

Hygiene versus fertiliser: The use of human excreta in agriculture – A Vietnamese example

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Abstract

The use of human excreta as fertiliser in agriculture is a common practice in parts of South East Asia benefiting production but at the same time a risk factor for increased helminth infections. This paper describes the hygienic handling of human excreta for use in agriculture in Central Vietnam from a practical farming perspective presenting the farmers perceived health risks and benefits of its use. Further, in the study findings are discussed relating to the new Vietnamese guidelines for the use of human excreta in agriculture to their implications on an on-farm context. A total of 471 households in five communes responded to a structured questionnaire. This survey was supplemented by focus group discussions, key informant interviews and participant observations. More than 90% of the surveyed households used their own excreta as fertiliser and a total of 94% composted the excreta before use, either inside or outside the latrine. However, due to the prevailing design of the latrine and the three annual cropping seasons, it was found that for a minimum of one cultivation season per year 74% of the households will have only 3–4 months for composting before the input is needed in production, which is short of the 6 months stipulated in the national guidelines. The community associated great benefits from using human excreta in agriculture, especially if composted, and did not associate risks with the use of composted excreta if it was dry and lacked odour. It is recommended that the guidelines be revised and attempts made to identify ways of reducing the time needed to ensure the die-off of helminth eggs, including the use of pH regulators, such as an increased use of lime in the latrines.

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Introduction

Applying human excreta to agricultural fields has, for centuries, been part of the agricultural tradition in

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Vietnam and Southern China, where farmers perceive latrine waste as “valuable fertiliser.” Despite the potential health risk, especially for helminth worm infection, the practice is still widespread (Phuc et al., 2006). Helminth infections are often given low priority by health authorities as they are not associated with high mortality but do result in high morbidity, reduced growth among children, and negatively impacts on the learning capabilities of school children (Phiri et al., 2000; Stephenson et al., 2000b). Considering the high prevalence in many Asian countries, helminths infection has a considerable impact on the household health and economy (van der Hoek et al., 2003).

To limit the risk of helminth infection, the Vietnamese government has recently introduced a set of guidelines for the proper composting of human excreta before its use in agriculture (Ministry of Health, 2005). The guidelines have been established taking as a starting point for the use of traditional Vietnamese composting latrines. This type of latrine, with one or two cement vaults raised above ground, is the most common latrine design in Central and Northern Vietnam and is also the prototype of many Eco-San-type latrines (Winblad and Simpson-Hébert, 2004). In the double vault composting (DVC) latrine, only one vault is used at a time and when full, sealed off and left to compost. After a period of composting, the seal is broken and the excreta is manually removed from the vault. In the single vault (SV) latrine the vault is continuously used and, therefore, the excreta used as a fertiliser is a mixture of fresh and semi-composted excreta.

The Vietnamese guidelines on excreta use recommend a minimum composting period of 6 months inside the latrine since this is regarded as sufficient time to kill the *Ascaris* spp. eggs (Ministry of Health, 2005). These are the helminth eggs known to maintain the longest viability with potential for infection up to 1 year following an exposure to the external environment (Feachem et al., 1983). However, it still remains to be seen if farming households will follow the guidelines and whether a 6-month retention time can be accommodated within the local farming systems considering the demand for excreta input in agriculture. If the latrine types or compost guidelines are not adapted to the local practices of excreta use, it is likely that many households will not follow the recommendations (Jensen et al., 2005).

The objective of our study was to describe the current use and handling of human excreta as fertiliser in agriculture, including composting practices, in two communes in Central Vietnam. Farmers' perceptions of health risks and hygiene related to the use of latrine waste as fertiliser were also investigated. Finally, the study findings are discussed in relation to the new guidelines for the use of human excreta in agriculture in Vietnam.

Materials and methods

Study area

The study was conducted in Nghe An province in Central Vietnam among farmers in two mountain communes: Thach Son and Khai Son; and in three lowland communes: Nhan Thanh, Hop Thanh, and Dien Dong. All the communes were included in a large-scale province-wide project, initiated in 2002, aimed at improving access to domestic water supply and sanitation. The findings of this study aim at assisting future interventions in the project areas.

