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VERSION 1

Developing sound tools for transition to sustainable food and agriculture

Methodological notes

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Acknowledgements

AUTHORSHIP AND DEVELOPMENT PROCESS

These methodological notes are a product of the Livestock Environmental Assessment and Performance (LEAP) Partnership. Three groups helped produce them, namely: an ad-hoc task force, an advisory board, the LEAP Secretariat and the LEAP Steering Committee.

The task force was composed of: Camillo De Camillis (FAO, task force leader); Monikka Agarwal (World Alliance of Mobile Indigenous Peoples); Pablo Manzano (International Union for Conservation of Nature); Nicolas Martin (European Feed Manufacturers' Federation, The International Feed Industry Federation); Aimable Uwizeye (FAO, LEAP Technical Secretariat).

The advisory board was composed of the leaders of the LEAP Technical Advisory Groups (TAG) on feed and livestock sectors formed from 2012 to 2014, namely: Alexandre Berndt (EMBRAPA, Brazil – co-Chair of the Large Ruminant TAG); Stewart Ledgard (AgResearch, New Zealand, Chair of the Small Ruminant TAG); Greg Thoma (University of Arkansas, USA, Chair of the Poultry TAG, Vice-Chair of the Large Ruminant TAG and co-Chair of the Pig TAG); Theun Vellinga (Wageningen University, the Netherlands, Feed TAG Chair); and Ying Wang (Innovation Center for US Dairy, USA – co-Chair of the Large Ruminant TAG). The advisory board reviewed the methodological notes and provided inputs raised at TAG level.

The LEAP Secretariat coordinated and facilitated the work of the task force, guided and also contributed to the content development. The LEAP Secretariat, hosted at FAO, was composed of: Pierre Gerber (Coordinator until January 2015); Camillo De Camillis (LEAP Manager); Carolyn Opio (Technical officer and Coordinator since February 2015); Félix Teillard (Technical Officer); and Aimable Uwizeye (Technical Officer).

The LEAP Steering Committee provided overall guidance for the activities of the Partnership and helped review and clear the methodological notes for public release. During development of this document, the LEAP Steering Committee consisted of:

Steering committee members

Monikka Agarwal (World Alliance of Mobile Indigenous Peoples, in LEAP since October 2014); Douglas Brown (World Vision); Giuseppe Luca Capodieci (The European Livestock And Meat Trading Union, International Meat Secretariat); Camillo De Camillis (FAO); Richard de Mooij (The European Livestock And Meat Trading Union, The International Meat Secretariat); Elsa Delcombel (Government of France); Lalji Desai (World Alliance of Mobile Indigenous Peoples – 2014 LEAP Chair); Pierre Gerber (FAO – LEAP Secretariat Coordinator until January 2015); Mathias Ginet (Government of France, in LEAP since October 2014); Jan Grenz (Bern University of Applied Sciences, Government of Switzerland, in LEAP until March 2014); Vincent Guyonnet (International Egg Commission); Dave Harrison (International Meat Secretariat); Matthew Hooper (Government of New Zealand); Hsin Huang (International Meat Secretariat; Delanie Kellon (International Dairy

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Alejandro Acosta (FAO, Global Agenda For Sustainable Livestock, in LEAP since February 2015); Rudolph de Jong (International Wool Textile Organization, in LEAP until October 2014); Jeroen Dijkman (FAO, Global Agenda for Sustainable Livestock – in LEAP until January 2015); Matthias Finkbeiner (International Organization for Standardization); Neil Fraser (FAO, Global Agenda For Sustainable Livestock); Michele Galatola (European Commission, DG Environment); James Lomax (United Nations Environment Programme); Llorenç Milà i Canals (United Nations Environment Programme); Paul Pearson (International Council of Tanners, in LEAP since February 2015); Erwan Saouter (European Commission, Joint Research Centre); Sonia Valdivia (United Nations Environment Programme); and Elisabeth van Delden (International Wool Textile Organization).

MULTI-STEP REVIEW PROCESS

The LEAP Secretariat and the LEAP Steering Committee reviewed these methodological notes and provided feedback before clearing and releasing them for public review.

