "ribbon bar". This layout style is based on a set of options (buttons) each being added to a page based on the requirements of that page. The bar for the home page (for example) would include buttons for such functions as exist, help and a control centre. This was a link to a summary page of the whole farm system that summarised the evolving farm system as described via a graphical representation with each icon in the schematic linking to an aspect of the farm such as land spreading, farm management, manure treatment etc. Returning to the home page, accessible tabs would link into a series of pages based on data, nutrient balance and system design each with their own set of options.

The nature of the package is that it will provide a simulation based on default data of one of a series of standard "scenarios" as the operator can select. He can alternatively create a new scenario to describe his own farm or one with a proposed modification. For this he will need to supply certain minimal data (animal numbers, cropland areas and crop types etc) with all other data taken from the database. If preferred, any of the default data used can be replaced by the user’s own figures. The outputs will include graphical representations of the nutrient balance (or imbalance) and as selected, the specification and related design of chosen treatment options.

Data would fall into two groups, essentially relating to the animals (enabling the calculation of the production of manures (and the nutrients contained) and to the crops produced on fields receiving the manures. The latter represented the more challenging task and implied calculations based on estimates of crop uptake where “crop” would refer to the part of the plant removed from the field (and thus from the system). Imbalance units would probably be given as kg nutrient per year and as a percentage of the amount produced but other units could easily be included as necessary.

Output styles could clearly be determined by the users preferences for easy assimilation of the presented information and attendees were asked for their preferences.

On the decision part of the software, an example of a recently completed package was given. In this, questions cascaded from a start point following a pattern of a file directory. Thus (for example) question 1 (first level) – various outputs (second level) each including their subsequent questions with answers on the third level and so on. At the end of the process would be a series of final actions or prescriptions. Not

shown, but cross linking routes would be expected.

Discussion

Various questions asking for clarification including the intended target user (answered as farm advisors and their equivalent). Concerning the purpose of the software, this was stated as enabling the user to (a) identify an imbalance in the current manure management at a farm (and the extent of this if it is the case) and (b) to offer measures to reduce this imbalance. It was emphasised that the options proposed were choices - the software was about helping the user to make the most appropriate choices.

Other questions related to defining the system boundary for the nutrient balance (essentially the farm and local fields available for land spreading), the need for clarity in the navigation through the software and help functions. The second was answered by the idea of adding the schematic of the farm scenario on the summary page. Related to help, ideas such as a "Wizard" function and warning functions were put forward. Lastly, there was some discussion over the presence of "micro-nutrients" in the model such as Cu, Zn, Mg, Ca, Mb and B.

2.2.3 Manure handling and land spreading

HM presented the requirements of this part of the project using a series of questions set out on overheads reproduced in Annexe 3.

This session was not meant for presenting plans for the manure handling and nutrient fluxes part of the DST but rather as a consultation of national experts on the content, limits and design of the DST. The session was therefore organized as a discussion round following a list of questions dealing with the following aspects:

- Livestock production : only intensive production? What livestock types? Differentiation between large and small farms and different breeds?
- Water use : what method to use to estimate it? Seasonal variation?
- Manure collection: how to determine quantity? Special systems to consider? Bedding?
- Recycling on crops (and in fish production): how to determine crop surface available for recycling? How to dose manure? What data is available on fish production
- Manure transport (optional; not covered for time reasons) : what techniques? How to determine accessibility? Costs?
- Manure spreading (optional; not covered for time reasons): what techniques? Seasonal variations? When to apply manure?
- Markets for manure and manure products (optional; not covered for time reasons) : how to assess potential market for manure?
- Environmental impacts (optional; not covered for time reasons). What environmental impacts should be considered?

The main points arising

- Data collection and approaches to model specification and development

Livestock Farm Structures

- "Large" and "small" farms are adequately discriminated by existing input parameters (e.g. feed use).
- Extensive backyard production is beyond the scope of this tool.
- Intensive and expanding dairy industry should probably be included.
- Breed effects are not likely to be significant.
- Smallholder mixed farming can be excluded (closed system, low environmental load). Specialist small-scale livestock producers might need to be considered in specific cases but could probably be accommodated by the existing model structure.

Animal Management

- Level of resolution of ration data: probably OK to base on recommended values but also include "poor quality" example.
- Data collected as feed allowance over the whole phase and feed conversion will be related to the type of feed used over the phase.
- Mostly dry feeding – no need to separate liquid feeding systems.
- Use of default data for excreta composition is not a big issue in Thailand as the rations are pretty standard.
- Housing system – issues apart from manure collection are not generally significant. Manure collection differs amongst livestock classes, e.g. growing sow manure may be collected, dried and sold whereas grower manure goes to slurry.

Water Consumption

- Can be estimated for specific farms (flow rate x time). How do we address the question for more generic recommendations? Default value for flow rate related to an estimate of the time spent watering.
- Wallow system can be accommodated. Dunging generally takes place in the wallow but some farms will also clean the floors with extra water.
- No need to include water for evaporative cooling as this is part of a separate system (not usually contributing to effluent volumes).
- Housing clean-up at the end of the cycle should also be included.

Manure Collection

- Simple balance equation for slurry production is acceptable.
- Bedding is not an issue in Thailand except for broiler systems (rice hulls or sawdust). One-off building clearance at the end of the cycle.
- Layer waste is slightly wet, scraped out daily and dried or mixed with water prior to anaerobic digestion.
- Meat duck is as per broilers.

Recycling to Crops.

- Solid manure can be marketed via middle men. Transportation costs per unit of nutrient are too high.
- Controlled (rather than *ad hoc*) application of liquid slurry can help to avoid excessive vegetative growth in rice.
- How to handle constraints and risks: educate the farmer (!). Health and odour problems associated with pesticides and herbicides are perceived by farmer as worse than those of manure.
- Perception of health risks is low amongst the farming community. Some uncertainty about actual health risks?
- Dosing considerations: based on P (supplementary mineral N if required; dose to 100% of requirement; ask a crop specialist about the importance of soil type).
- User-defined safety margin?
- Reduce use of mineral fertilizer when manure is used. This corresponds with the experiences of the participants and is increasingly practiced by farmers.

Manure Transport

- Piping of manure has been used but potential problems with crossing other peoples' land.