Selection of households and study population

In each of the communes a list of all the households was obtained from the local People's Committee. Twenty per cent of the households from this list, by selecting every fifth household, were included in the study, e.g. household number 1, 5, 10, 15, etc. In case the head of household refused to participate or was absent (after two visits, where the interviewer returned after 1 h each time) or an elderly person whose mental state made it difficult to ask and answer questions, that particular household was not included and the next household on the list was selected. The total sample size was 511 households, of which 40 households (8%) were excluded because they did not belong to the target group of the study, i.e. they did not use excreta from their latrine as fertiliser in agriculture or the household used the neighbour's latrine. The total study population was, therefore, 471 households.

The main respondents were the head, or the spouse of the head, of the household. In each of the communes a female research assistant with previous experiences in field surveys was recruited and trained to assist with the collection of data. In spite of the risk of introducing an interviewer bias it was decided to select research assistants among members of the local Women's Union of the local People's Committee as they were the best educated in the area with a completed high school education, had detailed knowledge of the study area, could easily build a good rapport with the respondents and made it logistically more feasible to undertake the survey. The research assistants were sensitised to the aims of the research study and the importance of reducing the potential for bias was highlighted during training and field supervision. The survey was conducted in August and September 2004.

Interviews

A structured questionnaire was used to obtain information about age, gender, occupation, and education

for all household members and to assess the socio-economic status (livestock/land holding/production/education/income, etc.) and latrine types in each household. The excreta use practises were illuminated through questions on excreta storage and handling, including asking about composting time of excreta before the use in agriculture, means of excreta and compost collection, storage, transport, application, and main crops cultivated. In addition, the engagement of household members in handling latrine wastes and the hygiene practices involved were identified.

The principal investigators trained and supervised the field assistants on how to work with the questionnaire and instructed them on the use of a household-level hygiene observation checklist (presence of soap at water tap, latrine type, etc.). In the course of the training, the data collection tools were pre-tested and updated accordingly. The interviews and survey forms were in Vietnamese. The principal investigators checked the filled out questionnaires and survey forms as a means of quality assurance. Each of interviews lasted for approximately 1 h.

Focus group discussions

Two gender-separated focus group discussions (FGD) were conducted in Vietnamese half way through the questionnaire survey in each commune, including 8–10 persons engaged in farming activities and between 20 and 50 years of age. Each FGD lasted approximately for 1 h. An FGD guide was developed, which included questions on farmers' perceptions of the use of human excreta as fertiliser in agriculture; why and how people composted human excreta before usage; and peoples' knowledge and perceptions of diseases associated with human excreta storage, handling, treatment, and use.

Key informant interviews

Throughout the study period, key informant interviews were conducted in each commune. The informants were persons from the People's Committee, Women's Union, Household's Union, and health officials. These key informants were selected to represent the perspectives of the official organisations supporting agricultural development and hygiene promotion in the study area.

Participant observation and follow-up survey

Following the questionnaire survey and the FGDs, it was decided to have two researchers stay for 1 month with the community in two of the study communes to allow for an opportunity to triangulate earlier findings with participant observations, in-depth interviews and additional FGDs.

Data analysis

The data from the structured interviews were analysed with SPSS[®] version 13.0 software. Chi-square test and *P*-values were used for testing the significance. The responses given by the study participants were assigned codes before data entry and data were entered twice to cross-check for errors in entry before analysis.

Non-computerised analyses were used to analyse qualitative data. A code sheet was created following the focus group guide and data were coded in a table form to identify general patterns. Based on the coded tables, attempts were made to identify general patterns, as well as diversities in the responses provided according to the specific themes or questions. Methods used included content analysis and use of quotes. Analysis also gave consideration to the actual words used by the participants, the context, and specific responses.

Results

Latrine type and composting of excreta

The latrine types of the households are listed in Table 1. The DVC is the only latrine that makes it possible to compost inside the sealed latrine vault, where all of the different designs present can be emptied and the composting process can be carried out outside the latrine in a special box next to the pig pen, the latrines were normally constructed adjacent to the pig pen, or in the garden/field where the excreta was placed in a heap. In Table 2, the different sites for composting the excreta are listed including how many households that compost only outside and thereby necessitate to remove the fresh excreta from the latrine vault.

