BUILDING A GLOBAL AGENDA OF ACTION

IN SUPPORT OF SUSTAINABLE LIVESTOCK SECTOR DEVELOPMENT

Global Agenda of Action – Thematic Area
Greening livestock sector growth: closing the efficiency gap in natural resource use

Issue. Increasing population and consumption are placing unprecedented demands on agriculture and natural resources. Global demand for meat is projected to increase by 85% from 2005/2007 to 2050 and this demand will have to be met from an increasingly scarce natural resource base. Consequently, the livestock must significantly increase its natural resource use efficiency to meet society's growing food and environmental needs.

Definition. Natural resource use efficiency is a measure of the amount of natural resource inputs used to produce a given quantity of output. This includes the quantity of use (e.g. hectares of land or litres of water) as well as changes in the quality of natural resource stocks (e.g. soil erosion, biodiversity loss, nutrient runoff).

Basic facts/description of the issue. The livestock production function comprises human-made inputs such as labor, capital, infrastructure and feed as well as natural resources such as water, land, air and biodiversity. All of the human-made inputs and some of the natural resource inputs (e.g. land and water) can be further categorized as conventional production inputs. Standard productivity programs and methods have tended to focus on improving and measuring the efficiency with which conventional production inputs are used. Natural resource efficiency can be enhanced by interventions that improve efficiency in the use of:

1. natural resources relative to human-made inputs, and
2. human-made and natural resources combined.

Further, natural resource efficiency can be enhanced by technology that advances the performance of the world's most efficient producers, and/or by development and extension efforts to "close the efficiency gap" between the world's least and most efficient producers in similar agro-ecological conditions.

Historically, agricultural R&D has focused on improving productivity, or the efficiency with which conventional inputs are transformed into marketable outputs. This process, which is motivated at the producer level by profit maximization, has led to significant productivity improvements over the past half a century. Ludena et al. (2007) estimate that total factor productivity (TFP), which measures the efficiency with which all conventional inputs are transformed into outputs, increased at an annual rate of 1.1% for ruminants and 2.7% for non-ruminants, compared to 0.5% for crops between 1981-2000, globally. The study shows that developing countries as a group have been "catching up" to more efficient producers, assisted by the spread of technology, infrastructure development and credit. However, efficiency gaps do not automatically address themselves, especially in areas with poor market development and deficient infrastructure. For example, TFP growth in Sub Saharan Africa has only increased at an annual rate of 0.5% and 0.4% for ruminants and non ruminants, respectively, over the same period.

Natural resource efficiency can, in many cases, be enhanced by conventional productivity improvements. For example, the introduction of advanced genetics, feeding systems, animal health control and other technologies have enabled industrialized countries to reduce their overall land requirements for livestock by 20% while at the same time doubling total meat production, over the past four decades. Productivity gains can also dramatically reduce GHG emission intensities in ruminant based systems (FAO, 2010). Thus there is potential to substantially improve natural resource use efficiency by the transfer of technology and knowledge from the world's most to least efficient production systems. And doing so may allow the sector to reap a "double dividend" by enhancing producer profits and environmental outcomes.

However, improved productivity does not assure improved natural resource efficiency. A recent study on OECD agriculture has shown that while most countries have simultaneously enhanced their TFP and nutrient use efficiency between 1990 and 2003, some countries (Australia, USA, Canada, Portugal) have increased TFP but reduced their nutrient use efficiency over the same period (Coelli et al. 2009). Consequently, there may be situations where natural resource use efficiency improvements will reduce farm profitability.

To develop a strategy to enhance natural resource efficiency and at the same time increase profitability in the livestock sector, we need to understand the role of efficiency gains in the use of both conventional and natural resources. However, while staying cognizant of these important interactions, perhaps the Agenda can add most value by focusing on natural resources, given that , in the absence of market prices for valuable natural resources, agricultural R&D has focused almost exclusively on improving conventional productivity?

Proposition. Bearing in mind that the opportunities for enhancing natural resource use efficiency will vary significantly among regions and production systems, we hypothesize that environmental gains from bringing a large number of inefficient producers to an acceptable level are much larger than adjusting the performance of efficient producers to ever higher levels.
However, we would like feedback as to whether this is an accurate assumption which can be supported with empirical evidence? If we cannot support this claim is it due to lack of evidence, or because it is incorrect? If it is the former, then what type of information and analyses are required to improve our understanding of the issue?

Scope/boundaries/scale. Consensus is needed to establish practical livestock system boundaries for the framing and measurement of natural resource efficiency. The system boundary can be narrowly defined to only incorporate natural resource impacts that occur within the confines of the farm or, at the other extreme, it can be drawn very broadly using a life cycle approach to cover impacts associated with the entire food chain, including those associated with production of all inputs and with the processing, transport and marketing of all farm outputs.
One possible compromise, to keep the information requirements manageable while including the vast majority of natural resource impacts, is to include feed production and animal production?
In addition to establishing an appropriate system boundary, we also need to reach agreement on the scope of natural resources to assess. While it would be ideal to include the full range of natural resources, we need to keep the assessment manageable and prioritize according which resource issues need to be addressed most urgently, and according to which we are likely to have the most success in addressing. To do this we need to establish a basis for ranking each natural resource. We may also give priority to measurable resource stocks/flows that can serve as proxies for a group of critical natural resources
Further consensus is needed on the scale of assessment. Should we focus on the farm scale or the agro-ecological system scale for each animal species or both? Or is there a more appropriate scale?