2.2.4 Treatment options within balanced agriculture

In the final session of the meeting (other than the conclusions), CHB set out the main categories of treatment option that might apply to the farm situation in Thailand. Eight broad headings were set out – storage, screening, sedimentation, composting, lagooning, aerobic treatment, anaerobic digestion and drying. The presentation material is set out in Annexe 3. The main points arising from the discussion on each option is as follows:

- The session wants to give an overview of different treatment options. The aim is to provide the basis for choosing the best and most appropriate option.
- Treatment is not an end in itself but rather a part of a sustainable manure management system. We use treatment to achieve a specific aim, e.g. to cross-over the gap between the manure recycling potential and the existing nutrient surplus.
- It is hardly possible to make money with manure. Although the solid fraction of the manure can often be sold with profit in Asia, the liquid fraction can not usually be sold and does therefore often not cover the costs for its handling.
- In manure management, the outputs of some options become inputs for other options. A good understanding of the total system is therefore important.
- Storage can be anything that holds the liquid. It can also be a treatment and is usually an essential part pf a recycling strategy. Treatment has very little influence on the nutrients in the manure, but it can reduce the pathogens. In warm climates pathogens decrease faster than in a cold environment.
- What would be the reactions of farmers in Thailand to the propagation of larger storage capacities:

  - Health issues would not convince farmers.
  - Storage to enable an organized recycling would be hardly convincing.
  - Very big ponds would not be acceptable to farmers.
  - If land is available for lagoons, it is not interesting to have structured stores.
- Mixing of slurry is not done in Thailand. Rather the solids are largely kept outside the slurry by daily removal from the house (not valid for wallow system).
- Crusting is hardly an option because of high dilution of the slurry, lack of crusting material and reduction of evaporation.
- Screening/separating might only be an option for large farms because of costs. It can be of interest if it reduces maintenance costs (blocked pumps and pipes). But such equipment is usually too complicated for on-farm use.
- Solid manure collection is mainly done for sows because of the higher dry matter content of the faeces and the easy collection in one line in crate system.
- Settling systems are simple but the sludge has a very low dry matter content. They can help to reduce P and thus improve the N/P ratio of pig slurry, thus allowing the application of larger quantities of slurry per hectare.
- Centrifuges give a high value product but are clearly too expensive for the use in Thailand.
- Drying of solids is more common than composting. Composting is currently hardly done on big farms but is sometimes practiced on small farms. With rising fertiliser prices and a compost value of 4-6 Baht per kg it might be economical for some large farms.
- Aeration can remove N. It could for example be used as last step of lagooning systems in combination with biogas on small or medium farms. However it is hardly practiced in Thailand. The production of N2O as a by-product to the nitrification-denitrification process raised concerns but it was pointed out that the emissions were still less than from uncontrolled disposal.
- The ANIMOX process was mentioned – CHB noted its potential but underlined that only established and available technology would be included.
- Labour cost and labour scarcity are the major driving forces for manure management systems in Thailand. We want to move to systems with less labour and lower operating costs.
- Anything without benefit (not only economic benefits) is not an option.

This last viewpoint clearly raises the need of a regularity dimension to any implementation plan as very few treatment schemes or procedures to protect the environment will ever be profitable.

2.3 Review of data collection - Thailand

This session was between the data coordinator, Dr Thammarat, two students assisting with the process, Lalita Rammont (economic information) and Achara (agronomic information) and the project team of Burton, Menzi, and Thorne. The first session was led by Burton, the second by Menzi. CHB led the introduction setting out the desired timeframe. The proposed target was that the supplied

spreadsheets for each of the agronomic and economic issues along with a set of supplementary questions for HM would be returned by the end of July. This would represent a first draft and realistically, some (but not many) questions would be unanswered and points would be raised by the coordinator. **ACTION Dr Thammarat.** In return, HM and CHB would review the data and supplementary points of clarification returning this to Dr Thammarat by the end of August **ACTION CHB, HM** thus enabling a final version of the data by the end of October 2008.

2.3.1 Data collection for treatment system

CHB set out issues of data variability and how this can be handled. Variability reflects both context and information source. The former is simply a reflection of fact that numbers are rarely fixed and can be influenced by many factors especially location. Because of this zoning is proposed to reduce some of the extreme variations. Variability due to information source is a reliability function with errors due to misunderstandings as well as poor measurements. Whatever the reason for variability, it is important to have some idea of the precision of any supplied value in the sense of A ± a where a is the variation given as a percentage. The precise nature of "a" can be the subject of debate – whether the extreme range or a statistical function such as one standard deviation. Crucially though it needs to be accurate in order to enable subsequent sensitivity analysis of the model to check against false outcomes. This would be the case if one element was especially determining in the model recommendations – inaccuracies in any related data could thus lead to the wrong conclusions.

The necessary action is to attract to all data an estimate of the error band thus giving a degree of confidence in its use. Thus as an example, take the price of a metre-cubed of sand, delivered to the farm. A single value of, say, 116.23 USD seems useful but if we need to add a variation factor of ± 20% because of uncertainty of the quote because of location, delivery costs etc, the actual price could be between 93 and139 USD. Quoting to 5 s.f. is clearly unjustified. The correct figure would thus be 120 USD ± 20%.

ACTION Dr Thammarat to include errors estimation with all data values. To simplify the task, data could be classed as levels A to F where A is the best at <±5%, B: 5-10%, C: 10-20%, D: 20-50%, E: 50-100% and F: >100%.

Dr Thammarat and his student had completed most of the supplied spreadsheet but had a series of questions (mostly asked by the student) based on matters of definitions and clarifications which were answered. Other matters raised included:

- Location relative to urban centres identified as the principal source of variation in input prices.
- Retain the option of reviewing the zones (B and C may be similar. Zone E may be too variable to be of use as an aggregating zone).
- Considerable debate about the level of specificity required. The issue will be to get the balance right between level of detail and feasibility. Include a "notes" column in the datasheet to specify greater detail about what is being costed if necessary.
- Points of clarification:

- Equipment rental (excavation) driver costs may need to be included. Perhaps more appropriate not to specify at this level of detail – i.e. overall cost of excavation machinery would be adequate.
- Open roofed area is a roof with no sides. Roof may or may not be pitched.
- Where options exist (e.g. type of material for tank; steel, concrete etc.) go for the commonest / cheapest option.

Where this type of query is arising, apply the principle of selecting the most representative option. If in doubt, annotate the entry in the database. Always try to indicate the scale of variation in prices.

2.3.2 Data collection for agronomic matters

The data collection is well under way. Several options of additional experts to consult were discussed (e.g. feed companies, extension services, universities). For pig production a good part of the information needed was already discussed between Harad Menzi and Dr Uthai Kanto during the last visit in November (**ACTION : HM to assemble datasheet**). HM will also provide the default values assembled in the AWI project as a basis to check the newly collected data.