The public review – announced to the public through an article published on the FAO Web site – was launched at the 2nd Annual Meeting of the LEAP Partnership on 23 April 2015 and lasted until 15 September 2015. The scientific community working on GHG emissions from livestock accounting was alerted through the fora of the Mitigation of Climate Change in Agriculture (MICCA) Programme, and of its Livestock and Climate Change Mitigation in Agriculture Discussion group. Experts in Life Cycle Assessment (LCA) were informed via the LCA mailing list held by PRé Consultants. The public review period was advertised at the 25th Annual Meeting of the European Branch of the Society of Environmental Toxicology and Chemistry (SETAC Europe). The following bodies were also asked for their input: Global Research Alliance – Livestock Research Group (GRA); Global Alliance for Sustainable Livestock; Global Alliance for Climate-Smart Agriculture

(GACSA); Mitigation of Climate Change in Agriculture (MICCA) Programme; Standing Committee on Agricultural Research (SCAR); Joint Programming Initiative on Agriculture, Food Security and Climate Change (FACCE-JPI); European Food Sustainable Consumption and Production Round Table; European Commission's Cattle Model Working Group members. Comments were also sought from relevant FAO technical officers.

John Kazer (Carbon Trust, the United Kingdom) participated in the public review and hence contributed to improving the quality of this technical document.

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1. Why the LEAP Partnership

The overall goal of the Livestock Environmental Assessment and Performance Partnership (LEAP) is to improve the environmental performance of the livestock sector while considering economic and social viability.

"You can manage what you can measure," well reflects the philosophy underpinning all technical activities of the Partnership. LEAP aims at developing both globally accepted assessment methodologies and reference databases to help make livestock production systems more sustainable through environmental benchmarking.

Building consensus among stakeholders was considered important, partly because of livestock's significant impact in terms of climate change and the environment, and partly because of the mistrust towards environmental science developed by decision-makers over the years as a result of often conflicting assessments published by experts. Differences in methodology, indicators, and data used by the various organizations engaged in environmental studies have in fact frequently produced contradictory findings that have been sharply criticized by politicians, scientists and livestock supply chain professionals. To re-establish trust and help decision-makers arrive at informed choices on issues concerning the environmental sustainability of livestock, LEAP's founders, mindful of Socrates' statement that "The only true wisdom is in knowing you know nothing", agreed to make a new start. The LEAP Partnership was set up in 2012 on the basis that joining forces and engaging in technical discussions in a collaborative manner is the only way to analyse methodological issues from all possible angles and so resolve them effectively and efficiently.

2. Consensus achieved

The LEAP Partnership is a global, multi-stakeholder initiative co-chaired by FAO and composed of government and private-sector representatives as well as NGOs and CSOs. LEAP works in collaboration with the Global Agenda for Sustainable Livestock, and under the auspices of such stakeholders as UNEP, OIE, ISO and the European Commission.

The LEAP life cycle assessment (LCA) guidelines represent the latest agreement found by the LEAP Partnership on methodology and indicators for quantifying and interpreting the environmental performance of livestock production systems[1]. All LEAP guidelines are freely available for download on the Partnership Web site[2].

These technical documents were shaped by technical advisory groups made up of world-ranking researchers and technical officers in environmental assessment, feed processing and livestock production systems. All LEAP guidelines are the result of a structured, multi-level participatory technical development process open to all LEAP partners. The process involves successive review steps, including several internal consultation rounds with the LEAP Steering Committee, an external review conducted by three technical experts, and public consultation.

LEAP outputs such as technical guidelines and databases are living deliverables, which are subject to change and improvement as new science becomes available, as methodological gaps are exposed through testing, and as new partners join LEAP, bringing new perspectives with them.

Although LEAP technical documents are acknowledged as providing the reference framework for environmental assessment when they are released, science evolves fast in this field and hence LEAP partners and stakeholders can build on LEAP technical outputs and go beyond them. That is why formal endorsement is not currently required from LEAP partners and they are not legally obliged to comply with LEAP guidelines. However, although LEAP partners and other organizations use LEAP guidelines as normative references for their recommendations, any deviation from LEAP guidelines and principles should be notified and a reasoned justification provided.

[1] Release of LEAP technical documents is cleared by the LEAP Steering Committee on a consensus basis. Consensus does not necessarily mean unanimity. Involvement in the external technical review does not necessarily represent endorsement by the experts or their organizations.

[2] www.fao.org/partnerships/leap/livestock-partnership.

