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# Global Assessment of Manure Management Policies and Practices

E. Teenstra, T. Vellinga, N. Aektasaeng, W. Amatayakul, A. Ndambi, D. Pelster, L. Germer, A. Jenet, C. Opio, K. Andeweg



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Wageningen UR Livestock Research  
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In 2014 is een inventarisatie gemaakt van het dierlijke-mestbeleid in 34 landen in Azië, Afrika en Latijns Amerika, gevolgd door een diepgaande inventarisatie van het mestmanagement in de praktijk in Bangladesh, Viet Nam, Ethiopië, Malawi, Argentinië en Costa Rica. De inventarisaties tonen de belangrijkste drempels voor een verbetering van geïntegreerd mestmanagement en indentificeren zes kansen voor daadwerkelijke verbeteringen in beleidsontwikkeling en in de praktijk; met uiteindelijk doel de voedselzekerheid te verbeteren en gelijktijdig de methaanemissies terug te dringen.

In 2014 an assessment of livestock manure policies was performed in 34 countries in Asia, Africa and Latin America, followed by an in-depth assessment of manure management practices in Bangladesh, Viet Nam, Ethiopia, Malawi, Argentina and Costa Rica. The assessments revealed the key barriers for improving integrated manure management and identified six opportunities for actual practice changes to improve manure related policies as well as farm practices with the overall objective of improving food security while mitigating methane emissions at the same time.

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© 2014 Wageningen UR Livestock Research, P.O. Box 338, 6700 AH Wageningen, The Netherlands, T +31 (0)317 48 39 53, E [info.livestockresearch@wur.nl](mailto:info.livestockresearch@wur.nl), [www.wageningenUR.nl/en/livestockresearch](http://www.wageningenUR.nl/en/livestockresearch). Livestock Research is part of Wageningen UR (University & Research centre).

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Report 844  
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# Table of contents

	<b>Acknowledgements</b>	<b>7</b>
	<b>Summary</b>	<b>9</b>
<b>1</b>	<b>Introduction</b>	<b>11</b>
	1.1 Background	11
	1.2 CCAC and Short-Lived Climate Pollutants	13
	1.3 The Livestock and Manure Management Component	14
	1.4 Global Assessment of Manure Management Practices and Policies	15
<b>2</b>	<b>Enabling Environment for Manure Management</b>	<b>17</b>
	2.1 Manure Policies	17
	2.2 Incentive Framework	20
	2.3 Information, Knowledge and Expertise	20
	<b>2.4 Conclusions</b>	<b>22</b>
<b>3</b>	<b>Manure Management Practices</b>	<b>23</b>
	3.1 Bangladesh	24
	3.2 Viet Nam	25
	3.3 Ethiopia	26
	3.4 Malawi	27
	3.5 Argentina	27
	3.6 Costa Rica	28
	3.7 Conclusions	29
<b>4</b>	<b>Discussion &amp; Key Messages</b>	<b>31</b>
	4.1 Discussion	31
	4.2 Key Messages	32

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# Summary

The Livestock and Manure Management Component (LMMC) of the CCAC Agriculture Initiative to reduce Short-Lived Climate Pollutants (SLCPs) supports the adoption of integrated manure management practices across the globe by increasing knowledge and awareness, removing barriers to action and enhancing practice change.

Livestock play an important role in global food production and in agricultural and rural economies in many developing regions. While the livestock sector is one of the fastest growing subsectors of agriculture, it is also an important contributor to anthropogenic greenhouse gas (GHG) emissions, in which manure and manure management account for 10% of total livestock emissions.

Manure is a valuable source of nutrients, organic matter and renewable energy. However, manure management is often poor and as a consequence, nutrients and organic matter are lost, causing environmental and climate problems and threatening public health.

Technologies for and knowledge of integrated manure management are available; however implementation is often challenged by (1) a lack of awareness of manure's potential; (2) a lack of knowledge and a supporting knowledge infrastructure; (3) ineffective policies; (4) dispersed expertise; (5) a lack of resources and investments.

Integrated manure management encompasses all activities associated with management of dung and urine; from excretion; collection, housing, and storage; anaerobic digestion, treatment, transport to application, and includes losses and discharge at any stage along this 'manure chain'.

To-date, very little is known about manure management at a global scale. A global assessment has been performed to improve insight on manure management at farm level, barriers to adoption of integrated manure management practices, and understanding of the existing policies, institutional and incentive frameworks. The assessment targeted diverse regional and national key stakeholders ranging from farmers, extension workers, researchers and policy makers.

Regarding existing manure management practices, there is a wide variation. However, a common trend emerging from the survey is the difficulty in managing urine and liquid manure especially in non-mechanized situations and on smaller farms. Proper management of liquid manure requires investments in infrastructure. Labour availability was cited by several farmers as a constraint to improve their manure management.

Four key barriers have been identified in the assessment.

The first and most important is the limited awareness of the importance of integrated manure management in contributing towards food security and reducing SLCP emissions. The value of manure is often not recognised by farmers, local extension staff and policy-makers.

Additional to this, is the level of knowledge. This is often linked to a) the level of education of many small-scale farmers, in some regions the low level of literacy is still an obstacle; and b) the lack of a knowledge infrastructure, to support farmers in improving manure management. Knowledge development is not a one-off intervention, but requires continuous investment.

Thirdly, the limited access to financial credit and other incentives remains an important barrier especially for small-scale farmers who lack collateral to access credit to undertake investments. Proper integrated manure management is associated with high investments in capital, labour and knowledge which, on the short term, increases the costs of production.

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Finally, ineffective manure (or related) policies and legislation often do not support sound manure management. The main drivers for manure policies are focused on energy production or problems regarding environmental or public health issues. The fertiliser and soil improving value and the food security benefits of using manure are often not drivers for policy. Improved coordination between relevant ministries (e.g. Ministries of Agriculture, Energy, Public Health and Environment) is important for the development of coherent and holistic policies.

This assessment has provided an insight into the potential improvement strategies. An effective manure management improvement strategy, focussing on the added value of manure as a fertiliser, should focus on the following main barriers: the lack of awareness and knowledge, the access to credit and the development of customised solutions for simple manure storage and application equipment. In many countries, bio-digester programmes have proven to be a successful strategy. Manure policy should facilitate this strategy using a coherent approach, by balancing the potential fertiliser and energy value and the potential risks.

This global assessment provided not only insights on manure management and the barriers for improvement. It also identified (a) a number of opportunities where manure management can be improved: the Opportunities for Practice Change and; (b) the need to leverage stakeholder engagement to improve awareness and create networks targeted at enhanced engagement in improved manure management.

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# 1 Introduction

Manure is a valuable and largely untapped resource. Sound manure management practices enhance food security by making better use of nutrients in manure for soil fertilisation, while producing energy and reducing climate emissions. Proper integrated manure management is however not common practice in most livestock systems leading to loss of nutrients, environmental degradation, human health risks and emissions of greenhouse gases.

The Livestock and Manure Management Component (LMMC) of the CCAC Agriculture Initiative supports integrated manure management practices by increasing knowledge and awareness, removing barriers to action and enhancing practice change. This Global Assessment report provides an overview of manure policies and an in-depth assessment of on-farm manure management practices in three regions: Asia, Africa and Latin America. Although limited sources have been used due to constraints in time and resources, the assessments mostly confirm many experts' opinions and views and give a good picture of the present situation in the surveyed countries.

## 1.1 Background

Livestock play an important role in global food production and in agricultural and rural economies in developing regions. During the last decades, global production of meat, milk and eggs has expanded rapidly in response to a rapid growth in the consumption of livestock products. This increase in demand which has been particularly strong in developing regions has largely been driven by growing populations and incomes. This growth in demand for animal protein is expected to double in 2050.

Livestock is one of the fastest growing subsectors of agriculture: a doubling of demand for animal-source foods is expected for developing countries and a 70% increase for the world as a whole (Alexandratos and Bruinsma, 2012)<sup>1</sup>. While the livestock sector makes an important contribution to global food supply and economic development, it also uses significant amounts of natural resources and impacts on the environment.

### *Manure as a valuable resource*

In addition to being a by-product of livestock production, manure is a valuable resource and can be used for multiple purposes; as fertiliser for crop production and improved soil health, a source of energy, or as basis for construction material. While manure is a valuable source of nutrients and renewable energy, if poorly managed, it poses serious human health and environmental risks. Between 60% and 95% of the animal's nutrient intake via feed is excreted via dung and urine containing undigested carbon and nutrients. Manure may be disposed of as effluent, or collected, stored and used. Liquid manure (urine and slurry) is more difficult to collect and is often flushed into the environment. Many methods of manure storage emit large amounts of methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O), especially liquid manure storage. Direct discharge of animal manure into the environment emits nutrients, which can contribute to public health risks (e.g. waterborne diseases), biodiversity losses and economic losses (e.g. water treatment costs). In the absence of the implementation of adequate integrated manure management practices, these negative impacts of manure are poised to increase.