Moving towards an objective statement. Our objective statement needs to outline targets for natural resource use efficiency. But we first need to decide on the metrics/methods that should be used for this purpose. Can we rely on existing metrics/methods or do we need to develop new ones? Given the multitude of natural resources that are linked to livestock production, does it make more sense to use several metrics to individually represent each resource, or should we aim for a framework that can assess the use efficiency of several resources collectively? Below is a list of some currently available metrics/methods that could be used:
1. Yield gap assessment – this is typically used in crop science and it describes the difference between the actually attained yield and the potentially attainable yield in a given location. This partial measure of efficiency, which has not yet been applied to livestock, can help us to understand how much more output can be achieved from the current, or reduced, quantity of land.
2. Other partial indicators may include phytomass appropriation efficiency (i.e. estimates of total terrestrial phytomass necessary to produce a unit of food); land use efficiency (which as discussed above could serve as proxy for multiple natural resources); animal biomass efficiency (estimated be

comparing the amount of off-take with the standing biomass of a herd – this may also serve as a proxy for multiple resources); nutrient use efficiency (based on the N & P balance of the farm system).
3. A total factor productivity (TFP) framework extended to incorporate a broad range of natural resources and environmental indicators could provide a more comprehensive and robust framework for assessing natural resource use efficiency
4. Life cycle assessment (LCA), can be used to comprehensively assess natural resource impacts along the entire food chain, which can be expressed per unit of output. This approach can be applied to single or multiple natural resource uses.

As mentioned, the metrics selected to set targets in the eventual objective statement will depend on the methods used. For example, if we use an modified TFP framework, extended to incorporate nutrient use efficiency – we could base our target on the work of Coelli and Hoang (2009), who estimate that nutrient use efficiency can be improved by 47.4% by a combination of conventional productivity improvement, and from adjustments to the mix of inputs (based on their N and P contents) used. Are there simpler partial indicators such as land use and water use efficiency for example, that are still robust which could be more easily applied?

Problem statement. The livestock sector presently occupies 3.73 billion hectares globally: 3.38 billion of hectares are used as pastures and grazing land, while an additional 0.35 billion hectares are devoted to feed production. This represents about 30% of the earth's ice free land and around three quarters of total agricultural land. The efficiency of livestock production systems from a physical standpoint, and with regard to both human-made and natural resources, is neither well described nor well known. This has contributed to a deficiency in understanding the long run potential to reduce the sector resource requirements via efficiency improvements.

Most new agricultural lands arise through the clearing of forests, resulting in huge losses of environmental goods and services, including stored carbon, biodiversity, water and air quality regulation. Thus, the intensification of land use, through improving yields and represents one key strategy to minimize further deforestation and its attendant losses in natural resources. The potential for further sustained growth in crop yields is alleged to be gradually diminishing in several major producer countries, mainly because the exploitable gap between average farm yields and genetic potential is closing. An important question is whether this also holds true for livestock?

Projections by Wirsenius et al. (2010) go some way towards answering this question, by showing how an increase in global average feed-to-food conversion efficiency from 5.1% in the reference case to 6.2% in an improved productivity scenario, would correspond to a reduction in land use of 510 million hectares (or 13%) by 2030 compared to the reference case, and a 20% reduction in global feed use – with virtually all of the fall estimated to come from reduced grazing on grasslands and crop residues. The productivity growth needed to support these changes are well below the growth rates estimated to be possible by livestock specialists. This demonstrates the large reductions in land use that could be achieved via plausible productivity improvements, that are based on faster live weight gains, coupled with a faster transition toward higher land-use intensity in low and medium-income regions, with higher pasture productivity and a larger use of cultivated feeds of good nutritive quality.

As discussed, animal and land-based yields only provide a partial measure of natural resource use efficiency. And, in the absence of market prices for valuable natural resources, these resources have been omitted from standard efficiency and productivity analyses. This poses and couple of important problems that need to be resolved. Firstly, while it is widely accepted that the livestock sector is confronting production constraints from the growing scarcity of finite natural resources, there is still a paucity of quantitative data on these constraints. Secondly, there is no universally accepted framework for assessing the natural resource use efficiency, particularly for multiple natural resources. However, we know that to address the sector's dual requirement for increased production and better environmental outcomes (i.e. for green livestock growth) a methodology which can incorporate efficiency in the use of both priced production inputs and unpriced natural resource inputs into the same framework is essential. Because this will enable the profitability and the environmental

performance of the sector to be addressed simultaneously – which again, is the key to devising a strategy for green livestock sector growth.

Proposed ACTIVITIES

Analysis/assessments of technical/economic/institutions

Develop capacity to quantitatively evaluate and benchmark the environmental performance of different production systems and supply chains, and assess the potential natural resource use efficiency gains that can deliver both environmental and production benefits.

These assessments need to be complemented with cost benefit analyses for suitable policy interventions. Strategic analyses will also be needed to identify appropriate institutional arrangements to support these interventions.

Information generation and sharing

To be discussed

Outreach/advocacy

Possible links can be made with green growth agenda. Where the approach addresses GHG mitigation, links to UNFCCC intergovernmental processes could be established.

Policy support

To be discussed

Piloting and capacity building

Region-specific training and capacity building investments will be developed to facilitate the adoption and transfer of practices/technologies that enhance natural resource use efficiency, in different settings.

Pilot projects will be established in representative regions and subsectors where there: 1) are acute natural resource use constraints; 2) is a significant natural resource use efficiency gap between the most and least efficient producers and 3) is sufficient institutional capacity and technical expertise to support the interventions. Example include: peri-urban dairy production in Africa and South Asia, Pig production in Latin America and South East Asia.

Mainstreaming/Up-scaling

To be discussed