Livestock's Contribution to Sustainable Development:
Goals and Metrics for Progress

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ABBREVIATIONS:

ASD – United Nations Agenda for Sustainable Development
ASF – Animal Source Foods
CGE – Computable General Equilibrium
FAO –Food and Agriculture Organization of the United Nations
GHG – Greenhouse gases
ICT – information and communication technology
kWh – kilowatt hours
LD – Livestock Dependent
LSDG – Livestock Sustainable Development Goal
LSDI – Livestock Sustainable Development Indicator
MMTC02e - Million Metric Tons of CO2 Equivalent emissions
PPaM – Production, Processing, and Marketing
SDG – Sustainable Development Goal
UN – United Nations

CONTENTS

Introduction

Human progress has been dependent on the products and services of livestock since at least the advent of agriculture, and even the most modern post-industrial societies remain critically reliant on animals for food and nutrition security. As our understanding of economic development advances, so must our recognition of livestock's perennial importance. Meanwhile, the UN 2030 Agenda for Sustainable Development (ASD) has become the universally endorsed framework accepted by all and applicable to all countries. Despite the expressed interest of leading livestock stakeholder groups to align their action plans towards the achievement of the 2030 ASD objectives, goals and targets, there remain major gaps in awareness, understanding, and consensus on how this could be done.

Livestock is especially vital to the economies of developing countries, where food insecurity is an endemic concern. The demand for livestock products is expected to continue to increase in the next 20 years, with a significant portion of production and consumption taking place in developing countries. This growth in demand presents significant opportunities for achieving economic, health, and poverty reduction benefits through the development of the livestock sector. However, such growth carries with it tremendous responsibility in safeguarding the earth's resources and ecosystems, and ensuring development is inclusive, fostering gender equality and equitable growth.

To better support integration of livestock policy and practices with sustainable development strategy around the world, this report examines the many linkages between the livestock sector and development, as reflected in the United Nations 2030 Sustainable Development Goals (SDGs). In the following sections, we review the pervasive linkages that can be leveraged to facilitate more effective development policies through livestock promotion, as well as to make livestock policies more effective in fulfilling sustainability goals. This approach can support a new generation of policies that advance the SDGs to 2030.

To affirm and further advance the global agenda for sustainable development, we also present a set of livestock sector objectives and metrics to assess progress towards them. In particular, we define a Livestock Sustainable Development Goals (LSDG) corresponding to each of the more general SDGs promulgated by the United Nations to evoke their supporting role in achieving sustainable progress of global living standards. While the Livestock Sustainable Development Goals and indicators are of independent relevance to FAO and livestock policy generally, their conformity with the SDGs recognizes the usefulness of the latter in the international development dialogue and makes more explicit the integral

contribution of livestock to improving livelihoods for the majority of the world's poor who live in rural areas.

This report assesses such contributions to the global development and food security agenda, assembling and synthesizing local and national evidence to demonstrate the many ways in which the livestock sector can support individual livelihoods and global development. By more clearly identifying livestock's many contributions, this document is foreseen can serve as a reference guide for supporting Member States and stakeholders in realizing the livestock sector's potential to advance the 2030 Agenda for Sustainable Development.

Livestock and the UN Sustainable Development Goals

In the following sections, we examine each of the UN Sustainable Development Goals for 2030 in detail, reviewing research and evidence on livestock's contribution to each goal and proposing a corresponding Livestock Sustainable Development Goal that formally affirms these contributions. For each of the seventeen SDG/LSDG pairs, we also propose metrics for progress, or Livestock Sustainable Development Indicators (LSDIs).[1] These indicators offer a rigorous and consistent means to draw upon the large and diverse reserve of microdata that has been assembled from developing countries. Over fifty indicators are proposed, each offering independent evidence to better interpret the effectiveness of sustainable development policies ex post, concurrently, and even (using simulation methods) ex ante.

By establishing more direct links between livestock to the SDGs, along with indicators that establish evidence of progress toward these goals, we can support more effective global policy and private agency. Better recognition and measurement of linkages between livestock and sustainable development can facilitate more coherent and effective strategies nationally and in coordination with bilateral and multilateral development partners. Better understanding of the livestock sector's role in sustainable development can also help private sector actors contribute to improved livelihoods, food security, and advance the SDGs generally.

[1] All SDG and LSDG pairs are summarized together in Annex A below. The LSDIs are summarized in Annex B.

End poverty in all its forms everywhere

1.1 Livestock and Poverty

While extreme poverty rates have been significantly reduced since 1990, approximately 20% of the population in developing regions still lives on less than $1.25 a day. More than an income threshold, however, poverty limits access to education, health services, nutrition, and economic opportunities. SDG 1 takes a multidimensional approach to ending poverty with targets emphasizing the eradication of extreme poverty, as well as promoting inclusive economic growth, equal rights to economic resources and property rights, and building resiliency at the national and regional level to withstand economic, social, and environmental shocks.