3. LEAP guidelines: key features

LEAP LCA methodologies are voluntary, collectively-agreed, and science-based. Designed as environmental measurement tools, the LCA methodologies in the LEAP guidelines help achieve increased consistency in environmental assessments of feed and livestock production from the farm level all the way up to regional and global systems.

To date, LEAP has delivered guidelines on feed, poultry, small and large ruminants, and on pig supply chains. These guidelines represent global reference assessment tools because they are:

- aligned as far as possible with ISO 14040: 2006 and ISO 14044:2006, the international standards on LCA;
- built on (and often ahead of) many other standards, technical specifications and guidelines such as ISO/TS 14067:2013; FAO's Sustainability Assessment of Food and Agriculture systems (SAFA) guidelines (FAO, 2014); Greenhouse Gas (GHG) Protocol of 2011 by World Resources Institute and World Business Council on Sustainable Development (WRI and WBCSD, 2011); ENVIFOOD Protocol (2013); ILCD Handbook (EC JRC IES, 2010a, 2010b, 2011); the European Commission's Product Environmental Footprint guide (EC, 2013); PAS 2050:2011; PAS 2050-1:2012; BPX 30-323-0, 2011 and BPX-30-323-20, 2014, the International Dairy Federation (IDF) guide to standard life cycle assessment for the dairy sector (2010);
- based on the latest cutting-edge science such as that produced by the Global Research Alliance – Livestock Research Group and the UNEP SETAC Life Cycle Initiative.

Experts in environmental assessment and in feed and livestock production systems are the targeted audience of LEAP technical documents.

As science on carbon footprinting and climate change matures, LEAP recommendations on GHG emission accounting, and climate change impact assessment and reporting become increasingly structured and detailed.

LEAP guidelines on livestock supply chains strive to be both specific and applicable to the many different production systems operated worldwide. In other words, LEAP guidelines are of relevance not just to agribusiness such as large-scale, intensive livestock production systems, but also to subsistence agriculture, including pastoralism and community-supported agriculture, and to family farming.

In order to come up with tools for monitoring environmental performance over time and for identifying cleaner livestock production systems, a cradle-to-gate LCA approach was used in developing the LEAP guidelines on livestock supply chains. This addresses all aspects of the system, starting with feed production and moving up to cover the farm gate, off-farm activities and the primary processor gate (dairy product processing, and slaughtering are also included). Packaging life cycle was left out of the scope.

Relying on the modular approach, LEAP guidelines on poultry, small ruminants, large ruminants and pig supply chains are to be used in conjunction with LEAP guidelines on feed (FAO, 2016a, 2016b, 2016c 2016d).

The adoption of a commodity-based perspective, under which outputs such as products[3], residues and waste streams are clearly distinguished on the basis of their individual economic value, is a major strength of these guidelines. For this feature makes it possible to clearly define the scope of the assessment in terms of system boundaries, thus providing increased consistency across assessments. This feature not only paves the way towards assessment result comparability, but can be seen as a fundamental prerequisite for broader sustainability assessments of livestock commodity value chains.

Since methodological inconsistencies are likely to produce misleading results, and given that more than a single data modelling approach exists in LCA, it became obvious that mixing data modelling approaches should be avoided. Scrupulousness in pursuing alignment with the principles underpinning the LCA attributional data modelling approach described in the UNEP SETAC Life Cycle Initiative's Principles for LCA databases (Sonnemann and Vigon, 2011) makes these LEAP guidelines uniquely sound. It was found that this is the only way to ensure that all inflows and outflows are correctly accounted for according to the attributional perspective, while also complying with the internationally-agreed rules on allocation contained in the Guidance for Product Category Rule Development issued by The Product Category Rule Guidance Development Initiative (Ingwersen and Subramanian, 2013).

As far as LEAP accounting requirements are concerned, it was agreed that allocation of emissions, releases and resource use among the products concerned should be avoided as much as possible. Should allocation be necessary because of the assessment goal, then practitioners are recommended to make use of the decision tree diagram in the LEAP guidelines, section "Multifunctional processes and allocation", which provides a principled basis for following the ISO 14044:2006 procedure for allocation step-by-step. In addition, recommendations on default allocation keys have been provided[4]. LEAP guidelines are aligned with, but go beyond the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, providing detailed guidance on how to account in different situations for enteric fermentation, methane emissions, and those GHG emissions from changes in land use. As the latter may not be directly caused by the specific product system investigated, and default values on the GHG emissions from land use changes often lack in-depth peer review, it was agreed that impacts from land use change should be reported separately.