- Harald clarified a number of issues relating to the data collection protocol with Thammarat and his second student,
- Information on various production parameters available from DLD derived from links to pig producers associations etc. Need to review different sources for accuracy and how up-to-date they are.
- Review a number of parameter values (e.g. final liveweight in broiler systems).
- Try to cross-check data with a number of different sources.
- Need for a clear definition of terms (e.g. piglet / fattener etc.).
  ACTION HM to circulate glossary of terms.
- Manure utilisation. Canvas reasons for and against use of different manures and derivatives on various crops. Effectively there would be a matrix produced. One might foresee a simplified scoring system which shows the readiness of crop farmers to use different types of manure on their crops: one plus (+) possible; two plus (++) appreciated, one minus (-) hardly, two minus (--) impossible. Example from HM :

	fresh liquid	digested liquid	solid fresh	solid dried	compost	supernatant (wastewater)	other
rice	–	– –	–	+	–	+	
wheat	+	++	+	–	+	++	
cassava	+	++	++	–	+	++	
orchard	+	++	++	++	++	++	

- Concerning land application, Dr Thammarat asked for any available information.
  ACTION : CHB to supply copies of Defra leaflets and a copy of the Matresa book.

2.4 PMO de-briefing session - Thailand

This wind up session was split to discuss issues relating to the development of the policy DST and that for treatment and landspreading (MAUREEN). These notes only relate to the latter.

The meeting was attended by PMO staff including the project leader, Arux Chaiyakul, Thammarat, Sommai, (representing the FAO) Chalermpao Steinfield and Wagner and the three members of the visiting group preparing the software package (Menzi, Thorne and Burton). Following a brief introduction by CHB, PT, HM and CHB in turn provided a review of their aspects of the projects. Powerpoint material used is included in Annexe 3. The main discussion points are summarised below.

Model development

- Clarification that the role of the tool is to aid to planning farm systems rather than a simulation model. Its operation is based upon choices made by the user with the objective of moving towards a balanced agricultural system.
- The user was clarified as being at the level of farm advisor and regional agricultural office rather than the farmer himself.
- The tool is not intended for policy implementation although it may be used within such a process.
- The tool can be used to demonstrate compliance with some aspects of regulation but depending on the line of choices, it does not necessarily deliver solutions that are compliant. ***Rather it will propose the best options subject to the constraints applied by the software user which may or may not comply with legislation. In any case, the best options will be the closest to a nutrient balance scenario.***
- There was some misunderstanding between HS and the project staff on the application of the tool which were resolved externally to the meeting.

Manure and livestock handling and recycling on crops

In a short presentation a brief overview of the recent and upcoming work was presented, namely:

- Conclusions from team meeting in March
- Data collection by national counterparts
  - Datasheets and instructions for national counterparts
  - State of the data collection
- National workshop during this workshop
- Up-coming activities

Special challenges

- Costs for storage, transport and spreading make slurry recycling on crops prohibitive
- Manure distribution plan
- Fish pond systems

Manure treatment options

Each of the main treatment options were again set out and a period of more open discussion initiated with the following main points:

- Ranking of options would be possible but depending on the response of the user to questions it is more likely that only one or two would be present at the end of any particularly enquiry. Ranking could be on the basis of lowest cost but this may be misleading when comparing one option that is closer to nutrient balance than a cheaper alternative.
- The issue of regulation compliance again arose but the role of the model would be very limited if only such solutions were considered. It is noted that solutions with a net cost would not be popular : between the two constraints one may end up with no solutions in many cases ! Thus the model strategy remains one of proposing the best options.
- Importance of integrating manure management with wider crop application was noted. Fears of disease risks may yet remain a barrier.
- Principle of “best available technology” noting the inclusion of realistic economic limits.
- Parallel role of a code of good practice.

3. MEETINGS IN GUANGDONG PROVINCE, CHINA

3.1 Review of data collection - China

3.1.1 Data collection for treatment system

Beyond a brief clarification of the requirements of the exercise, the draft prepared by Prof Liao was reviewed and used as an agenda. On the question of zones to distinguish costs of services and certain materials, the five proposed were reduced to three: zone A, major city areas, zone B, middle economies an zone C, poor (rural) economies. It was agreed that the concept of zoning was necessary but the definition of zones could be left for each region/country to decide : PT confirmed that this would not pose any problems in the software operation. CHB set out the same timescale as for Thailand concerning the collection of data with end July the target date for the complete first draft **ACTION Prof Liao**.

Clarification on various terms given. Such local factors as definition of different brick types could be supplied by the coordinator. All costs should be current (July 2008) any expected variation can only be handled in subsequent revisions of the data base.

Costs for materials should include all taxes, commission and delivery to the farm site.

It was noted that despite energy costs rising, biogas is currently not ascribed a monitory value but some value needs to be included nonetheless. A zero value for biogas sold (as biogas not electricity) will distort the model operation. This matter needs further discussion.

Distinction between fuel oil (such as might be used for heating) and transport fuel was made : in many cases, this will only depend on government tax policy rather than production costs.

Some errors in the data collection spreadsheet were noted and corrected.

3.1.2 Data collection for agronomic matters

Due to a problem in E-mail communication the data-collection could not yet be started. However, unclear aspects could be briefly discussed and the data collection can now advance without delay. A general lesson was to always verify any transmission by e-mail and not to assume that anything sent was always received.

The time was used for clarification of the spreadsheet prepared by HM. Emphasised that it would apply primarily to the provincial level (Guangdong Province) : broader application across China so long as data remained valid. Dr Liao was encouraged to cross check all data and not to rely on any single source : this applies to any student support used (we met one of Dr Liao's PhD students). The PMO should be involved but Dr Liao would remain the responsible for coordinating and checking data.

3.2 PMO de-briefing session - China

In order to avoid two sessions with the PMO on subsequent days, a single meeting was held on Monday 23 June with both DST teams present representing the MAUREEN and COSIMO (Policy) software packages. As a consequence, for the MAUREEN team, the de-briefing session was held before the workshop which was referred to but clearly not discussed.

Special challenges in Guangdong

Dr Rao provided and overview of the project development highlighting some particular challenges in livestock development in the region.

- Pig numbers have declined. The Government is trying to create incentives for new pig farms to stop price increase for pork. Any measures creating new additional costs would be contradictory to this.
- Over 98% of the pig farms have not passed the compulsory environmental assessment because they can not meet the discharge standards set by the Environmental Protection Bureau.
- It is important that any software package is framed along the lines of “guidelines and help” and is not prescriptive.
- We should beware making “empty promises” which are unlikely to increase support – a practical and realistic approach is important.

Presentations

Presentations given by HS to summarise the Regional Workshop held in Bangkok the previous week. Outline of the [Policy] decision support tool and its objectives based around the exploration of the impacts of different policy scenarios on livestock agriculture.

Presentation given by Weaw to describe the proposed Policy package especially the database of current examples of policy implementation in other countries relating to environmental protection from livestock farming.

Presentations from CB, HM and PT to outline the objectives of the MAUREEN software : this was kept brief as most of the team present would also be present fo the workshop which was to take place the following day. CB reassured the PMO that the package was neither mandatory nor prescriptive : it would set out the choices for given farms/farm scenarios and show the benefits and related costs. The choice would lie with the farmer and regional authority.