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<sup>1</sup> Alexandratos, N. & Bruinsma, J. 2012. World agriculture towards 2030/2050. The 2012 revision. Global Perspective Studies Team. ESA Working Paper No. 12-03. Rome, FAO.

<sup>2</sup> FAO. 2013. Tackling climate change through livestock – a global assessment of emissions and mitigation opportunities, by P.J. Gerber, H. Steinfeld, B. Henderson, A. Mottet, C. Opio, J. Dijkman, A. Falcucci & G. Tempio. Rome.

## **BOX I: Global developments affecting manure management**

Several global trends can be observed which have influenced manure management practices and manure policies:

(1) In recent decades, driven by population growth and urbanization, livestock production has increased rapidly. Most of the increase in production has come from industrial farms clustered around major urban centres. Particularly in developing regions, this rapid growth has been spurred by dramatic shifts in the nature and location of livestock production. Traditional mixed farming systems, in which farmers raise a few animals alongside their crops, have given way to large industrial operations. These large industrial production units import massive quantities of nutrients in the form of concentrate feed and produce far more manure than can be recycled as fertiliser and absorbed on nearby land, with negative consequences for environment and human health. Environmental and human health concerns are often key drivers for policy addressing manure issues. This also explains why manure management related policies often originate from non-agricultural ministries addressing single issues, and as a result do not always align with farm practices.

(2) Synthetic fertilisers have been credited with the enormous increase in crop yields and productivity during the 20<sup>th</sup> century. The introduction of synthetic fertilisers has also indirectly reduced the indigenous knowledge on integrated manure management in which manure is eventually used to fertilise crops. Using synthetic fertilisers provides farmers with an opportunity to easily correct any flaws in their crop production system without having to worry about the use (or misuse) of organic fertilisers. Synthetic fertilisers do not replenish the loss of soil organic matter, an important factor for healthy soils which also increases the resilience to future climatic change. A growing population with the means to improve their diet will ensure fertiliser consumption will increase. Currently some countries continue to subsidise synthetic fertiliser use, hence creating a non-stimulating environment for integrated manure management. It should be noted that the production of synthetic fertilisers consumes a lot of energy (e.g. nitrogen) and natural resources (e.g. finite stock of rock phosphate).

(3) Another recent trend is the emphasis on harvesting methane from manure (and other organic residues), induced by the desire to reduce methane emissions, to develop alternatives to fossil fuels; or to create better living conditions (cooking, saving time and firewood etc.) for households using biogas. Efforts at harvesting methane from manure have solely focused on the construction and installation of anaerobic digesters, neglecting the value of the digestate. Only in exceptional cases and often initiated by NGOs, is attention paid to the use and application of the digestate. Using the digestate however, is by its definition an integral part of integrated manure management. A related issue is the malfunctioning or non-functioning of many installed anaerobic digesters, implying that many estimates of the mitigation potential, based on the number of constructed digesters may be overestimating the actual emission reductions and other benefits.

### *Barriers for manure management*

Throughout the last decades, several trends have influenced developments in the livestock sector including the current manure management practices as well as the type of manure policy frameworks that have evolved (see Box 1).

Technologies for integrated manure management practices are available, but implementation is a challenge due to (1) a lack of awareness of manure's potential by some farmers and policy-makers; (2) a lack of an effective enabling environment (service infrastructure, policies); (3) dispersed expertise; (4) a lack of resources to invest in effective manure management; and (5) a lack of adequate market signals to spur investment in the products of effective manure management.

## 1.2 CCAC and Short-Lived Climate Pollutants

The Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants, hosted by UNEP, is a world-wide effort to reduce the emission of Short-Lived Climate Pollutants (SLCPs). The Climate and Clean Air Coalition (CCAC) was set-up with the main objective of addressing short-lived climate pollutants by:

- Raising awareness of short-lived climate pollutant impacts and mitigation strategies.
- Enhancing and developing new national and regional actions, including by identifying and overcoming barriers, enhancing capacity, and mobilizing support.
- Promoting best practices and showcasing successful efforts.
- Improving scientific understanding of short-lived climate pollutant impacts and mitigation strategies.

The CCAC supports initiatives to reduce SLCP emission in various sectors, i.e. oil & gas, waste, bricks, cookstoves, HFCs, urban health and agriculture.

Short-Lived Climate Pollutants are air pollutants that have a relatively short lifetime in the atmosphere - a few days to a few decades - and have a warming effect on climate. They include black carbon (BC), methane (CH<sub>4</sub>), tropospheric ozone (O<sub>3</sub>), and hydrofluorocarbons (HFCs). Most of them are also hazardous air pollutants with detrimental impacts on human health, agriculture and ecosystems. Tropospheric or ground level ozone (O<sub>3</sub>), of which CH<sub>4</sub> is one of the precursors, is a harmful pollutant that has detrimental impacts on human health and plants and is responsible for important reductions in crop yields. O<sub>3</sub> also reduces the ability of plants to absorb CO<sub>2</sub>, altering their growth and variety. SLCPs are responsible for a substantial fraction of near term climate change, with a particularly large impact on sensitive ecosystems of the world.

Agriculture and related land use practices are a major source of SLCP emissions, constituting approximately 11% of all global greenhouse gas emissions. The agriculture and forestry sectors are responsible for roughly 40% of global black carbon emissions and approximately 50% of global anthropogenic methane emissions.

The main sources of global anthropogenic methane emissions include enteric fermentation in ruminant species (29%), rice cultivation (10%), and decomposition of manure under anaerobic and warm conditions (4%). Agricultural fields (4%), forests (16%), and grasses and woodlands (20%) are responsible for approximately 40%, or 3.0 million metric tons, of global black carbon emissions of 7.6 million metric tons per year.

**Table 1**

*Estimated development of methane emissions from animal manure in Megatons CO<sub>2</sub> equivalent.  
(Source: US EPA)*

	2000	2015	Relative change 2015 to 2000	2030	Relative change 2030 to 2015
Western World	103,252	106,518	+3%	103,113	-3%
Sub-Saharan Africa	16,066	21,729	+35%	26,616	+22%
Central & South America	21,867	25,981	+19%	29,224	+12%
South & East Asia	57,989	61,376	+6%	72,593	+18%
Total LMMC Regions	95,922	109,086	+14%	128,434	+18%

Detailed information based on in-situ measurements covering in the non-western world is virtually non-existent. The U.S. Environmental Protection Agency (EPA) has estimated current and future methane emissions (in Megatons CO<sub>2</sub>-equivalents) from animal manure in the world (see Table 1). From 2000 to 2015 in the western world (Europe, North America plus Australia and New Zealand)

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methane emissions from manure show a slight increase (3%) and a stronger increase (14%) in the regions covered by the LMMC. Particularly in Sub-Saharan Africa and Central & South America the estimates show significant increases which are mainly caused by an increase in cattle numbers. It is estimated the emissions of the three LMMC regions will keep increasing, with a forecasted increase especially in South & East Asia caused by a substantial growth of the pig sector.

Addressing these short-lived climate pollutants can have immediate, multiple benefits. Reducing SLCPs will have short-term benefits for human health and the environment as well as contribute towards slowing the rate of climate change within the first half of this century. Recognising that mitigation of the impacts of short-lived climate pollutants is critical in the near term for addressing climate change and can contribute towards public health, food and energy security, the Climate and Clean Air Coalition's Agriculture Initiative is supporting the Livestock and Manure Management Component to address methane emissions from livestock manure.

### 1.3 The Livestock and Manure Management Component

The overall goal of the Livestock and Manure Management Component (LMMC) is to integrate manure management practices into livestock systems and improve existing practices to reduce SLCPs and other harmful emissions to the environment, capture methane as an energy source, and optimise nutrient utilisation for crop production by managing and removing barriers to action with a view toward enhancing food security and sustainable development.