[3] These guidelines refer to products as both goods and services. Large ruminants, for example, not only provide a number of products, but may also deliver draught power and wealth security services.

[4] Distributing potential environmental impacts among co-products, also known as allocation, is currently a highly disputed topic in the LCA scientific community. How to handle multi-functional processes and distribute impacts among co-products largely depends on the choice of the LCA data modelling approach used (Pelletier *et al.*, 2015). Currently, conceptualization of the mainstream LCA data modelling approaches is still being fine-tuned (Brander, 2015; Soimakallio *et al.*, 2015; De Camillis *et al.*, 2013). Acknowledging that "mixing attributional and consequential life cycle assessment produces an analysis that has no clear meaning"(Plevin, Delucchi and Creutzig, 2014), when developing its own guidelines LEAP adhered strictly to the reference principles underpinning the attributional modelling approach. Further discussion and fine-tuning is envisaged in the context of the LEAP Partnership work programme 2016-2018. There still seems to be some room for improving consistency across LEAP guidelines. While the technical advisory groups on animal supply chains extensively preferred biophysical and physical approaches over economic keys, LEAP guidelines on feed supply chains adopted an economic approach. This seemingly poses a consistency issue, e.g. on whey, which is both a product of the dairy industry and a possible feed ingredient. LEAP technical advisory group leaders acknowledged allocation as a complex issue requiring a detailed procedure for practitioners. Fairness was also raised as a principle to bear in mind when discussing rules on allocation in specific application contexts. While sound solutions are necessary, it was acknowledged that, irrespective of the allocation approach adopted in attributional guidelines, the overall amount of resources used and of emissions released will not change.

The LEAP LCA guidelines address only climate change and energy use from fossil sources[5]. LEAP guidelines on feed, large ruminants and pig supply chains (FAO, 2016c, 2016d) are broader in scope and also capture additional issues. But in the future the scope of all LEAP LCA guidelines is expected to broaden in order to prevent any shift of burden from an environmental problem area to another[6]. LEAP biodiversity principles (FAO, 2016e) complement LEAP LCA guidelines.

The role of the interpretation phase is particularly emphasised in LEAP guidelines, especially when it comes to reporting assessment results. But even if uncertainty is minimised through strict adherence to the reference principles set for the attributional approach by the UNEP SETAC Life Cycle Initiative (Sonnemann and Vigon, 2011), other sources of uncertainty remain. For transparency's sake, reporting crisp numbers without uncertainty ranges should be avoided because it prevents stakeholders from correctly interpreting results.

[5] The scope of LEAP guidelines on poultry and small ruminants supply chains was limited to climate change and energy use from fossil sources because, despite their availability, assessment methods on potential environmental impacts such as e.g. ecotoxicity and eutrophication often deliver questionable results. In addition, the commonly-used life cycle impact assessment framework needs tailoring for livestock and other agricultural products.

[6] Due to the narrow scope of the current LEAP LCA guidelines in terms of both life cycle stages and environmental areas of concern captured, by applying the current version of the LEAP guidelines no conclusion can be drawn on the overall environmental superiority of any production practice over another, of any one product over another, of any organization over another and of any region over another.

4. LEAP guidelines: application contexts

The LEAP LCA guidelines are intended to create a level playing field among stakeholders in order to promote better environmental management at the level of farms and other organizations involved in livestock product supply chains. The idea was to design guidelines that, relying on the LCA attributional modelling approach, would drive environmental improvement by monitoring and benchmarking over time the environmental performance of the production systems involved[7].

In addition, LEAP guidelines can also be used in many other contexts. Attributional modelling is, in fact, widely used in support of environmental monitoring, which is often required to demonstrate progress towards specific environmental targets. Examples of application contexts include:

- National GHG Emissions Inventories in line with provisions from the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol;
- National GHG mitigation schemes;
- The FAO Global Livestock Environment Assessment Model (GLEAM);
- National energy plans promoting the use of renewable energy;
- Life-cycle-based environmental indicators for monitoring the performance of given sectors on the basis of a basket of products (Goralczyk, 2013).

In combination with economic input-output tables, the attributional approach forms the backbone of Environmentally-Extended Input Output Analyses used, for instance, to rank the environmental criticality of given economic sectors (Andreoni and Suh, 2013).