The majority of the extreme poor are concentrated in Southern Asia and sub-Saharan Africa, with most living in rural areas. Livestock plays a vital role for the rural poor majority in developing countries by providing financial capital (as a source of income and investment), physical capital (as a source of food and agricultural inputs), and social capital (as a source of prestige and respect) (FAO, 2009; Kristijanson et al., 2010; IFAD, 2011; Meinzen-Dick et al., 2011; Njuki and Sanginga, 2013).[2,3] Improving productivity and market access for livestock keepers, especially those living in areas linked with high rates of poverty, can

[2] The majority of poor livestock keepers (approximately 68%) are located in Sub-Saharan Africa and South Asia (Thornton eta l., 2007; Peden, 2007).

[3] The value of livestock is likely understated, and extends beyond poor livestock owners. Perry and Grace identify the role livestock plays for poor consumers who benefit from animal source food products sold in the informal sector (Perry and Grace, 2009); and other studies identify additional benefits derived from the livestock sector such as informal job creation generated from small-scale dairy and other livestock production in various Asian and African countries (Omore et al., 2004; Hemme et al., 2004).

spur inclusive economic growth and contribute to the first SDG in ending poverty in all its forms.[4]

Building resiliency among the poor and vulnerable to economic and environmental shocks, and ensuring equal rights to economic resources and land are both targets for SDG 1. Livestock makes valuable contributions to both. Diversification into livestock production builds resilience among farmers in areas of rain-fed agriculture, where uncertain weather patterns and droughts can devastate livelihoods (Misra et al., 2007). In bad crop years, livestock can serve as a vital safety net, providing income and food for vulnerable farmers. Small livestock, such as goats, and poultry can be highly valuable for marginalized populations including landless households and women since they require small inputs in terms of land and land quality (Heffernan, 2004; Rangknekar, 2006).[5,6]

As opposed to land ownership, which is skewed towards wealthier households, livestock are generally more equitably owned across wealth strata and gender, and therefore may have greater economic importance for poor households. (Flintan, 2008; Kristjanson et al., 2010; Maclachlan, 2015). Research conducted in India shows smallholders own roughly a third of cultivated land, but own the majority of poultry, pigs, and other small ruminants (Peden, 2007). Building capacity among smallholder producers to ensure livestock assets are sustainable and profitable can facilitate future pro-poor growth within the livestock sector.[7]

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[4] *Livestock Services and the Poor* reviews the market opportunities for poor livestock keepers, as well as the major barriers they face (including access to livestock services, finance, and group organization). Analysis is drawn from case studies in Bangladesh, Bolivia, Denmark, India, and Kenya (IFAD, 2004).

[5] Goats and other ruminants are also highly valuable for their ability to convert crop residue and other by-products into food edible for humans, playing an important role in agricultural systems with poor land (Oitjen and Beckett, 1996).

[6] *Gender, assets, and market-oriented agriculture: learning from high-value crop and livestock projects in African and Asia* gives a comprehensive overview of the importance of livestock in women's livelihoods and assets, and presents case studies in dairy and horticulture projects that lead to increase in income and household assets, however, in most cases the gender-asset gap did not improve. Support specifically targeting women farmers is suggested, which is further explored in SDG 5 (Quisumbing et al., 2014).

[7] Increases in livestock productivity for the poorest rural income groups are likely to have greater livelihood benefits than corresponding increases in land productivity since the very poor and landless can keep a few animals despite limited access to land (FAO, 2012a).

1.2 LSDG 1: End poverty in livestock-dependent communities[8]

Objective

By 2030, raise the minimum incomes of all livestock-dependent (LD) people above the global poverty line.

Indicators

LSDI 1.1: Proportion of LD population below $1.90 (PPP) a day

LSDI 1.2: Poverty headcount ratio (percent of LD population below national poverty line)

LSDI 1.3: Poverty gap ratio (incidence x depth of poverty)

LSDI 1.4: Share of poorest quintile in national consumption

LSDI 1.1: Proportion of LD population below $1.90 (PPP) a day

Definition[9]

Proportion of LD population below the international poverty line is the percentage of the population living on less than the World Bank, PPP corrected threshold (currently $1.90/day), with each income unit of the population weighted by the share of livestock income in total income. The $1.90 a day poverty line is compared to consumption or income per person and includes consumption from own production and income in kind. Because this poverty line has fixed purchasing power across countries or areas, the $1.90 a day poverty line is often called an absolute poverty line. The indicator allows for comparing and aggregating progress across countries in reducing the number of people living under extreme poverty and for monitoring trends at the global level.

Method of computation

[8] A household is termed livestock-dependent if they obtain more than 25% of their income from livestock production and products.

[9] The specification of several LDGs draws heavily upon the precedence of MDG work by other UN/CGIAR institutions, the World Bank in particular.