The Livestock and Manure Management Component focuses its actions in Africa, South and Southeast Asia and Latin America. The project is coordinated by a Central Hub (consisting of the Food and Agriculture Organisation of the UN (FAO) and Wageningen UR), working in close collaboration with three Regional Centres (Stockholm Environment Institute [SEI] in Bangkok, the International Livestock Research Institute [ILRI] in Nairobi, and the Tropical Agricultural Research and Higher Education Center [CATIE] in San Jose). Together the LMMC identifies opportunities and conducts work in regions, builds networks and partnerships, gathers information, and implements projects. The project organises activities among key stakeholders to reduce emissions of SLCPs through:

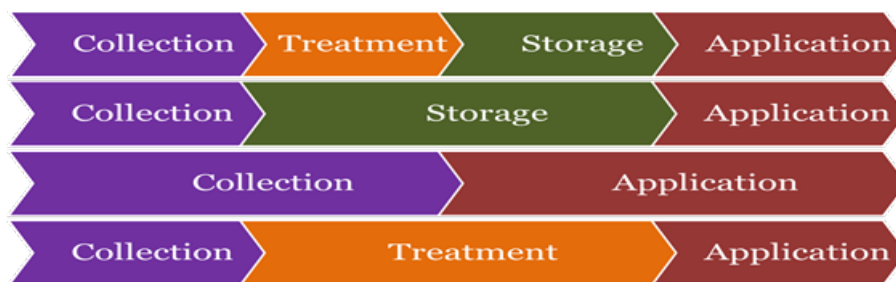
- raising awareness of manure management options at the level of policy, private sector and farmers organisations through outreach and communication;
- establishing networks to exchange manure management information, connect people, and forge partnerships;
- establishing a roster of experts to provide targeted technical assistance and training; launching projects and partnerships to improve manure management by providing information, experts, knowledge exchange, and access to resources; and
- establishing an internet-based information infrastructure to serve as a repository for global and regional knowledge on manure management.

Given the current situation and the importance of manure as a fertiliser and a source of energy and the potential for reducing emissions, this project focuses on opportunities for practice change addressing the key barriers to improve integrated manure management. This Global Assessment Report is the first step in identifying the current situation regarding integrated manure management and the barriers to improvement.

## BOX II: Integrated Manure Management Framework

Integrated manure management is important to mitigate GHG emissions, but also offers important benefits such as a provider of nutrients and organic matter for agricultural soils to maintain soil quality and fertility. Sound manure management also contributes to producing renewable energy and reducing nutrient losses from livestock production systems and reducing other detrimental environmental impacts of livestock production such as air and water pollution. Although manure management accounts for only 10% of total livestock emissions (Gerber et al., 2013), it offers key opportunities for mitigation that also deliver on other economic, social and environmental objectives.

Manure management encompasses all activities regarding dung and urine from excretion; collection, housing, and storage; anaerobic digestion, treatment, transport to finally application, and includes losses and discharge at any stage along this 'manure chain'. There is wide variation in livestock systems all over the world; production varies in size, intensity, land use and productivity. As a consequence, manure management shows many variations ranging from large lagoons for storage of liquid manure to small compost heaps with solid manure and other farm waste on smallholder farms. Despite the wide variation, a basic structure of the manure chain can be recognised, as depicted in the figure below.



Examples of manure chains always begin at manure collection and ends with application.

Manure contains nutrients and organic matter and is a prerequisite for maintaining and improving soil health and soil fertility. Hence, application of manure as a fertiliser is essential in maintaining and improving food security and livelihoods all over the world. We therefore state: 'Manure is food security'.

Besides the importance for nutrient cycling in agricultural systems, manure can act as a source of energy for small and large-scale energy generation and parallel to it, reducing methane emissions from manure. Especially in small-scale application, it will highly contribute to improving public health and to providing cheap fuel for many smallholders. Additional, black carbon emissions from burning dung or fuel wood can be reduced.

## 1.4 Global Assessment of Manure Management Practices and Policies

The assessment of manure management practices and policies was conducted in 2014. The ultimate objective was to document existing manure management practices, identify the barriers to farmer adoption of improved integrated manure management practices with the co-benefits of mitigating SLCPs and improving soil health and crop production; and thus food security. These barriers also present opportunities for practice change. The CCAC Agriculture Initiative has identified five key areas for action to overcome barriers including: (1) gathering knowledge, (2) raising awareness, (3) partnerships/networks, (4) policy and capacity development and (5) support of financing. Box II summarises the concept of integrated manure management.



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## *Why a Global Assessment?*

Optimal management of livestock manure remains a major challenge for the continuous and sustainable development of the livestock sector. To-date, very little is known about manure management at global scale. Much of the information is fragmented and most research on manure focuses on crop responses to fertilisation. Only a few surveys exist on the current manure management practices and/or the role of policy and the knowledge and financial infrastructure (the enabling environment) in driving integrated manure management. Assessing the exact nature of the problem is an important first step to develop the right actions to improve integrated manure management.

To improve insight on integrated manure management practices at farm level, barriers to adoption of integrated manure management practices, and understanding of the existing policies, institutional and incentive frameworks, this global assessment targeted diverse key stakeholders ranging from farmers, extension workers, researchers and policy makers.

## *Methods*

The assessment was performed in two phases. Phase 1 reviewed national policies and enabling environment (institutional and incentive structure) for integrated manure management in 34 countries. Phase 2 looked at current on-farm manure management practices in six countries. These in-depth surveys reveal manure management practices adopted by farmers, and – more importantly – the reasons why.

Due to the time frame of the project, the scoping study in Phase 2 was performed for a limited number of countries in South and Southeast Asia, Sub-Saharan Africa and in Latin America. Three targeted questionnaires focusing on policy, farmers' knowledge, infrastructure, institutions and farm practices were designed. An additional in-depth questionnaire specifically targeting farmers was designed to identify existing manure management practices and understand farmer's perceptions of manure management. These in-depth questionnaires were administered in six countries where opportunities for practice change have been identified.

## *Reading this report*

Chapter 2 of this report presents an overview of the enabling environment for manure management in 34 countries.

In Chapter 3, the results of the in-depth study of on-farm manure management practices in surveyed areas in the six countries are presented. Results of the Global Assessment are presented in Chapters 2 and 3 in a concise way. Detailed information can be found in a documentation report.

Chapter 4 discusses the results presented in Chapters 2 and 3, and summarises a number of key messages.

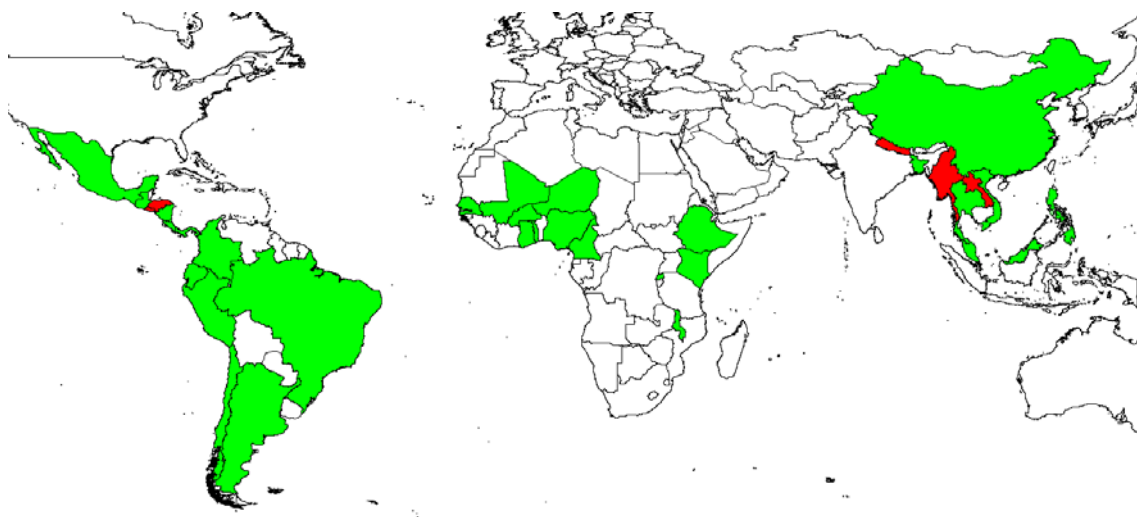
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## 2 Enabling Environment for Manure Management

In Phase 1 of the Global Assessment, two questionnaires were administered to representatives in Central and South America, Sub-Saharan Africa and South and Southeast Asia drawing on the networks of the respective Regional Centres in Costa Rica, Kenya and Thailand. The questionnaire included questions on the manure policies and the enabling environment for manure management. In the 34 countries, the questionnaire was administered to professionals and experts working in ministries, research institutes, universities, (international) NGOs and in the private sector. The main objective of the assessment was to have an overview of the current enabling environment (policy, financial and technical infrastructure and incentive framework), affecting manure management on livestock farms.

### 2.1 Manure Policies

Thirty out of the 34 countries in the survey have national policies related to manure management. The map in Figure 1 shows the responding countries with and without manure related policies.



**Figure 1.** Surveyed countries with (green) and without (red) manure management related policies.

With the exception of Malawi, Senegal and Malaysia, where only the Ministry of Agriculture is involved, policies are often defined by the respective Ministries of Agriculture and of Environment. The involvement of the Ministries of Energy and of Public Health in defining manure policy is also not uncommon. Table 2 summarises the current situation in the 34 countries in the survey.

Although soil degradation and low crop productivity are quite common in many of the surveyed countries, broader environmental goals such as achieving methane emissions reductions and meeting renewable energy targets, or lowering of energy costs at farm level were found to be key drivers of manure (or manure related) policies. Rarely do the policies promote holistic approaches to manure management, or emphasise the value of manure as a fertiliser and supplier of organic matter. In addition, several policies only target specific elements of manure management such as manure storage, application and disposal.