3.3 Software development workshop - China

3.3.1 Introduction

Those present included the MAUREEN team, the Translator, Prof Liao and from the

PMO, Dr Rao, Dr Ou, Mrs Ai, Mrs Tao and the PMO secretary, “Yvonne”. Midway through the day, two students of Prof Liao joined for their own general information.
CHB set out the agenda for the day which followed a similar pattern to that for Thailand. Some outline objectives of the software were repeated (as already made on the previous day especially that the model would guide users *towards* a balanced farming system but that this may not always be achieved. There was an overall broad consensus of this approach.

3.3.2 Software development

- The aim of the session is to have a two way discussion while running through the intended software. It is also good to hear about the participants experience with software in the past and what software would suite them.
- There are three parts of the software: 1) database, 2) simulation model, 3) treatment system design module. By linking the three, we hope to find a system that is optimally linked to the needs of the farm.
- The appearance for the user is similar to what we know from Windows programs or internet pages.
- First reaction of the participants to the model outlined
    - The department is also at present working on improving its website. MAUREEN could certainly be linked to this page.
    - As soon as the software is available the PMO will evaluate if it is suitable for farmers. If it is, the PMO will strongly support its dissemination.
    - We can also disseminate the model to producer’s organizations.
    - We are not yet sure if farmers will be interested to use this tool.
- The system will only produce reliable results if it is based on good data. But we are working with a very complex system which means a considerable demand for data. Default value datasets will therefore be provided which reflect the conditions and practice in Guangdong Province or more specific locations.
- The user can produce different scenarios. They can be based on default values or the users own data.
- What types of software have the participants used in the past?
- The most important question is how to persuade the farmers to use this model.
- At present, many pig farmers make contracts with others for drying and selling the manure. Thus they do not have to handle the manure themselves and the contractor will decide what use to make of the manure. Contractors usually produce only one type of fertilizer, depending on the price.
    - Manure taken by middlemen will be removed from “the system”.
- At present the only use of the liquid manure is to feed the fish in the farms own fishponds.
- For the siting of new farms, farmers will look at the density of existing farmers and the possibilities to have ponds.
- To raise the environmental awareness of the farmers is still a long way to go. However, farmers are usually aware, how much surface is needed per pig.
- This software is part of the whole project. In the second phase of the project the software can be improved based on the experiences made.

- Some counties of Guangdong have already introduced legislation which agrees with the nutrient balance principles of the project and the DST (e.g. policy that crop area has to be fully taken into account and that collaboration of crop and livestock farms should promoted.
- This software is very detailed. It might be easier to promote it if it were easier. Although the DST has great scientific significance, it might be difficult to use it with farmers.
- Validation of the model will be important. This will only be possible to a limited extent in the running project. However, although the DST is a new software specifically developed for the project, it is partly based on existing pieces of software (e.g. NuFlux and treatment system design modules). Therefore the complete tool will have to be tested but many parts of it are already established.
- The visualization of the results in the form of diagrams is helpful. But for farmers it would be good to make the diagram more vivid (e.g. with drawings).

3.3.3 Manure handling and land spreading

HM provided a broadly similar presentation on manure handling to that given in Thailand but with some additional detail showing the relationship between livestock production and arable food production. The central point of a balanced agriculture was made again. During the presentation, discussion arose at various points as encouraged by the questions presented.

To clarify, HM, explained that balanced agriculture was normally achieved on avoiding excess P application as the N was often deficient. Thus even if achieved, some additional N would be needed.

Dr Rao underlined his general concern that farmers are unlikely to pay much attention to anything that didn't imply some sort of financial reward. Making full use of manure would be a positive step.

- Size of farm important ? Yes as they collectively represent a large part of production. Manure similar. However, DST will be more easily promoted on larger farms.
- Include dairy or poultry ? Better to promote DST for pigs – dairy production relatively small.
- Distinguish pig breed ? Not important.
- Concentrate on farms in project area only ? Wider application desirable.
- Feed composition ? Liao will supply data. Dr Tao doubted that the implied variation would be large.
- Difference in housing type ? Dr Ou saw little impact on the difference in housing types on the manure produced.
- How to estimate water consumption ? This is a central question ! Suggested to estimate from changing volumes in the farm water reserve (often set up in a water tower). Some published standard values (Dr Liao). Separating water for cleaning and that for cooling a problem. Major effect of season.
- Special farm features ? none offered.
- Bedding materials ? Not used in Guangdong Province but likely in colder

zones of China.

- Identifying land for manure application : Dr Ai suggested that many farmers have enough land themselves – *there may have been a misunderstanding here. Several times manure was only taken to mean "solid dung" the liquid considered to be an effluent with little nutrient content and generally unhealthy and of little value. In reality most (50 to 90%) of the nutrients will be in the liquid manure phase*.
- The only options for disposal of liquid manure appear to be (a) to fish ponds (b) to biogas units (and then presumably to fish ponds or streams) and (c), in a few specific cases, to bamboo plantations. Dr Rao pointed out that livestock farmers in fact rarely have enough land to land spread their own liquid manure. In addition, transport is unlikely to be supported unless the farmers receive funding. Dr Rao did supply some detail of the use of channels of up to 400m to move manure around local areas.
- Compliance or closure ? Dr Rao doubted that many farms actually met current regulations but the pressure to increase pig production meant that closure was unlikely in the near future: such were the conflicts in policy.
- Land spreading ? Dr Rao doubted that this would be an option as local land was limited and transport to other field further away implied costs that could not be met.
- On utilising the nutrient content of manures, the concern was the lack of knowledge of the actual content. Common practice was to follow other local examples.
- A further point raised by Dr Rao was that farmers only rent land (from the local government) and that they thus have little or no long term interest in sustaining the local productivity. Looking at the short term (<5 years) the use of chemical fertiliser is often the safe option.

One might thus conclude from the points raised by Dr Rao during the workshop in China, that whilst based on good experience, that they together present a real challenge to the implementation of any scheme to improve manure management in the region. **If** local land is insufficient, **if** transport costs to neighbours fields can not be met, **if** the nutrient content of the [liquid] manure is not trusted, **if** there is not interest in long term land management, **if** there is no interest in any scheme that implies a net cost, **if** there is reluctance to risk a fall in pig production by imposing regulation – very few options remain if any.

3.3.4 Treatment options within balanced agriculture

Not withstanding the negative (if realistic) feedback from the previous session, the main options applicable to the region were set out and reaction was invited. In some cases a financial reward may be expected but this may not always be the case and even if true, the sums may not necessarily cover the investment costs made.

Storage

- May be necessary to synchronise operations (e.g. land applications / batch processing).
- Can also reduce pathogen loading and local perceptions of the importance of

disease (human and livestock) are increasing.