Table 1. Toilet types

	Number	%
Double vault composting latrine (DVC)	245	52
Single vault (SV)	202	43
Temporary (shallow hole/pit)	24	5
Total	471	100

Table 2. Domain of composting

	Number	%
Only inside the vault	318	67
Only outside the latrine	92	19
Both inside and outside the latrine	61	13

Overall, 80% of the 471 households composted excreta inside the latrine and 32% of the households composted outside the latrine with no socio-economic difference between the groups. For a great majority of farmers the preferences for composting site was determined by the type of latrine available within the household.

All 471 households added kitchen ash into the latrine vault after each defecation, but not all households used lime. In Table 3 the household use of lime is listed. In the FGD it was mentioned that ash lowered the moisture and thereby the smell, while lime was viewed, by some, to be a disinfectant which could quickly destroy organisms in the excreta. The addition of lime to the latrine waste was also done by most households to replace the direct application of lime to the agricultural fields. Also, it was normal to add 5–6 kg of lime inside the latrine or in the compost heap at the onset of composting.

Information from the questionnaire revealed that the farmers protected the compost heap from access by children and animals. This was done by 49% of the 153 households that composted outside the latrine by covering the heap with clay; 24% covered the heap with banana leaves and 26% kept the heap behind a small fence. Only one household did not protect the heap. It was observed that some of the farmers mixed human

excreta with animal excreta and farmers explained that this provided a “safer” product as the highly “contaminated” human excreta was diluted by adding animal waste.

The 153 households composting outside the latrine often mixed different materials with the excreta before composting. 99% applied ash, 55% used lime and 6% of the households used green leaves, straw, or other organic materials. In the FGD, the farmers explained that selected green leaves were applied to reduce the smell.

Cropping pattern and use of excreta as fertiliser

In order to establish the practice of using excreta as fertiliser, all households were asked about their cropping pattern and use of the previous year fertiliser. As can be seen in Table 4 almost all households in the area have the same cropping pattern with three crops per year.

There was a wide spread use of human excreta for the different crops and the farmers in the FGD mentioned that it was the limited availability of excreta that explained the limited use of excreta for the second (rice) crop compared with the first crop of rice. The farmers also explained that a composted human excreta was the most nutritious fertiliser for rice because people eat better food compared with animals. As expressed in the following statement made by a female farmer in Phuc Son, “human fertiliser is the dirtiest fertiliser but it is also the best one since people eat a lot of protein-rich food and that is why their fertiliser or their organic waste is better.”

Pig manure was regarded as the second most nutritious organic fertiliser and cow/buffalo manure the least since they eat only grass. In the FGD, members explained that human faeces improved the soil structure. Also, the farmers reported that excreta have a long-term effect on the soil in contrast to inorganic fertilizers,

Table 3. Households addition of lime to latrines

Liming frequency	Number of households	%
After every visit	72	15
Weekly	135	29
Monthly or less	92	19
Total number of households that are adding lime at any time in the composting process	299	63

Table 4. Cropping pattern and fertiliser use

	1. Crop	2. Crop	3. Crop
Month for sowing/planting	December/January	May/June	August/September
Crop type			
Rice (%)	99	98	
Sweet potatoes and corn (%)			70
Only corn (%)			21
Vegetables (%)			5
Crop fertilised with human excreta (%)	78	41	72
Application times for human excreta			
During soil preparation (%)	70	73	87
During sowing/planting (%)	45	32	32
One month after planting (%)		8	18

which work very effectively but only for a short while. Human faeces was compared with traditional Chinese/Vietnamese medicine ('thuoc bac'/'thuoc nam'), which improves peoples' general health and cures minor diseases. Inorganic fertiliser was compared with Western medicine ('thuoc tay'), which has an immediate effect on serious diseases but does not strengthen the body.