A key observation of the respondents is the lack of coherence between the total set of rules (Figure 2). This phenomenon was found to occur especially in countries where multiple ministries were involved in the policy design regarding manure. Overall, legislation is often not complementary and sometimes even contradictory and does not always fit with common farm practices. Figure 2 shows that only Viet

Nam and a few West African countries appear to have a coherent set of rules for manure management.

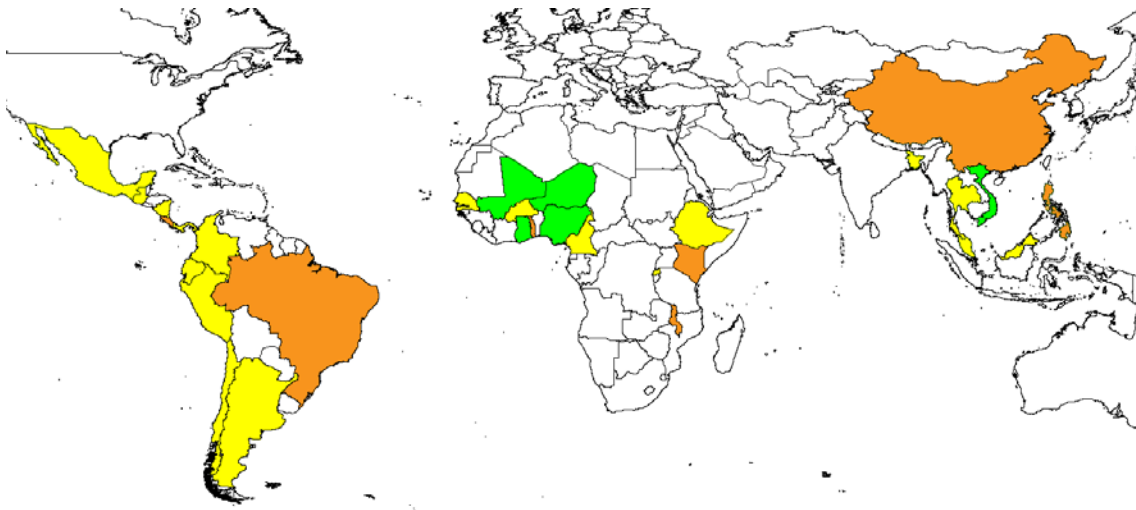
Table 2

Overview of the Manure Policy frameworks of 34 countries based on submitted questionnaires

Country	Manure Policy	Components addressed by the							Ministries involved			
		stocking rate	excretion	storage	treatment	digestion	application	discharge	Agriculture	Environment	Energy	Public Health
<i>Latin America</i>												
Argentina	Yes	x	x	x	x				x	x		
Brazil	Yes	x	x	x			x		x	x		
Chile	Yes	x		x	x	x	x	x	x	x	x	x
Colombia	Yes			x	x		x	x	nd <sup>a</sup>	nd	nd	nd
Costa Rica	Yes	x	x	x	x	x	x	x	x	x	x	x
Ecuador	Yes	x			x	x	x		x	x		x
El Salvador	No	n	n	n	n	n	n	n	na	na	na	na
Guatemala	Yes			x				x	x	x		x
Honduras	No	n	n	n	n	n	n	n	na	na	na	na
Mexico	Yes	x			x	x		x	x	x	x	
Nicaragua	Yes	x	x		x	x			x	x	x	
Panama	Yes	x	x	x	x	x	x		x	x	x	x
Peru	Yes	x	x		x		x		x	x	x	x
<i>Sub-Saharan Africa</i>												
Burkina Faso	Yes	x	x	x	x	x	x		x	x		
Cameroon	Yes	x	x		x	x	x		x	x	x	x
Ethiopia	Yes	x					x	x	x	x	x	
Ghana	Yes		x	x	x	x	x	x	x		x	
Kenya	Yes	x	x	x	x	x			x	x	x	x
Malawi	Yes			x	x				x			
Mali	Yes	x	x	x			x		x	x		x
Niger	Yes	x	x	x	x	x	x		x	x		x
Nigeria	Yes		x	x		x	x	x	x	x		x
Rwanda	Yes	x	x	x	x				x	x		x
Senegal	Yes	x	x	x	x		x		x			
Togo	Yes						x	x	nd	nd	nd	nd
<i>South &amp; East Asia</i>												
Bangladesh	Yes	x	x	x	x	x	x	x	x	x	x	x
China	Yes	x	x	x	x	x	x	x	x	x	x	x
Lao PDR	No	n	n	n	n	n	n	n	na	na	na	na
Malaysia	Yes	x	x	x	x	x	x	x	x			
Myanmar	No	n	n	n	n	n	n	n	na	na	na	na
Nepal	No	n	n	n	n	n	n	n	na	na	na	na
Philippines	Yes	x	x	x	x	x	x	x	x	x		
Thailand	Yes	x	x	x	x	x	x	x	x	x	x	
Viet Nam	Yes	x	x	x	x	x	x	x	x	x	x	x

<sup>a</sup> no data reported

<sup>b</sup> not applicable



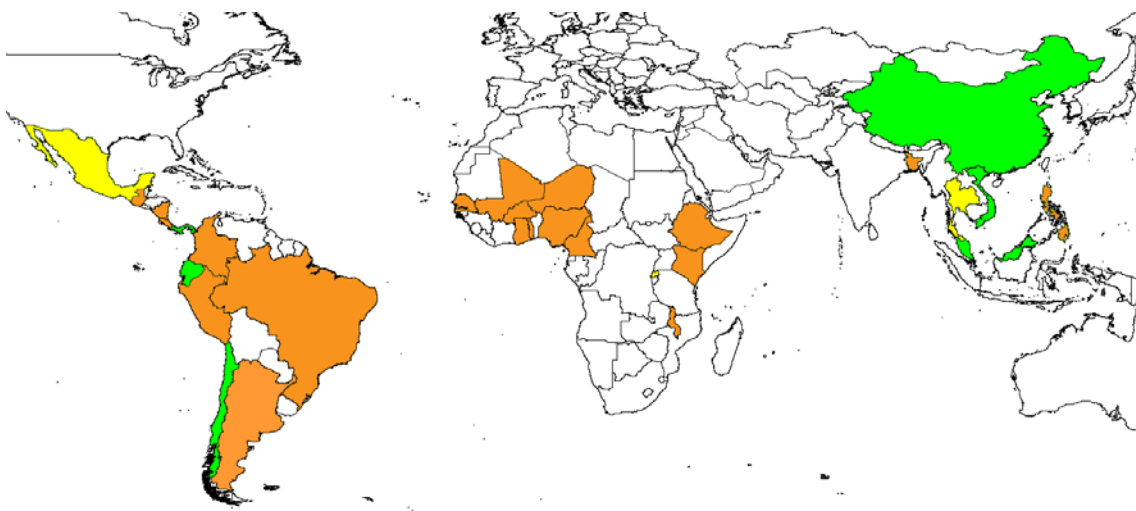
**Figure 2. Level of coherence in the manure legislation**

**Green** = very good: very complementary; holistically approached national policy in which relevant ministries have adapted their departmental policies to each other's responsibilities resulting in an integral manure management policy (taking into account i.e. human health, different pollutions, use of natural resources etc.)

**Yellow** = moderate: some contradicts, i.e. environmental policy in line with proper manure management, but no connection with human health policies; or overall no conflicting policies but maybe still some policy gaps remain to be solved.

**Orange** = bad/none: contradictive; no holistically approached national policy, policy often based on single issues by responsible ministries, with as a result conflicting legislation.

Having legislation on manure management is one thing, enforcing it is a whole other issue. Generally, enforcement of manure policies is regarded as being weak (Figure 3). Particularly in situations where multiple ministries are involved, there is often a lack of coordination between the ministries and their enforcing bodies resulting in unclear procedures and penalties. Enforcement of regulation was found to vary across the surveyed countries; respondents from China, Viet Nam, Malaysia, Panama, Ecuador and Chile indicated well-coordinated law enforcement.



**Figure 3. Level of enforcement**

**Green** = very strict: non-compliance immediately leads to penalties;

**Yellow** = moderate; strict but first a warning and a time frame within which improvements have to be made;

**Orange** = weak/none: rules are not enforced or just on selected farms (based on size, location etc.).

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It should be noted that the absence of manure policy does not indicate the absence of good manure management practices. For instance, despite having no manure policy, farmers in El Salvador have for several years applied manure to coffee. In addition, pig and poultry manure is used in organic crop production, and a number of the larger livestock and poultry farms with bio-digesters use the digestate in crop production.