- Crucial for pig farms:
    - during late (?) season;
    - during rainy season it is required to avoid flow into rivers or elsewhere.
- Perception is that there is room for improvement to storage practices in Guangdong Province.
- Practises need to address:
    - solid storage – currently no fixed storage;
    - liquid storage – most farms store in lagoons.
- Mixing not attractive to farmers as:
    - they can't see why they are doing it;
    - and therefore can't justify the cost.
- Farmers' would need to be made aware of – and accept – the benefits of mixing (avoiding sludge build up etc.). However cost is still likely to be an issue.

Separation (Screening)

- Numerous design options with a range of costs and capabilities (in terms of product quality / final dry matter content).
- Separation not locally regarded as an important process *per se* but as a preparatory for anaerobic digestion.
- On some farms, solid manure is removed by hand before washing so separation is not required. Valuable for reducing water use but less efficient than machine separation.
- Should not ignore potential benefits of P removal (up to 70 *per cent*), where P surplus may be a problem.

Separation (Sedimentation)

- Generally cheap and effective for P and heavy metal removal.
- Commonly used in Guangdong Province. Sludge is removed with a pipe and a pump and then trucked away.
- Standard exists and, if it meets the standard, the sludge can be sold as fertiliser.
- Centrifuge to concentrate sludge would give a high quality product but would probably take some selling on cost grounds!

Composting Options

- Range of systems available; mechanised or manual (again at very variable cost).
- Currently not attractive to pig farmers as it is hard for them to make profits from it. Could be implemented in fertiliser factories?
- Has been implemented with government support on demonstration farms. However, breaking into the highly competitive fertiliser market without subsidies is difficult as margins are very small (lack of quality control

exacerbates this).
- May become a more viable option as inorganic fertiliser prices increase.

Aeration

- Can be an effective means of removing N from waste water as well as supplying O_2 to fish ponds. However, costs money to install and run.
- Already a common practice in Guangdong Province (particularly in the Pearl River Delta).
- Improved efficiency and cost-benefit of equipment may be a valuable intervention for the project to examine.

Lagoons

- Sequential movement of water through a series of (fish) ponds can eventually allow release to river systems.
- Potentially a strong option as can evolve from existing piggery – pond systems.

Anaerobic (Including Energy Production)

- Small farms (3 – 8 pigs) may benefit from down-scaling the technologies. 60,000 anaerobic systems are being installed annually on small farms to provide gas for cooking / light. Subsidy of Y1000 on an installation cost of Y2500.
- Farms above 100 pigs also have systems for cooking / piggery heating.

Drying Options

- Reduce pathogen levels as well as facilitating transport.
- Has not been practised in Guangdong Province and not yet under serious consideration. DST might help to examine the issues and promote if potential is identified.
- Labour-intensive but can add substantial value.
- Sufficient sunshine but rainy season is quite long.

3.4 Internal meetings – China

Session 1

Two sessions took place on the available time Saturday afternoon : the first involved the whole team including Weaw along with Henning Steinfield and Ge Backus (who were coincidently present to pursue the DST software package aimed to support policy development. Taking advantage of the available time together, the common ground between the two DST's was discussed.

Clearly it would have been desirable to link the two packages but the practicality of this was beyond the scope of the current project definitions. The option remaining was use the MAUREEN package to generate information to support the Policy DST but this would not be via a formal electronic link.

A brief resume of the needs of each package was given. For the Policy DST, the need was to evaluate the likely consequence of one of a series of scenarios based on the implementation of certain policies including the costs to the farmer and the benefit to the environment (noting any commercial benefit if any). For wide scale modelisation, farms would need to be divided into a limited number of categories and for each, the cost and consequences of compliance to a given proposed policy could be explored.

The key problem (relating to some incompatibility) stems from the objective of the MAUREEN model which is not intended to be prescriptive, leaving the final choice to local advisors/farmers on how far they would accept obligations on improving the manure management. Thus the outcome of the model would not guarantee compliance to any particular regulation although it would clearly represent a positive step none the less. The concern is that a model that simple gives the user an unattractive solution (even if it offers compliance) would be largely disregarded.
It remains possible that some output from the MAUREEN model for defined standard farms would be useful for a policy model. It was further noted that in very few cases, would direct discharge to the surface waters be proposed; recycling to land being the main objective.

It was agreed between both teams to keep each other informed of progress.

Session 2

The DST project team (CHB, PT and HM) reviewed progress on the model and the timescale in particular. Concerning the former, the following non-binding timescale was proposed and agreed as a good guideline :

Preparation of flowsheet of treatment options showing main calculation modules and how these fit together; completion of a proportion of such modules (say 25%) to enable programming. **ACTION : CHB** Submission to PT by end July 2008.

Completion of the “front end” of the programme for feedback from HM and CHB to be completed by PT by end August. **ACTION : PT**

Detailed feedback to PT on draft of model by HM and CHB before next meeting (9/10 Oct 2008) **ACTION CHB/HM**

Completion of land application modules by interim meeting (9/10 Oct 2008) **ACTION HM/PT**

Review meeting Zollikofen (9/10 Oct 2008) : date to be confirmed no later than end-July 2008. Attendance PT/CHB/PG/HM.

Last modules from CHB and HM to be sent to PT by end November 2008 **ACTION**

CHB/HM

First complete version of programme completed by end-December 2008 This will be circulated to all three PMO's and relevant contacts for evaluation at the beginning of January at least 2 weeks before the following mission **ACTION PT**

Mission to SE Asia to progress evaluation and subsequent revision of draft software proposed as late January or early February 2009 subject to agreement.

Revision and testing of software expected during February/March 2009 with possible completion in April 2009.

A possible formal launch of the three DST software packages has been mooted for May or June 2009 but this remains a matter for the FAO and is general beyond the scope of the current project.

4. MEETINGS IN VIETNAM

4.1 Software development workshop - Vietnam

4.1.1 Introduction

As for the workshop held in China, the group assembled would turn out to be similar to those subsequently present of the PMO debrief held on the last day of the mission. Those present included the MAUREEN team, Weaw (for the FAO), the translator, Mrs Chi + Miss Ain and Mrs Thuy the data coordinators for the North and South of the country, a team from the PMO (Dr Duc, Dr Chinh) and invited experts: Dr Huy (the National Centre for Scientific & Technical Information and Documentation), Dr Siem (Consultant in Agricultural Research), Dr Ding (Water Resources Management Centre) and a representative from the Ministry of Health (Preventative Medicine). In a similar fashion to the two previous workshops, the agenda for the day was presented and the broad objectives of the software package laid out. Time was again taken for clarification on certain general issues including the central environmental objective of reducing water pollution. There was concern that air emissions and health related matters might be overlooked. CHB reassured those present that such things would feature in the model but that there had to be a principle function enabling decisions and that this was water quality.

4.1.2 Software development

PT once again provided a presentation that both described the structure of the software package and included demonstration of the elements already available. One key point is the deliberate intention to provide “a feel” of similar to the Microsoft Internet Browser, this being one software package that is almost universally known. There would thus be a “home page” from where one would navigate around the package using intuitive links built into the various options displayed.