The importance of composting was mentioned repeatedly in the FGD. It was viewed as important for occupational health reasons to compost excreta before use, as fresh human faeces was perceived as potentially very harmful to health, whereas composted human faeces was not associated with significant health risks. It was also mentioned that composted excreta made it easier to apply in agriculture. Even though some farmers considered fresh human faeces a more nutritious fertiliser they still preferred a composted product. Questions on whether the composting process could prevent diseases showed a small but significant difference between the sexes in the household interviews: 68% of the men as opposed to 59% of the women thought that composting human excreta before using it in agricultural could prevent diseases (χ^2 : 4.356, $P < 0.05$). 48% of the men compared with 37% of the women mentioned that composting human excreta is good for the soil structure ($\chi^2 = 5.815$, $P = 0.016$). In the FGDs, the male participants showed a greater interest in discussing the agricultural benefits of composting than the female participants.

Frequency in use of composted human excreta as fertiliser

Despite the minimal crop variation in the area, there were great differences between the households in the application pattern of composted human excreta. To establish the frequency of excreta use during the year, the application patterns for the different crops were established by asking the household what fertiliser was used for each crop the previous year (see Table 5).

With a starting point in the current practices, the maximum composting time achievable by the households can be determined, i.e. a household that fertilises crops 1 and 3 with excreta need two composting periods per year (Table 5). The first composting period lasted 8 months (January–September) and the other period only 4 months (September–January). Only the 24% of the households using excreta for only one crop per year were able to compost for periods exceeding the guideline value of 6 months (Ministry of Health, 2005). On the other hand, 74% of the households would have at least one composting period of only 3–4 months duration and 19% of the households would have three composting periods per year of only 3–4 months. In spite of the actual practices, members of the FGD mentioned that

Table 5. Annual frequency of human excreta application on crops

Human excreta used as fertiliser for	Number of households	%
Only first crop in January	35	7
Only second crop in June	3	0.6
Only third crop in September	74	16
Both first and second crops in January and June	80	17
Both first and third crops in January and September	156	33
Both second and third crops in June and September	21	5
All three crops	90	19
At least one crop per year	459	98
At least two crops per year	347	74
Only two crops per year	257	57

human faeces must be composted for 6 months prior to application on the fields. The head of the health station emphasised that people disliked the use of fresh excreta, and most people knew that fresh human faeces can be harmful to health and, therefore, they preferred to compost excreta for at least 6 months. The Women's Union representative at village level confirmed that people knew that they should compost for at least 6 months.

Health risks associated with fresh and composted excreta – household perceptions

In the FGD, in semi-structured interviews and key-informant interviews, people also expressed a concern with health risks related to human faeces related to both occupational and general community health. The respondents explained that they 'feared' human faeces very much. They emphasised that human faeces could be harmful to health and mentioned that contact with human faeces could cause diarrhoea and intestinal diseases, as well as lung diseases. It was highlighted that the bad smell '*mui ho*' coming from latrine waste presented a health risk when handling faeces. Respondents in FGDs mentioned that they feared bad smell because the bad smell could transfer bacteria and cause diseases through airborne transmission, but most people were not able to say what diseases the bad smell could cause. Those who had an idea typically related it with lung diseases; in a semi-structured interview the leader of the health station in the area also related bad smell with the risks of respiratory infections. He explained that the smell carried bad substances to the food, and people would be infected with food polluted by bad smell or bad air. In general, the community found that wet human faeces had more bad smell and was more

harmful whereas excreta with no smell were considered harmless.

Many farmers did not find it necessary to use protective measures when applying human faeces in the fields because it was decomposed and did not smell anymore. Also, farmers in semi-structured interviews explained that they did not use masks, boots, or gloves when applying excreta in the fields because it was not practical and also because the human faeces used was composted, dry, and without smell. A male farmer mentioned, “when we work in the fields, we can’t wear our boots. We keep our feet bare. Wearing labour-safety clothing or boots is very inconvenient.” To the question if he wears a mask when applying human excreta he replied, “no, I don’t because the faeces is completely decomposed. We keep the faeces for a long time and make it dry and the smell gets degassed and also we get used to the smell that is left.” In the same FGDs it was concluded that “we do not fear spreading decomposed faeces by hand.”