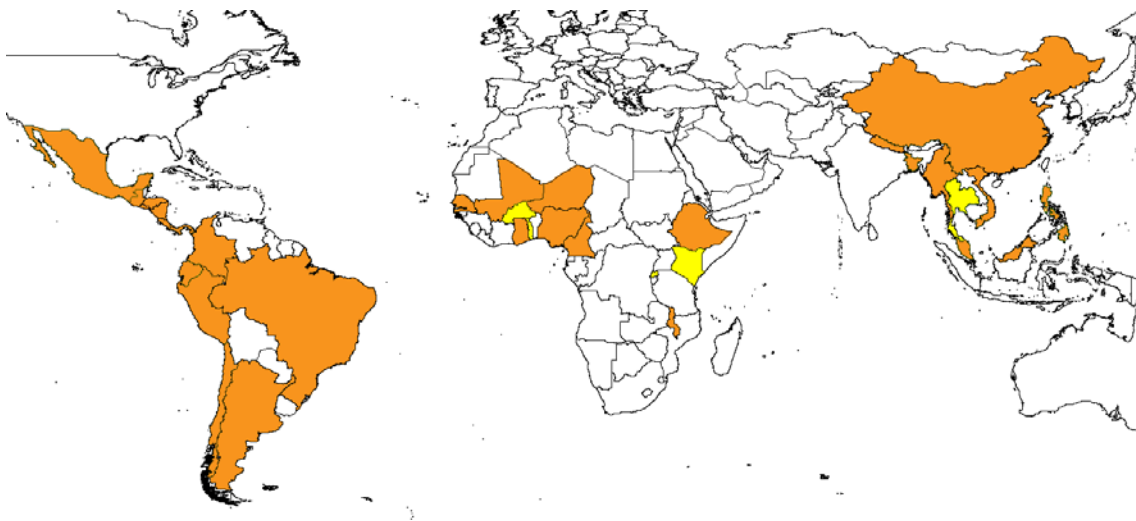
## 2.2 Incentive Framework

A number of services to farmers is available in most countries, ranging from extension by governmental and non-governmental organisations, vocational training, to laboratory services for analysis. Small-scale farmers reportedly take advantage of these services at least as much as medium-size and large farms, suggesting that the services are not significantly biased toward a particular farm size. Some governments however seem to place more emphasis on middle and large-scale farms, notably in Viet Nam, Nepal and Philippines. In Africa, such services for smallholder farms are more often provided by NGOs rather than by national governments. Contractors, large farm-equipment and laboratory facilities are often available but tend to have a higher use by large and medium-sized farms.

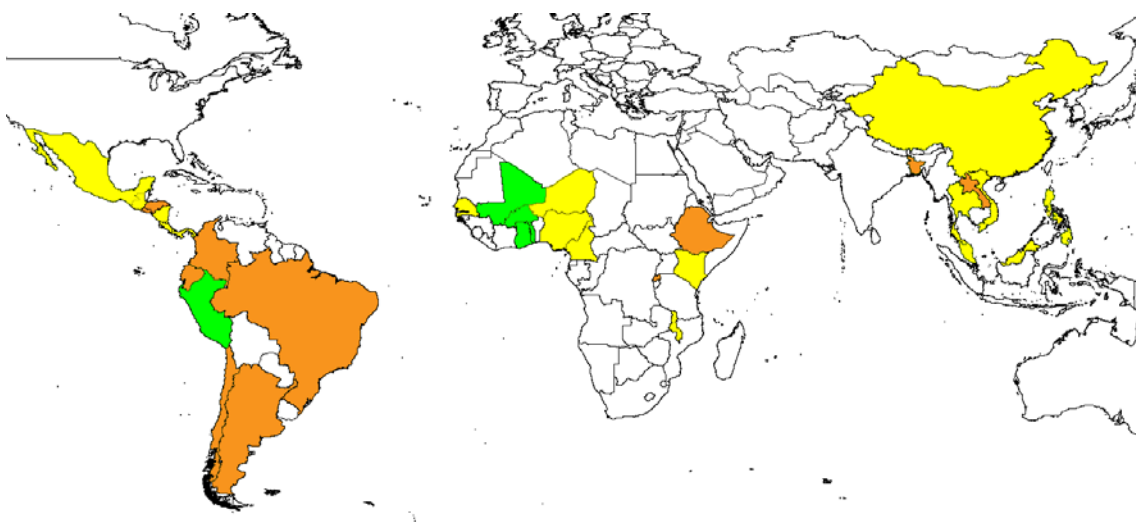
Many countries utilise subsidies and other incentives such as soft credit or credit guarantees as incentives for farmers. Findings from the survey show that often financial incentives target the installation of anaerobic digestion. However, not all countries use the same set of incentives to stimulate best practices in manure management. In Chile, for instance, dairy farmers can earn 'environmental bonuses' if they apply proper manure management. It was observed that subsidies are prevalent in East African and less in West African countries. Incentives may also be provided by private sector enterprises, this was specifically reported in some Latin American countries. In Ethiopia, the use of synthetic fertilisers is promoted instead of the use of manure.

## 2.3 Information, Knowledge and Expertise

Small-scale farmers are consistently reported to be less knowledgeable on manure management than medium-size and large-scale farmers. The knowledge level of farmers was found to increase with farm size and seems to be related to the level of education. Extension service providers and trainers tend to have higher levels of knowledge due to the higher education and of training obtained. Figures 4 and 5 give an indication of the knowledge level of small and large scale farmers and field extension staff. In addition, integrated manure management tends to be most present in school curricula at the level of agricultural universities and vocational training courses.



**Figure 4. Reported knowledge level of small-scale farmers and lower educated people**  
**Green** = high: know it all  
**Yellow** = moderate: know enough  
**Orange** = low: know a little bit but not enough.



**Figure 5. Reported knowledge level of middle and large-scale farmers and higher educated people**  
**Green** = high: know it all  
**Yellow** = moderate: know enough  
**Orange** = low: know a little bit but not enough.

#### Communication channels

All farmers have access to media, including television, newspapers, farmers' magazines and social media. Although radio was not included in the questionnaire, it was cited as the primary medium for reaching farmers, especially the smallholder farmers. Social media, magazines and journals were found to be commonly used by middle and large-scale farmers.

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## 2.4 Conclusions

The global assessment of the policies and the enabling environment reveals global differences in the approach to manure management. Responsibilities and successive actions differ between policy-makers and farmers; whereas policy addresses national issues, farmers mainly focus on the short-term returns on investments. Higher incomes and thus improved livelihoods and food security, are main driving forces of farmers. And although reduction of SLCPs may have positive effects in the near term, this is not the primary concern of farmers. This is a force field in which both policy-makers and farmers have to be aware of each other's responsibilities.

It is fair to conclude that stakeholders in the enabling environment with strong commercial objectives are mainly interested in supporting government initiatives if they are able to realise a profit. Non-commercial stakeholders are more likely to be receptive to support national policy development and implementation. Findings from Africa illustrate this point where non-commercial stakeholders (e.g. NGOs) tend to pay more attention to smallholder farmers than to middle and large-scale farmers.

### *Manure Policy*

1. Legislation is often developed by policy-makers with no or limited knowledge of existing farm practices and driven by broader national goals. Findings show that:
  - a. Overall legislation is often not complementary and even sometimes contradictory.
  - b. Legislation is often not aligned with common farm practices.
  - c. Often the legislation shows gaps (single-issue solutions).
2. Manure legislation is seldom enforced due to weak coordination between ministries and their enforcing bodies.
3. Unclear rules and penalties for non-compliance leave much room for personal interpretation by government officials and may lead to arbitrariness in treatment.

### *Incentives*

4. Subsidies, (soft) credit and credit guarantees are strong incentives for on-farm investments. This has been proven by the bio-digester campaigns in various countries. It would be wise to extend this to the complete chain of manure management, including storage and application.
5. Often farm-equipment is available, but due to the high investment and maintenance costs, only larger farms are able to invest in on-farm machinery and infrastructure.

### *Knowledge*

6. Overall knowledge levels of smallholder farmers and local extension staff on integrated manure management is low. Knowledge levels on larger farms seem higher and seem positively linked with an on average higher education.
7. The knowledge gap between farm practice and the higher education institutes implies a dis-function of the extension system.
8. Focusing exclusively on anaerobic digestion e.g. to mitigate SLCPs from manure, undermines the development and implementation of alternative solutions. Utilising and improving the knowledge on bio-digester infrastructure provides a good opportunity to promote integrated manure management.

### 3 Manure Management Practices

Based on the preliminary results from the national level assessment presented in Chapter 2 and the regional knowledge and experience, the Regional Centres each selected two countries on which to focus further research and within these countries, survey sites with a potential opportunity for change were identified. More in-depth information from these regions should reveal the current manure management practices and barriers and provide a baseline and justification for the LMMC to financially support opportunities for practice change in the respective countries. The six identified countries are Viet Nam and Bangladesh for Asia, Ethiopia and Malawi for Africa and Argentina and Costa Rica for South and Central America.