The session was delivered in a slightly modified fashion based on the two previous workshops – this was to concentrate much more on provoking reaction by setting out a series of questions. It was noted that the software preparation could only be effectively done by a team approach. The principle points made are set out below :

- Concern that the software should be easy to use – comment added about training.
- Concern that the data used should be easily revised to apply to local situation.
- System parts : management and handling of the data; system characterisation; design of systems (including treatment options).
- Standard data (supplied in a database) and various standard scenarios to enable rapid outputs in response to few keystrokes. Option of modifying any data and of preparing new scenarios to describe specific or a standard farm.
- Whilst awaiting the DST-MAUREEN software, could examples of other equivalent software be sent?
- Inclusion of other local people on subsequent mission to test out software.
- Initial version will be in English with Vietnamese version subject to a future contracts.

- Importance of training – training of trainers – session needed – when ?
- Discussions on specific data deferred to separate session (below).
- Software should include recommendations of which manure and manure products to which crops.
- Graphical output of data preferred – illustrations welcome.
- Issue of soil quality (as opposed to supply of nutrient) – discussed under agronomy (below).
- Interactive options very welcome – idea to observe directly the effect of changing and input was of special interest.

4.3.3 Manure handling and land spreading

- Need for a soil component expressed (see later). This is clearly a big issue amongst these groups.

Livestock Production

- Agreed to focus on intensive livestock production system (although associated cropping systems may be more extensive).
- System will not have a spatial (GIS) component but the wider project is also developing a spatial DST which may offer the possibility of linking the systems.
- Geographical dimension to manure application plans (i.e. plot locations) might be difficult to realize.
- Where required, climatic variables likely to influence outcomes will be included in the DST.
- Not entirely resolved whether to include poultry and cattle (dairy + beef) as well as pigs. Level of detail for pigs likely to be greater. Some viewed poultry and cattle manure as relatively easy to dispose of so a specific focus on them is not really required.

Water Consumption

- On-farm estimates for specific scenarios may not be feasible.
- Use best estimate correlated with housing type?
- Seasonal variation in water use needs to be considered. There may even be day-to-day variation related to the ambient temperature when there is no evaporative cooling.
- Consensus would be that amongst farm variation is high, particularly where an evaporative cooling system is used.
- Wallow system is common; water may be changed up to three times a day depending on ambient temperature.
- Stratify farms by water-use categories?
- Consider end of cycle washing separately.

Recycling to Crops (and Fish)

- Market generally adequate for the disposal of solid manures. Liquid manures are more problematic.

- Manure price will influence the suitability for different crops?
- In some areas chemical fertiliser may be regarded as more convenient to transport and spread. Even so manure may be regarded as a “better” fertiliser. Decision may be crop-dependent. Also perception of relative cost-benefits of the two will be crucial.
- Farmers may stop using manure (and related compost) when there is a diarrhoea outbreak. Standards needed to instil confidence.
- Complaints from neighbouring rice farms may enhance liquid manure disposal paid for by pig farmers.
- Key informants on constraints to manure recycling on crops: crop farmers, local “livestock waste management” officers, Ministry of Health, Ministry of Environment, fertiliser producers and consumers.
- Extension officers are very important for promoting appropriate application regimes.
- Acceptability to farmers difficult to assess as farmers can be somewhat vague about their practices. May also find it difficult for them to express a view about the technologies with which they are not familiar.
- A number of complications relating to assessing the area of land available for manure application exist (e.g. requirement of crop and livestock producer, contractual arrangements, accessibility of crops). None of these appeared to have been satisfactorily resolved during the discussion.
- It is not feasible to consider the soil type and its nutrient status for dosing manure in the model. However, if the farmer has such information he can use it in the interpretation of the dose proposed by the model.

4.3.4 Treatment options within balanced agriculture

- The introduction gave an overview of the potential treatment options, namely storage, separation-screening, settling, composting, aeration, lagooning, anaerobic digestion (biogas)

Storage

- Storage is also a form of treatment as it has an influence on the characteristics of the manure. One important aspect is the reduction of pathogens which even a short storage can achieve.
- What really matters is the question why we want storage. The primary aim often is to overcome times with no possibilities for application. Most farms in Vietnam practice this. However, the storage volume is often too small. A special difficulty is, that the storage should be covered during the rainy season.
- Farmers would need recommendations about the storage volume needed per pig.
- There is a cattle project funded by Danida in Hanoi where appropriate manure management options are demonstrated.

Screening/Separation

- There are different screening systems following the same principle that the

liquid is passing over a screen through which the liquid fraction can percolate. The liquid and the solid fraction are collected in different vessels. Fine particles tend to remain in the liquid.

- The advantage of screening is that it is a cheap and simple option. A large part of P can be removed from the liquid but there is hardly an effect on the BOD.
- There are systems in variable costs, ranging from cheap to expensive. The price depends largely on the separation efficiency and what characteristics of the solid fraction is achieved.
- In Vietnam some farmers have used small screening devices. However even this cheap technology is too expensive for most farmers. However, simple screening options could be interesting for larger pig farms in the future.

Settling techniques

- Settling techniques can also remove smaller particles from the liquid. Up to 80% of the P remain in the sludge. The volume of solids removed is higher than for screening (up to 100%). However it can take a long time.
- The best system, the centrifuge, is very expensive and therefore hardly of interest in Vietnam. Such technology is only justified for large farms (e.g. >1000 pigs). However, as organic fertilizer should be cheap, the technology is rather not applicable for Vietnam, even if the solids are of very high quality.

Composting

- The solid fraction from screening and settling can be used for composting together with other substrates. The product can be highly improved in quality and pathogens can be greatly reduced. The price for compost is usually higher than for solid manure or dried dung. There are different technologies for composting. The more expensive options would only be justified if the farmer can be sure to get a significantly higher price.
- In Vietnam compost is a bio-fertilizer which is used for special crops like flowers and horticulture. For manure the farmer can get VND 10.000-20.000 per bag of 25 kg (depending on dry matter content; poultry manure about VND 1000 per kg), for high quality compost they can receive VND 10.000 per kilogram.
- Not every farmer can do good composting. Often “compost” is a fake.
- In some Provinces of Vietnam composting is used for the treatment of domestic waste for composting. Composting was not propagated so far for animal wastes. The question is how domestic and animal wastes could be composted together. However this might carry a high risk of pathogen transmission and the introduction of problematic materials (e.g. metal, glass) in the compost. As domestic waste in many Vietnamese cities results from separate collection of different wastes the substrate should be of good quality (especially vegetable wastes, coffee wastes, rice straw).

Aeration

- Aeration is a recognized method to remove excessive nitrogen, e.g. if the

manure is to be used for fish production. However most of the aerators used are inefficient.