One hundred and three households composted excreta outside the latrine, and therefore had to handle fresh human excreta, and of these 91% used what they perceived as special protective measures including, dedicated work clothing, gloves, boots, and hats (see Table 6).

Table 6. Type of protective measures used by respondents handling fresh and composted human excreta

	Handling fresh human excreta (<i>n</i> = 217) (%)	Handling composted human excreta (<i>n</i> = 471) (%)
No protection used	47	8
Protective clothing	52	91
Hat	50	80
Gloves	31	39
Boots	31	46
Gauze mask	47	72

Table 7. Age and gender division among farming household members engaged in use of human excreta in agriculture

Person	Collection/ composting of faeces (%)	Application of faeces in agriculture (%)
Wife	57	67
Husband	33	26
Children	15	16
Others	1	1

n = 471.

As seen in Table 7, it was mainly women who were responsible for the collection, composting and application of excreta in the fields. Men and children also did take part in the handling of excreta but much less than the women, however, still in 77 of the households the children were handling the excreta.

Discussion

We found that nearly all farmers in the project area used human excreta as fertiliser. However, due to the cropping calendar many farmers could only compost the excreta for 3–4 months, thus not meeting the requirement of a minimum of 6 months composting set out in the recent guidelines by the Ministry of Health (2005). When the composted excreta were free of bad smell the farmers perceived the excreta as safe to handle and apply in the field.

A modification of the current practices of applying lime and the concomitant creation of alkaline conditions could enhance the inactivation of helminth eggs and reduce the composting time needed. Thus, reducing the risk involved in handling excreta and at the same time meet the crop demands for human excreta every 3–4 months. However, more research on the topic is needed before appropriate guidelines could be established.

Latrine types and composting definitions

Ninty-two per cent of the 511 initially surveyed households used their own excreta as fertiliser in agriculture, of which more than 90% had either an SV or a DVC latrine. Both these latrine types accommodate the households’ preference for using excreta easily and conveniently as fertiliser. However, the collection and use of excreta from a SV latrine represents a higher health risk than the DVC latrine type. Even if the bottom of the excreta heap in the SV latrine has composted for 6 months, excreta at the top will still be fresh and farmers will, therefore, have contact with fresh excreta when they empty the full latrine. However, the majority of farmers believe that if they empty a SV latrine every 6 months they have met the government’s guidelines of the 6-month composting period and that the excreta is safe to be used as fertiliser.

Composting practises and guidelines

By mapping the annual agricultural production calendar for the surveyed households and their fertiliser use practices, it was found that 74% of the households had only 3–4 months available for composting excreta for at least one of the three crops cultivated per year. These households can, therefore, not meet the new

Vietnamese guidelines which require a minimum of 6-month composting time (Ministry of Health, 2005). However, the estimated composting time based upon the information on production calendar was quite different from the responses obtained from the household survey where more than 50% stated that they were composting excreta for at least 6 months as required by the national guidelines. This may be due to recall bias or possibly an interest by the household members to provide a response that follows the official policy.

Due to the short time span between fertiliser applications available for these households, three different intervention scenarios could be developed:

1. Change latrine type to a non-reuse system.
2. Only use human excreta as fertiliser for every second crop or only once per year, and use commercial NPK fertiliser for the remaining crops.
3. Use additives that increase pH to obtain a more rapid pathogen die-off inside the vault.

The success of the first scenario will be questionable since it has already been tried in several rural sanitation projects and evidence exists that the households are not always willing to use new latrines that do not accommodate excreta use (Water and Sanitation Programme, 2002). This has previously resulted in the removal of the fresh excreta from the latrine and will, therefore, pose a significant health hazard.

Intervention to scenario two, above, will probably have a better chance of success than scenario one, because the households are actually allowed to use the excreta. However, this creates two new problems. Larger families do not have enough space inside the latrine for 8 months to 1 year retention time; therefore, the excreta has to be removed during the composting process. The hygienic risk of this removal will, therefore, have to be addressed. Furthermore, we have found that the households perceive excreta to have additional qualities as compared with chemical fertiliser and this may make the farmers reluctant to comply with a guideline stipulating that excreta should only be applied on every second crop or only once per year.