#### Information gathering

In order to examine the on-farm manure practices, information was gathered in two steps. First, the Regional Centres consulted local experts using a general questionnaire on the current farm practices and thereafter in a semi-structured interview. This led to the second step in which a minimum of 10-15 farmers were interviewed with an in-depth questionnaire. Respondent farms were selected based on the estimated contribution of the livestock system to SLCP emissions, in which the number of animals and the time the animals spent in confinement were the most important factors. Given the limited time and resources, the in-depth interviews were designed to provide a general overview.

#### General country information

A general overview of the livestock densities, population densities and production per hectare of the selected countries are presented in Table 3.

The surveyed countries in Asia both have high population densities and stocking densities and a moderate to high percentage of the population active in agriculture. In Bangladesh, cattle and poultry densities are high, while in Viet Nam, pigs have a high density, especially compared to other countries.

**Table 3**

*Stocking densities, population densities, net production per hectare and percentages of male and female labour in agriculture. Data from FAOstat, January 19, 2015.*

Countries	Livestock density (heads/km <sup>2</sup> )			Population density people/km <sup>2</sup>	Net prod/head (X 1,000 \$)	Rural population (%)	economically active in agriculture (%)		In depth interviews farmers (#)
	Cattle	Pigs	Chicken				Male	Female	
Bangladesh	269	0	3054	1743	12	72	37	57	21
Viet Nam	75	250	2975	855	39	70	62	64	17
Ethiopia	150	0	138	224	25	83	81	74	23
Malawi	20	39	296	291	10	84	64	94	20
Argentina	33	2	72	30	286	8	11	2	11
Costa Rica	73	23	1117	162	134	36	20	5	23
<b>TOTAL</b>									<b>115</b>



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In the selected countries in Africa, the population density is comparable to each other and much lower than in Asia. The stocking density of cattle in Ethiopia is relatively higher compared to other African countries, but still not as high as in Bangladesh. No pigs and relatively little poultry can be found in Ethiopia. In Malawi, the cattle density is much lower, but that of pigs and poultry are higher compared to Ethiopia. In both countries most of the economically active people can be found in agriculture.

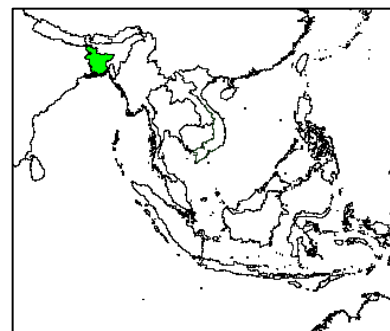
Population densities in the Latin American countries are much lower than in the African and Asian countries. Cattle density in Argentina is comparable to Viet Nam, but still lower than in Ethiopia and Bangladesh. Densities of pigs and poultry are low in Argentina. In Costa Rica, stocking densities are higher than in Argentina, but still much lower than in the Asian countries. The fraction of active people in agriculture is much lower than in other continents, and the participation of women in agriculture is low.

The relatively high stocking densities of cattle and pigs in Asian countries indicate that manure can be a problem in those regions compared to African and Latin American countries. The high fractions of people active in agriculture indicate that most of the agriculture is practiced on small farms with low mechanisation levels and a high labour demand. In Bangladesh and Malawi, the fraction of women engaged in agriculture is much higher than the fraction of men active in agriculture; this points to an important target group for knowledge transfer. The difference in agricultural structure is clearly shown by the agricultural labour and the net productivity per hectare. In Costa Rica and Argentina, land and labour productivity are much higher compared to the African and Asian countries.

Subsequent sections present the findings of the expert interviews and identified opportunities for practice change per selected countries.

### 3.1 Bangladesh

Bangladesh has 21 million households with livestock (cattle, buffalo, goat, sheep, or poultry) of which 19 million farms with poultry and 10 million farms with cattle and buffalo. Mixed crop-livestock systems are the most prevalent farming system. The survey was conducted in different regions of Bangladesh covering irrigated and rain-fed areas under humid and sub-humid areas. In total, 21 in-depth interviews were conducted on mixed farms with livestock.



#### *Summary of Findings*

Although some farmers collect urine and liquid manure, virtually all is discharged. More value is given to solid manure; the experts' assessment states 70-80% of the farmers store solid manure in uncovered heaps of which roughly 50% is used as crop fertiliser and 40-50% as fuel for cooking. Although some extra value is given to solids from cattle, and which is largely used for crop fertilisation, solid manure from other animal species and urine and liquid manure in general were mostly regarded of no value.

The survey identified the lack of sufficient farm labour to engage in manure management and insufficient collateral to access credit as important constraints to proper on-farm manure management. This might also explain why there has been low investment in improving manure management in the last five years. And although 80% of the farmers did receive some information during this period, it seems fair to conclude that information provided was either insufficient or inappropriate since 75% of the respondents regarded the lack of information as a key constraint to integrated manure management. About 40% of the respondents cited Illiteracy as a major constraint to the dissemination and uptake of knowledge.

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### *Identified Opportunity for Practice Change*

The inventory of policy, knowledge, incentives and manure management practices have identified an opportunity for improvement. The specific opportunity is that Bangladesh is one of the CCAC members that is working on the SNAP initiative of the CCAC: Supporting National Planning for Action on SLCs. SNAP has the objective to support rapid and large-scale implementation of SLC mitigation at the national level. Two of the abatement measures selected for reducing black carbon and methane emissions in the Bangladesh National Action Plan under SNAP were related to biogas production from livestock and poultry, namely 'substitution of biomass cook-stoves with stoves using clean-burning fuel (biogas)' and 'control of methane emission from livestock through anaerobic digestion of manure from cattle and poultry'.

Currently, for SNAP the primary responsibility in the country has been allocated to the Ministry of Power Energy and Mineral Resources, the Ministry of Environment and Forest and the Ministry of Commerce.

The LMMC has in turn identified additional key stakeholders to engage in this process, including the Bangladesh Livestock Research Institute (BLRI), Department of Livestock Services, Ministry of Fisheries and Livestock, and Ministry of Local Government & Rural Development and Cooperatives. The added value of cooperation between the OPC and the SNAP initiative, therefore, will be strengthening the linkages between the different institutes and ministries with the aim of developing a coherent policy and strategy that effectively addresses integrated manure management.

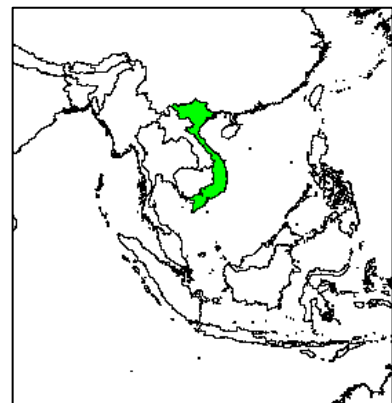
In addition, the LMMC can help to inform on the best practices available on the ground and how those can feed into the national policy making; SNAP provides a mechanism for up-scaling.

This can build on the current on-going efforts of the Bangladesh government to promote and support the installation of community based bio-digesters, and existing farm-level training framework which can be broadened with relevant components of integrated manure management once these components are integrated in the National Action Plan.

## 3.2 Viet Nam

The survey was conducted in the Mekong Delta region of Viet Nam. Within this area, mixed crop-livestock systems are predominant in which poultry are found on about three quarters of the farms, pigs on half of the farms and cattle and buffaloes on 15 % of the farms.

In total, 17 in-depth interviews were conducted on landless livestock farms and mixed farms with livestock.



### *Summary of Findings*

According to the expert assessment in Viet Nam, the majority of large and medium-scale farms have bio-digesters installed over the last five years. 70-90 percent of the digestate is used for on-farm fertilisation or aquaculture; regardless of farm size. Nevertheless, 70% of the small-scale farm was found to discharge urine. With the exception of a few cattle farmers, 90% of the interviewed farmers do not regard manure as a valuable fertiliser. About 50% of the interviewed farmers have improved their manure management, mainly through installation of a bio-digester. The main driver for manure management improvement was improved human health, which obviously is closely related to the extension messages. Broader environmental considerations (for odour and water quality) were cited as important drivers for adoption of manure management practices. This survey clearly indicates that farmers are not aware of the nutrient (and economic) value of manure, including digestate from bio-

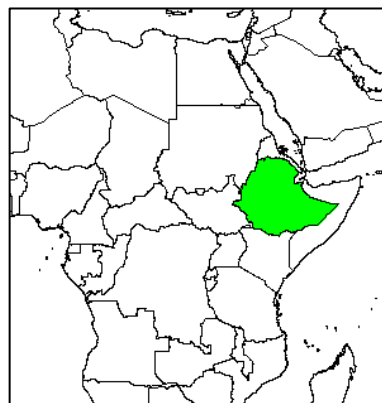
digesters. Television, group meetings and bi-lateral contacts were identified as key source of information for farmers, in which farmer-to-farmer exchange is a major source of information.