- There is a range of possible equipment, some of which can reduce N three to four times more efficiently than surface aerators.
- In Vietnam fish farmers use aeration. However, farmers would hardly consider aeration for livestock waste treatment because of the high electricity costs.

Lagooning

- The driving force for lagooning often is the reduction of organic matter and N if the effluent should be used for fish production. If the effluent is to be used for fish production, the last lagoon should not contain any fish,.
- The disadvantage is the large land requirement, especially in Vietnam where land is often scarce. The technique might be applicable for some farmers with sufficient land and mixed livestock and fish production.
- There is a project in Hanoi which looks a hygienic aspects of fish produced with manure.

Anaerobic digestion

- Again there is the choice between high cost technology with high efficiency and low technology with lesser efficiency.
- If the biogas is used for electricity generation, the price for the electricity will be the determining factor for the choice of the technology.
- Anaerobic digestion has been used by Vietnamese farmers for a long time, also for electricity generation.
- Biogas production should be combined with CDM. Vietnam has a Biogas program financed by the Dutch Government. Even small farms can apply for this.

Drying

- Drying is only appropriate in Central Vietnam where it is dry and sunny. In the North and the South there is too much rain and moisture. Most of the N will be lost during drying.

  For any more aspects that could not be covered in the workshop the participants can contact Colin by e-mail later : colin.burton@cemagref.fr

4.2 Review of data collection - Vietnam

4.2.1 Data collection for treatment system

Discussion of zones and clarification of other queries relating to the spreadsheets sent out. Data precision discussed : important to indicate accuracy but equally to avoid excessive precision (significant figures) which is not justified.

- Background information and the timetable foreseen.

- If there is a considerable variability of a price, it is reasonable to give a range. This can then also be used for sensitivity analysis.
- If the definition of a system is ambiguous or unclear it would be good to include a photograph or a drawing. It might also be good to include some photographs in the software.
- It is good to include comments in the cells where something might be unclear.
- A first set of values should be delivered by the end of July. Until the end of August we will send a list of additional questions that have come up.

Storage

- Landprice: In Vietnam there is an official land price and a market price which is considerably higher. It is probably better to use the market price in the model to reflect the real situation.
- Prices of material include delivery.

Structures

- For the digging of lagoons prices for machinery and manual digging can be differentiated, if appropriate.
- For liner, if it is not PVC, a short description should be added.
- Cover for steel tank: use the most common and make a note which was used.
- Concrete lined pit includes a floor. Especially below the groundwater level, a reinforced floor is necessary.
- Pit includes excavation costs.

Machinery

- Flow rate: just to give the order of magnitude.
- Usually the cheapest locally available type of reasonable quality should be considered.
- For dosing pumps accuracy is import. Give size if it is different from value given in the template.
- Mash size for screens is important only if it changes the price.
- The maximum trough-put according to the supplier should be given for screens.

Reactors

- Price for plastic tank 20 m^3 will be checked (South).

Pipes and valves

- “Solid pipes” should be “rigid pipes”.

Services

- Lines 9 to 11 are for liquid manure for a distance of 2, 5 and 10 km with a 10 ton truck.

- Transport of liquid manure or actually any form of “fresh manure” is forbidden in Vietnam. Therefore, indicate what it would cost if it were possible.
- If “gas” is given in kg, the calorific value must also be given.
- Rise straw should rather be given in kg than m^3.

Units can always be changed, as long as they are compatible and clearly defined.

4.2.2 Data collection for agronomic matters

The data collection is already well advanced, especially in the South. Unclear aspects could be discussed and efficient progress should be possible during the near future. It is important to give special attention to collecting information about actual standard practice rather than statistical data and recommendations (except for crop nutrient requirements).

4.3 PMO de-briefing session - Vietnam

To a large extent, this was an extension and especially a summary of the previous workshop as no one was present who had not participated in the workshop a couple of days earlier. One additional item included was led by Weaw which was to provide a review of the progress on the DST dealing with policy which included a series of questions left for reaction in due course.

Relating to the MAUREEN DST, CB, HM and PT each provided in turn a brief summary presentation of the material covered in the workshop followed by discussion of remaining points. The main issues arising were :

- The absence of a standard for manure spreading and the inappropriate use of the water standard (for direct discharge to rivers) in its place.
- Request for progress reports on the software development over the coming months leading up to the next mission (expected Jan/Feb 2009).
- Concern over the need for treatment – explained that this is only one option where land spreading by itself is not sufficient.
- Concern over which option will come out of model – emphasised that this is all choices with the final decision lying with the farmer/farm adivisor.
- Wetlands proposed as an alternative option – CHB noted that such systems are limited to very dilute effluents and imply a large land area.

Special challenges in Vietnam

- Fast changing pig sector (intensification, larger farms, new systems)
- High complexity of area-wide manure distribution plan
- Manure distribution plan
- Fish pond systems
- Livestock promotion zones
- Environmental law, article 46: fresh manure can not be transported outside of farm
- Industrial wastewater standard also applied to agriculture

4.4 Final internal meeting

In a final session between the MAUREEN team, discussion of this report and agreement of content; discussion of a draft schematic of the model structure (Annexe 4), timeframe for project completion as set out above, preparations for the next interim meeting in October and the option and nature of interim reports. This last may take the form of e-mail bulletins.

5. CONCLUSIONS AND ACTIONS

General conclusions from the modelling development point of view

1. The major challenge in developing the DST will be to implement an acceptable balance between software accessibility / usability and describing the user's situation at a level of detail that is adequate for generating meaningful results / recommendations.
2. A number of approaches will be taken to enhance usability:
   - Using "familiar" user interface designs (e.g. based on Microsoft Office products) to make the user feel at home.
   - Basing navigation within the tool on "hyperlinks" – mirroring, where possible, the operation of an internet browser. Again, this should be familiar to most users and allow them to orient themselves rapidly.
   - Where possible to allow alternative graphical or "quick start" routes into the tool's major functions.
   - Offer features that can be run with minimal interaction with the tool's core database (users will have access to data but this will not be the default mode of operation).
3. When implementing individual components of the model, it is suggested that each "enhancement" should be reviewed systematically for its impacts on usability and associated improvements in model accuracy. Where the latter are insufficient to justify compromising the former, their inclusion should be rejected.
4. With these considerations in mind, PT will initially produce a "bare bones" version of the tool (by early September, 2008) implementing all major aspects of the system's structure. This will then be used to support progressive inclusion and enhancement of each of the elements in the core model and DST.
5. The guiding principle behind the development of the tool should, as much as possible, be to "**keep it simple**". It must be remembered, however, that MAUREEN is attempting to describe a complex set of processes in a multi-dimensional system. Over-simplification will be just as destructive as obscuring the tool's outputs by over-complication.
6. During the meetings, some participants queried the extent to which the tool would be "validated". It needs to be clearly stated that the tool's core model will be based on already validated bio-physical relationships that have, in most cases, been subject to peer-review. In fact the questions raised, generally related to "testing" the tool and constitute a separate issue.