The attributional approach is also extensively used in the context of business-to-business environmental reporting; product environmental communication; product-oriented environmental management systems; as well as in conducting hot-spot analyses and identifying suitable criteria for eco-design, green public procurement, or in selecting environmental key performance indicators in support of green purchasing. Future-oriented scenarios can also be assessed in a static manner through an attributional approach.

Whereas the LEAP guidelines can be used in all above contexts, the LEAP Partnership has not determined which form of LCA data modelling is best suited for application in contexts going beyond environmental monitoring.

[7] LEAP guidelines are specific to livestock production systems. In order to benchmark the environmental performance of integrated multi-outputs farming systems and conclude that overall environmental improvement was actually achieved, the other farming technical outputs delivered by the production system (e.g. crops, silkworms, timber, honey, mushrooms) shall be assessed through complementary LCA guidance documents. These technical documents shall be consistent with LEAP LCA guidelines in order to come up with the overall environmental footprint of the farm concerned or of the agriculture sector as a whole, and be able to track the overall environmental performance over time.

5. Complementary recommendations for policy-making and business strategy

LEAP guidelines rely on the attributional approach (De Camillis, Zamagni and Bauer, 2013; Sonnemann and Vigon, 2011; Zamagni *et al.*, 2012), flagged as the only one making it possible to provide "visible figures" in the sense that no emission attributed to the system assessed can in theory remain hidden when the approach is used.

While developing technical guidance documents, LEAP technical experts acknowledged that, as maintained by W. Edward Deming, "management by use only of visible figures, with little or no consideration of figures that are unknown or unknowable" is one of the "seven deadly diseases" of management.

But "unknowable figures" such as those from environmental disasters and accidents are beyond the scope of any traditional LCA and, thus, also beyond the scope of LEAP analysis. For completeness' sake, however, methods such as environmental risk assessment can serve to identify "unknowable figures" and provide supplementary information.

The LEAP Partnership technical members also note that, depending on the application context concerned, there may be room for application of other LCA modelling approaches attempting to show "figures that are unknown"(Brandão and Weidema, 2013; Dandres, 2013; Earles and Halog, 2013).

When it comes to strategic decision-making, both in public policy and in business, the LEAP Partnership acknowledges the necessity to analyse both "visible figures" and "figures that are unknown". The latter refer to those processes that are likely to take place or to be avoided as a consequence of a change in offer or in demand, and their modelling is rooted in a different epistemological approach to that of attributional modelling. For shaping policy measures and business strategies, environmental assessments using both attributional and consequential approaches should be conducted in parallel before any unambiguous conclusion can be made regarding the soundness of any environmental improvement measures, including but not limited to GHG mitigation options. This is needed to prevent perverse effects on the environment and on society, in line with the conclusions drawn by Anex and Lifset (2014), who recently reviewed discussions in this field. In particular, consequential assessments are recommended to complement attributional assessments of future-oriented scenarios to provide environmental information on:

- displaced productions (e.g., avoided production of mineral fertilizer due to manure deposition). As livestock product value chains produce valuable materials that are likely to replace products manufactured from non-renewable resources, strategic decision-making should account for environmental credits due to displaced productions.

- knock-on effects on other product systems and other sectors (e.g. indirect land use change owing to land grabbing) due to changes in demand or offer of livestock products or their production inputs.

Capturing and assessing knock-on effects makes it possible to account for possible perverse effects and benefits determined by changes in policy or strategy. This modelling feature is particularly important for agriculture because food security is often threatened by competition between food, feed, fibre, timber and fuel.

At the very least, consequential assessments shall be conducted in a qualitative manner to support strategic decision-making.

Otherwise, quantitative approaches can be used. The LCA consequential modelling described by Brandão and Weidema (2013) is indeed an assumption-dependent approach, and hence results cannot be precise by definition. As recommended by Brandão *et al*. (2014), when using such an approach the assumptions set by practitioners shall be reviewed by relevant stakeholders, e.g. in the context of multi-stakeholder partnerships. Alternative LCA consequential modelling approaches rely on econometric models to account for rebound effects (Dandres, 2013; Earles and Halog, 2013). When using such approaches, the assumptions underpinning the econometric models shall be clearly flagged in the assessment reports. Whenever quantitative approaches are used, interpretation of results shall include a commentary on uncertainty and assumptions.

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