#### *Identified Opportunity for Practice Change*

Manure management of farmers can be optimised by raising awareness and knowledge about the effective use of manure including bio-slurry as a fertiliser, and the additional co-benefits that it brings related to increased productivity, food security and reduced environmental risks. This can be achieved through the development of a training module on integrated manure management to be used in future trainings for technicians and farmers with and without a bio-digester. The module should connect with the farm-level trainings of the current National Biogas Programme and address farmers currently without bio-digesters.

### 3.3 Ethiopia

Oromia (Fiche) and south regions (Awassa) were chosen for the in-depth interviews because they are the regions with the highest livestock densities and number of animals in confinement in Ethiopia. It is also expected that these regions will have the highest growth rates in terms of animal numbers as a consequence of rapidly growing cities and increasing demand for livestock products. It is important to note that confining animals, especially cattle in Ethiopia is not only meant to shelter animals but most importantly, to protect from theft and predators. The animals are usually grazed in communal grazing lands during the day. With the exception of specialised poultry farms, all farmers keep local poultry which scavenge around the household during the day and are confined at night. In total, 23 in-depth interviews with farmers were conducted.



#### *Summary of Findings*

In both regions urine and liquid manure is not collected. However, manure management practices were found to vary between the two areas.

In Fiche, according to the experts, 50-80% of the solid manure was dried and used as fuel for cooking; meanwhile, only three of the 11 interviewed farmers in Awassa partly used manure as fuel. As a consequence in Awassa farmers used more manure for fertilisation of crops. It was noticed that farmers further away from cities had easier access to firewood and therefore the use of manure as fuel was of less importance. On the other hand, all interviewed farmers considered manure as having no or limited fertiliser value.

Lack of knowledge on manure management was found to be widespread. The extension system in Ethiopia heavily relies on government extension workers and improving manure management is also not encouraged by extension workers because their performance is partly based on the amount of synthetic fertiliser they distribute. The survey also revealed inconsistencies in policies that impact manure management; while the Ministry of Energy and Water supports the installation of farm household bio-digesters and provides farm-level training on its use, the Ministry of Agriculture promotes the use of synthetic fertilisers, which therefore acts as a disincentive in promoting the use of manure and bio-slurry as fertilisers. 60 Percent of the interviewed farmers indicated that a lack of regulation was a crucial institutional constraint for optimal manure management. About 40% of the Ethiopian interviewees indicated that illiteracy proved to be a crucial constraint in accessing the available information.

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### *Identified Opportunity for Practice Change*

Development of a coherent manure policy (involving key stakeholders e.g. the Ministries of Water and Energy and of Agriculture), including training components on bio-digester maintenance and integrated manure management resulting in proper manure management are key entry points and have been identified as an opportunity for practice change.

## 3.4 Malawi

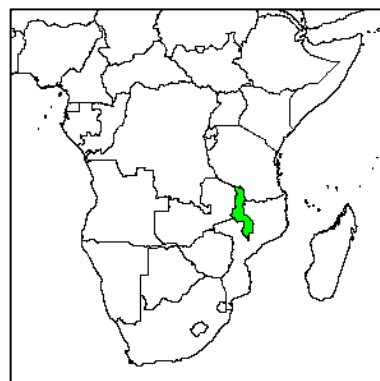
An in-depth survey with 20 farmers was conducted mainly on mixed crop-livestock farms in western Malawi, near Mchinji and in northern Malawi, near Mzuzu.

### *Summary of Findings*

40 percent of the interviewed farmers did not store and use manure. Of the farms that did manage the manure, five had bio-digesters. Including farmers with bio-digesters, about 60% of the farmers stored solid manure in uncovered heaps. Small and middle-sized farms seem to use more of their manure than the larger farms. Lack of labour to collect and handle manure properly is an important bottleneck on more than half of the farms. However, the key barrier to improving manure management is a lack of information. Regarding biogas production, 2 of the 5 sites with bio-digesters were not functioning because the owners didn't know how to fix the problem. Local radio and farm/field visits were the most cited channels of information for the interviewed farmers.

### *Identified Opportunity for Practice Change*

The lack of knowledge and awareness about the value of manure and proper management of manure is a main barrier in these areas and can be addressed by providing training for extension workers and innovative farmers on: the sustainable use of bio-digesters, better use of gas surpluses, and on improving management of manure/bio-slurry to reduce SLCP emissions and enhance the value of the manure/bio-slurry as a fertiliser. In addition, provision of training for the entrepreneurs that install the digesters on issues such as improved methods for handling the slurry from the biogas plants. The training can be linked to the current government Crop-Livestock Integrated Project (CLIP) which uses "innovative" farmers to transfer new technologies to other farmers in the region.



## 3.5 Argentina

In Argentina, currently more than 50% of slaughtered beef cattle are fattened in corrals (feedlots). As the beef industry is rapidly transforming, new and specific legislation and good practice guidelines are being developed to cope with the dynamic situation. No information on current practices and impacts from manure handling in Argentinean feedlot industry is available.

In total, 11 in-depth interviews were conducted on feedlot farms in the state of Buenos Aires.

### *Summary of Findings*

With the exception of one feedlot, the rest of surveyed feedlots neither have concrete floors nor roofs. This implies that surface run-off of urine occurs and manure can be washed away by rain implying loss



of nutrients. Eight out of 11 interviewed feedlot farmers store liquid manure in lagoons with waterproof floors, but without cover. Five farmers reported drying and stacking up the manure collected. About 75% of the interviewees store solid manure. Regarding utilisation, only about half of the respondents used manure for on-farm fertilisation. However, six out of 11 did not use their manure for on-farm fertilisation, even though four had land available on their farm. In recent years, nine out of 11 surveyed farms have made improvements mainly in manure storage and some treatment. Health and environmental considerations were cited as main drivers for these improvements.

Almost all farmers received information through the media; with television and Internet playing a prominent role. Most farmers are well-educated and able to actively search for information and in addition, the beef producers' organisation also provides information for its members via its website. The type of information that these farmers search for is mainly related to cost-effective technology options for manure management to reduce environmental problems.

Limited access to credit for investment in infrastructure, machinery and equipment was identified as one of the main barriers to improve integrated manure management. Additional barriers cited include labour availability and the absence of clear regulations.

#### *Identified Opportunity for Practice Change*

The geographic clustering of beef production that has occurred as a result of the rapid growth of the Argentinian feedlot industry requires urgent adjustment of policy and practice frameworks. The current political pressure to address the potential environmental and climate concerns of these production systems, academic interest in the sector, and the industry's desire to optimise the economic returns from its investment in manure management systems, provide an excellent opportunity to inform policy and practice change to promote integrated manure management in Argentinian feedlots.

## 3.6 Costa Rica

Although the identified opportunity for practice change covers the whole of Central America, for practical reasons and because of its similarities with livestock systems in surrounding countries, Costa Rica was selected as the area for collection of more in-depth information. The information was gathered for the dairy and pig sectors.

Large farms are located mainly in the humid tropics, while the medium-sized and small farms are located in the tropical humid premontane near the skirts of the massive volcanoes and a shorter distance from large cities.



#### *DAIRY Sector*

The survey was conducted on 11 specialised dairy farms, with confinement or semi-confinement, in the central valley and the counties of the northern zone of Costa Rica. The farms have an average area of 41 ha, ranging from 5 to 180 hectares. On average the farms have 273 animals, varying from 30 to 700 animals.

#### *Summary of Findings*

About half of the interviewed farmers have implemented some technology to apply manure on pastures and are aware of economic benefits for their farm. Although a few respondents cited the lack of information and equipment as a barrier to adoption of integrated manure management, in general dairy farmers do not face any severe technical, socioeconomic or institutional constraints for further

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improvements. About half of the interviewed dairy farmers store and compost solid manure of which most is used for on-farm fertilisation. About 10% of the dairy farms have installed a bio-digester, but only 10-30% of the digestate is used as fertiliser.

#### *PIG Sector*

Diverse actors involved in pig production e.g. producers, extension agents and research centres, are aware of the problems associated with inappropriate manure management on pig farms. In total 12 in-depth interviews were conducted on landless pig farms in and around the central valley of Costa Rica.

#### *Summary of Findings*

Pigs are generally kept in confinement with floor and roof cover. The common manure removal practice on surveyed pig farms is flushing the floors with water. Most farmers perform some form of manure management e.g. collecting and storing, especially when they apply the manure on their own land. Half of them use bio-digesters and a lower proportion use oxidation ponds. About 25% of the interviewed pig farmers do not have enough land to apply manure. The current market price of organic fertilisers doesn't provide incentives to farmers to pursue any additional investment in on-farm treatment.

Many pig farmers have received support from the Ministry of Agriculture, but pointed out that more support in the form of access to credit and capacity development is required. Group meetings and bi-lateral contacts form their main source of information.