General conclusions from the agronomic point of view

1. For a wide application of the DST it will be crucial to keep it as simple as possible for the normal user. Reliable default values are therefore of key importance wherever they are possible.
2. It must be possible to utilize MAUREEN quite independently for different purposes, namely for 1) the assessment of the current situation with respect to nutrient balance and environmental impacts, 2) evaluating and planning new strategies (incl. design of appropriate treatment facilities), 3) management aid tools (e.g. manure distribution plan). A direct use of

MAUREEN as policy implementation tool should be avoided.

3. For the assessment of the current situation nutrient balances and fluxes and environmental impacts will be the main focus. Such applications should be possible with very little inputs apart from animal numbers, manure exports and local crops potentially available for manure recycling. Such applications should be feasible for extension service staff or advanced farmers with a short introductory training.
4. For evaluating new strategies which involve an investment into storage and treatment facilities, the DST will be faced with conflicting aims. On the one hand it will only be used broadly if the application remains simple. On the other hand, a simple application largely based on default values and assumptions carries a considerable risk of a wrong design of the size of the infrastructure. It might be advisable that such applications are only done by specially trained experts involved in the design of the systems.
5. Management aid tools (e.g. manure distribution plans involving slurry) can not yet be designed with the present state of knowledge. As they would have to be well adapted to a specific strategy it appear judicious to wait with designing such tools until first farms in the LWMEA project are ready to implement a recycling strategy. The stakeholders (livestock and crop farmers, extension staff) should then be directly involved in the process.
6. Slurry transport and spreading are aspects on which practically no experience exists in the project countries, apart from canals. The LWMEA project should give special consideration to this and involve research and extension groups to identify potential options.
7. It is not feasible at present to have precise information on the local crop surface available for manure recycling when defining the new manure management strategy and designing the corresponding storage and treatment facilities. Qualified guesses will have to do, but the explanatory text should clearly indicate the importance of a thorough investigation and give recommendations how this could be done.
8. It is not feasible at present to base the transport distance of fields for slurry recycling on information of each individual field. To overcome this, estimates can be used of how many percent of the slurry (and locally recycled manure) fall into different distance classed (e.g. >0.5 km, 0.5-1 km, 1-2 km, 2-5 km, >5 km).
9. A quantitative assessment of the accessibility of the fields for slurry transport equipment is not feasible at present. This restriction will have to be considered qualitatively when estimating the available crop surface.
10. Validation measurements will be essential to achieve credibility for for values on manure quantity and composition.
11. Although at first sight it appears commendable to consider variables like soil type and soil nutrient status, this is not feasible in the DST. However, if the farmer has reliable local information on the influence of these variables he can always take them into account in the interpretation of the DST results.
12. Solid manure that is marketed (mostly via contractors or middle-men) must not be of high concern in the DST, because a commodity with market value is always handled consciously. However, it would be advisable that the LWMEA project provides a code of good practice (dosing, time of use etc) for solid manure also.
13. If solid manure is not used locally, it can be excluded from the local manure

balance calculation. If it is used locally, due attention has to be given to its nutrient value when assessing the potential for recycling liquid manure.

14. It is permissible to assume that solid manure (fresh, dried, composted) from poultry and cattle is always handled more or less adequately because it has a good market value. Solid pig manure often has a lower esteem. In areas of high livestock density it is therefore sometimes not used in an environmentally acceptable way. For such situations, options to improve its value (e.g. through composting and proper dosing) should be identified and propagated.
15. The final use of the liquid effluent from pig production remains an open question and challenge in the LWMEA project (except maybe for systems with fish production). As long as farmers do not see a direct benefit for managing these effluents they will not be ready to take the necessary steps. It is crucial that the national teams (PMO) are given strong support for these aspects (collaboration with research groups, possibilities for demonstration experiments, international consultants). Although the project must realize that it will probably not be possible to fully solve this problem, this should remain the key focus of the project activities.
16. Reducing water use will be a top priority issue for the management of liquid manure.
17. Although it might sometimes prove impossible for the DST to provide a solution that appears acceptable to the farmer (especially if slurry recycling on crops is not considered feasible and discharge standards are leniently enforced), the DST can play an important role, although sometimes rather as an awareness raising than as a decision support tool.
18. A detailed code of good practice on (liquid) manure management must be an important part of the agronomic part of the DST and especially the material derived from it for the dissemination to farmers. The TOR for the DST did not yet give due emphasis to this aspect. However, such a code of good practice would have to be developed stepwise in collaboration with different national experts and stakeholders. This implies that it will hardly be reasonable to have a fully ready product until the launch of the DST but that this should rather be an aim for the final products and dissemination of experience from the LWMEA project.

General conclusions from the treatment system point of view

1. Reluctance in all three countries to commit to any policy that would oblige the investment in treatment facilities.
2. Some instances of an unrealistic expectation from treatment and a universal solution to a problem that has a clear land spreading (recycling) dimension. Treatment can remove N and some carbon source, otherwise, its role is to concentrate nutrients into useful products. Treatment can also enable a wider land spreading option by (a) sanitising and (b) reducing the volume of materials for transportation. Treatment can reduce offensive odours and some emissions (methane especially) but alone, this makes little difference to the likely surplus that can ultimately pollute surface and sub-surface water.
3. The uncertainty over water consumption (and thus in the volume of manure production) will be the biggest challenge in any design package.
4. Basic manure storage (necessary for efficient land spreading) is readily

achievable technology – if organised, it can also achieve some sanitary benefit.

5. Screening technologies again appropriate technology with some interest in the separated fibre as a solid fertiliser. The more basic systems are preferred although these produce the wetter solids.
6. Sedimentation options are also attractive and the periodic removal of sludge already has some application in Asia. Elaborate equipment such as centrifuges have little likelihood of acceptance even in the largest farms.
7. Aeration systems may have a role if linked to fish production but it is doubtful that they will be operated enough because of the clear cost of electricity. Considerable interest in alternative low cost aeration systems.
8. Lagooning is already well established in many areas and especially if coupled to fish production, the attitude is expected to be positive.
9. Biogas almost universally popular but expectations may be unreasonable especially for small farmers. The rising cost of energy will add to the attractiveness of this option. However, little benefit in anaerobic digestion alone in reducing nutrient content.
10. Drying schemes may find some favour in hotter drier areas such as Thailand where it is already done with some limited success.
11. Treatment to enable land spreading may yet be a crucial step as fears of crop contamination remain a barrier for manure use in some instances. The preparation of manure concentrates (especially if as solids with the nutrient content can be assured) may yet enable the wider use of manure as an organic fertiliser.

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