If the compost is to be used only after 3 months of composting time, it can be assumed that the compost contains various pathogens (Chien et al., 2001; Feachem et al., 1983). To increase the pathogen die-off in the latrine temperature, moisture and pH are among the most important determining parameters (Carlander and Westrell, 1998). Some Eco-san latrines are designed to utilize the solar heating to increase microbiological die-off. However, in a Vietnamese context this would require a reconstruction and relocation of latrines often built in conjunction with the pigpen and may, therefore, not be a feasible option. The moisture content in the latrines is already kept low due to the tradition of

adding kitchen ash after each toilet visit. Therefore use of pH regulators may be the most relevant intervention to increase the helminth die-off.

The addition of ash in the latrine both lowers the moisture and thereby the smell, and increases the pH (Pecson and Nelson, 2005). Sixty-three per cent of the surveyed households added lime at regular intervals and, therefore, an intervention optimising the use of lime would only require a minimal behavioural change. Intervention scenario three may, therefore, have a better chance of success compared to scenarios one and two. However, there is a need to assess to what extent the current use of lime affects pH and the effect the current lime usage has on helminth egg survival.

It has to be mentioned that increasing the pH in the excreta will simultaneously decrease the nitrogen content, due to nitrogen stripping and evaporation. Thereby the nutrient values of the compost will decrease. Further, in the future it can be expected that kitchen ash will be less available when Vietnamese households start to use electrical cookers instead of firewood and coal. A substitute to kitchen ash for reducing moisture content in excreta must, therefore, be found if the DVC latrines are to remain a success.

It is important to assess the role of the domestic domain for transmission of helminth infections if effective control measures are to be established. Farmers using the DVC latrine will have limited contact with fresh excreta as the design allows for safe storage and partly composting in the vault. However, contamination of the immediate environment around the household will occur when emptying of the latrines in SV latrines and when the more or less composted excreta is carried to the fields by a yoke with two overflowing baskets. Considering the high concentration of more than 50,000 eggs per gram of faeces in heavily infected persons (Stephenson et al., 2000a), it is highly possible that emptying latrines and handling excreta in the household premises are associated with the spreading of large quantities of infected eggs and other pathogens present around the household environment. Further were the personal safety precautions in connection with handling latrine waste rather limited in the study area. Fifty per cent of the latrines were emptied by hand and shovel before the excreta was placed in baskets and carried either to the field or to the compost heap.

Conclusion

This study made use of a diversity of methods to better understand the practise of human excreta use in agriculture. Had we only made use of traditional interviews or questioners asked only about the households exact composting time for human excreta we

would have found that more than 50% of the farmers in the project area could live up to the Ministry of Health guidelines, but by analysing their actual cropping pattern and hereby fertiliser use it was found that 74% of them could not live up to the current guidelines. Hereby it is again stressed that by dealing with ecological/environmental systems in a field situation an interdisciplinary approach has to be taken in order to have a better overview of the circumstances.

The great majorities of the surveyed farmers used human excreta as fertiliser in agriculture and are likely to continue to apply this on their crops since this is seen as an important input to production and income generation. However, at present the prevailing agricultural practices and latrine designs do not make it feasible for the farming households to comply with the 6 months' minimum composting time outlined in the official national guidelines. It is recommended that these guidelines be revised through further research to include a component on the quantitative use of pH regulators in the latrines, i.e. amount of lime used in the latrine daily, to create a safe product within a maximum composting period of 3 months. It is believed that the situation experienced by the Vietnamese farmers with limited composting time available, can be transferred to especially China where a similar agricultural practise of fertilising with human excreta under the same climatic conditions are carried out.

It is believed that if the guidelines are developed and promoted in accordance with prevailing farmer perceptions and practices they can be effective. However, if they are not based on this approach and instead argue for interventions like rubber boots, abolishing household use of excreta, or 6 months' composting time, minimal health benefits can be expected.

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