#### *Identified Opportunity for Practice Change*

The in-depth assessment in Costa Rica identified knowledge exchange and concerted action across Central America as an important step toward the inclusion of proper manure management in the policies of Central American countries. The Central American Integration System (SICA) which promotes actions aimed at improving use of natural resources as part of its charter, can provide a mechanism to facilitate this regional approach. The currently proposed revision of the regional strategy that guides agro-environment and health issues, provides a unique opportunity to include integrated manure management. The resultant revised strategy will equally provide an additional basis for building regional partnerships and capacity around integrated manure management, and to inform related national policy-making.

## 3.7 Conclusions

The results of the in-depth surveys confirm the findings of the more general assessment on manure policies and the enabling environment that has been presented in Chapter 2. It also provides more in-depth understanding of manure management practices. Manure, and especially liquid manure, when stored, are poorly stored and handled and relatively often discharged into the environment. Despite the wide geographic range of countries and the variation in agricultural systems, some general conclusions regarding manure management can be drawn.

#### *Awareness & knowledge*

A key barrier in manure management is the lack of awareness of integrated manure management opportunities, which is often linked to a lack of knowledge and to a poor or incomplete provision of information.

#### *Policies*

The surveys on manure management practices showed that manure policy is only considered as a barrier for improvement by the Argentinian feedlot farmers, a group of well-educated farmers actively

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searching for knowledge and very aware of the manure problem. In other countries, manure policy is not considered a primary barrier.

#### *Subsidies & credits*

Proper manure management is associated with investments in capital, labour and knowledge which increase costs of production. Limited access to credit to invest in integrated manure management is an important barrier. Subsidies for synthetic fertilisers have an adverse effect on utilisation of manure as a fertiliser, while subsidies for bio-digester are often not directed at the maintenance of the digester and the value of the digestate.

#### *Labour & Equipment*

Proper manure management, storage, treatment and application is labour intensive. The combination of lack of awareness/knowledge, lack of labour and the inability to handle liquid manures in a non-mechanised environment, results in a low prioritization of manure storage and application.

Maintenance of bio-digesters is often reported as a problem, resulting in a loss of methane emissions and energy production. Maintenance of manure management infrastructure should be a key part of manure management policies and practices.

#### *Illiteracy*

Of the 115 interviewees 21 percent cited illiteracy as being an important constraint in accessing information on improving manure management. This emphasizes the need for visual communication materials tailored to the local circumstances. It also confirms the findings that television, radio, farm/field visits, group meetings and bi-lateral contacts are the most used and appreciated communication channels/methods. Notably the use of television and radio might be non-appropriate in places with a lack or limited availability of electricity.

#### *Incentives*

The majority of the interviewees who invested in improving manure management in the last five years consider improving human health, receiving (financial) incentives and complying to regulations as the most important drivers for their investment.

#### *Culture*

Awareness of 'the problems and or solutions' and having the knowledge and even the resources to act accordingly, is no guarantee for practice change. It also needs to be accepted as a solution. Improving manure management with eventual use as organic fertiliser has a trade-off that manure is no longer available as a fuel for cooking or for construction. The use of dung cakes for cooking is a common tradition in many of these regions.

#### *Closing remarks*

An effective manure policy, focussing on the added value of manure, should work on four main barriers: the lack of awareness and knowledge, the development of customised solutions for simple manure storage and application equipment and the access to incentive mechanisms. The successful bio-digester programmes in many countries have proven the success of this approach. It is shown that maintenance and the required expertise and knowledge infrastructure is important to ensure continuous use of bio-digesters. Therefore, a number of OPCs will focus on the knowledge development to ensure digesters' maintenance. It is fair to extend this to manure management as a whole, this is not a one-time action, but requires constant attention in training farmers and extension workers and permanent/long term programmes for financial credits.

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## 4 Discussion & Key Messages

### 4.1 Discussion

The Theory of Change of the LMMC distinguishes two main phases. In the first phase, a regional inventory of national manure policies and enabling environment including stakeholder consultations had to identify areas for practice change. In the same phase, selected areas were approached to gather more in-depth information on the existing manure management practices in order to develop an 'Opportunity for Practice Change', to be conducted in the second phase of the LMM project.

The national inventory of manure policies and the enabling environment as well as the in-depth on-farm surveys on integrated manure management practices have provided insight and information on the current status of manure policies and practices. However, we have to make a note on the quality of the gathered information. Results from the survey suggest that manure policy and integrated manure management are not always equally perceived and experienced by the respondents. It can be questioned whether respondents, fully understood the line of questioning or whether there is a clear understanding of issues related to manure e.g. whether policy makers are aware of how (and why) farmers manage manure.

Regarding the regional inventory of national manure policies it was noted that, when information was submitted by more than one country respondent, the information provided was influenced by bias, individual knowledge, position and experience, leading to differences and even contradictory responses. Nevertheless, the information collected at country level, whether provided by one or by more respondents, provides an overview of people's perception of manure policies.

In addition, the information gathered on on-farm practices during the in-depth interviews does not always confirm the information from experts that was gathered with the general questionnaire on integrated manure management practices and the semi-structured interviews. Again, the situational knowledge and experience of the interviewed experts may not have been accurate, perhaps also because often reliable statistics, especially regarding manure management, are not available. But also the selected farms for in-depth interviews did not always fit with the wider scope used by the experts.

Despite these conflicting responses, common findings become evident in the assessment.

The value of manure is often not recognised by farmers and policy-makers, especially in the case of liquid manure and urine. This is related to the training level and support of extension services. Manure policies do often not support integrated manure management: the main drivers for manure policy are focused on energy production and the need to address environmental or public health problems. Often the fertiliser value of manure is not a driver for policy. Policies related to aspects of manure were found to be contradictory.

Based on these findings, the tacit knowledge and experiences of the Regional Centres and the Central Hub, the presented results are valuable for a general global overview of current status and possible barriers for improving integrated manure management in practice. It also forms a sound basis for the selection of the six areas for further investigation.

The results of the assessment show that there is limited awareness of the value of integrated manure management and that the enabling environment (e.g. policy and extension) for good practice is not always optimal. It is clear that manure management policies and practices, and thus also solutions, are region and site-specific, and no one-size-fits-all strategy exists for improving integrated manure management.



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Local input and support to the Regional Centres was important for conducting the in-depth interviews on farm practices. This collaboration with local institutions will be even more crucial for the implementation of the Opportunities of Practice Change, as they need to be adapted to the local circumstances.

The selected areas are a good entry point for the first Opportunities of Practice Change. Experiences gained during implementation of the OPCs will form the basis further dissemination, awareness creation and leverage throughout the region, thereby supporting integrated manure management in livestock systems and consequently contributing to reducing emissions of SLCPs and improving food security.

## 4.2 Key Messages

Manure is a valuable resource. Sound integrated manure management practices can enhance food security by making better use of nutrients in manure for soil fertilisation, while reducing GHG emissions. Awareness raising, increasing the knowledge of farmers, extension workers and policy-officers; and improving the enabling environment are key to improving integrated manure management.

### *Awareness*

The awareness of the importance of integrated manure management for food security and reducing emissions from SLCP is in general limited. The value of manure is often not recognised by farmers, local extension staff and policy-makers. Current knowledge levels are often low and will not foster practice change.

### *Policies*

Manure policies and legislation do often not support sound integrated manure management. The main drivers for manure policies are focused on energy production and environmental or public health problems. The fertiliser value and food security aspect of integrated manure management often not a driver for policy. Improved coordination between relevant ministries (e.g. Ministries of Agriculture, of Energy and of Environment) need to support coherent and holistic policies.

### *Farm practice*

Manure, and especially liquid manure and urine, are in general not optimally used by farmers, causing loss of nutrients and possible energy source, resulting in negative impacts on the environment. If manure is used, the focus is often on bio-digestion, hence neglecting the opportunities for proper management across the whole manure chain. Investments for manure storage, treatment and application are especially challenging for small farmers.

### *Credits and financial incentives*

Subsidies, (soft) credit and credit guarantees are strong incentives for on-farm investments, and should support an integrated approach to manure management / to include integrated manure management in the prerequisites of (micro) financing programmes.

Financial incentives are currently targeted at the construction of anaerobic digesters and sometimes at purchasing synthetic fertilisers; this does not stimulate farmers to improve their manure management. Commercial credit suppliers (e.g. banks) in general are not attracted to invest in components to improve integrated manure management on farms because the financial breakeven point often takes too many years. However, this is not taking into account the co-benefits of the investment e.g. improved human and animal health and reduced environmental pollutions.

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Changing manure management practice requires knowledge and expertise adapted to the local circumstances in which they may need to overcome social and cultural barriers. Transferring and tailoring the basic principles, education, information, policies and an enabling environment (financial and technical infrastructure) are fundamental to successful integrated manure management and consequent mitigation of SLCPs.

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improve the  
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