The basic formula for this indicator is a headcount poverty measure, defined with respect to some exogenously specified poverty line and formally expressed as follows:

$$LSDI\ 1.1 = \frac{q_{LD}}{n_{LD}}$$

where

$q_{LD} = \sum_{i=1}^{q} \lambda_i$= cumulative livestock dependence among the poor

$n_{LD} = \sum_{i=1}^{q} \lambda_i$= cumulative livestock dependence in the population

λ_i = share of livestock income in total income of household i

The subset of poor people is defined with respect to a national or international poverty threshold, the current international poverty line being $1.90 a day. Estimates should be based on incomes or consumption levels derived from household surveys. Whenever possible, consumption is preferred to income for measuring poverty. When consumption data are not available, income is used.

Consumption, which includes consumption for own production, or income per person, and its distribution are estimated from household surveys. Household consumption or income is divided by the number of people in the household to establish the income per person.

The distribution of consumption or income is estimated using empirical Lorenz (distribution) curves weighted by household size. In all cases measures of poverty to obtain Lorenz curves are calculated from primary data resources rather than existing estimates.

Poverty in a country is estimated by converting the international poverty line to local currency using the latest purchasing power parity (PPP) exchange rates for consumption taken from World Bank estimates. Local consumer price indices are then used to adjust the international poverty line in local currency to prices prevailing around the time of the surveys. This international poverty line is used to identify how many people are below the threshold.

The PPP-based international poverty line is required only to allow comparisons across countries and to produce estimates of poverty at the aggregate level. Most countries also set their own poverty lines (see indicator 1b).

Data resources

Data on household income, consumption and expenditure, including income in kind, are generally collected through household budget surveys or other surveys covering income and expenditure.

When available, household consumption data are preferred to income data. National statistical offices, sometimes in conjunction with other national or international agencies, usually undertake such surveys.

Only surveys that meet the following criteria are used: they are nationally representative, include a sufficiently comprehensive consumption or income aggregate (including consumption or income from own production), and allow for the construction of a correctly weighted distribution of consumption or income per person.

The most recent estimates of PPP for developing countries are based on data collected between 1993 and 2015, standardized to 2005 international prices. Global price comparisons are carried out by the International Comparisons Program of the World Bank and others.

LSDI 1.2: Poverty headcount ratio (% of population below the national poverty line)

Definition

The poverty headcount ratio is the proportion of the national population whose incomes are below the official threshold (or thresholds) set by the national government. National poverty lines are usually set for households of various compositions to allow for different family sizes. Where there are no official poverty lines, they may be defined as the level of income required to have only sufficient food or food plus other necessities for survival. This indicator allows for monitoring the proportion of the national population that is considered poor by a national standard. Most poverty analysis work for countries is based on national poverty lines. National poverty lines tend to increase in purchasing power with the average level of income of a country.

Method of computation

Household income (or consumption) and its distribution are estimated from household surveys (see indicator 3). The incomes of various household types, by composition, may then be compared with the poverty lines for those types of household. If the poverty lines are expressed in terms of income per adult equivalent or some similar measure, the incomes of the households must be measured on a similar basis. Household income may be converted to income per adult equivalent by using the modified equivalence scale of the Organisation for Economic Co-operation and Development (OECD)—in which the first household member over 16 equals 1, all others over 16 equal 0.5, all under 16 equal 0.3—or some other equivalence scale. Household incomes are then divided by the 'equivalized' number of people in the household (two adults would equal 1.5 according to the OECD scale) to establish income per person.

Once the number of households that are below the poverty line has been estimated, the number of people in those households is aggregated with livestock dependency weights to estimate the percentage of the LD population below the line.

Data resources

Data on household income, consumption and expenditure, including income in kind, are generally collected through household budget surveys or other surveys covering income and expenditure.

National statistical offices, sometimes in conjunction with other national or international agencies, usually undertake such surveys.

LSDI 1.3: Poverty gap ratio (incidence x depth of poverty)

Definition

Poverty gap ratio is the mean distance separating the population from the poverty line (with the non-poor being given a distance of zero), expressed as a percentage of the poverty line. This indicator measures the "poverty deficit" of the entire population, where the poverty deficit is the per capita amount of resources that would be needed to bring all poor people above the poverty line through perfectly targeted cash transfers.

Method of computation

The poverty gap ratio is the sum of the income gap ratios for the population below the poverty line, divided by the total population, which can be expressed as follows:

$$LSDI\ 1.3 = \frac{1}{n}\sum_{i=1}^{q}\frac{z - y_i}{z}$$

where z is the poverty line, yi is the income of individual i, q is the number of poor people and n is the size of the population. The poverty gap can also be expressed (and thus calculated) as the product of the average income gap ratio of poor people and the headcount ratio, or LDI 1.1 above. Note that

$\sum_{i=1}^{q}(z - y_i)$ = total income deficit of the poor = minimum cost to eliminate poverty with perfect targeting

$$LSDI\ 1.3 = \frac{1}{n}\sum_{i=1}^{q}\frac{z - y_i}{z} = \frac{Targeted\ Welfare\ Budget}{Untargeted\ Welfare\ Budget}$$

1- LSDI1.3 = Gain from targeting = % of untargeted budget saved.

All these formulas are calculated based on data on individuals (y_i as individual income or consumption). If household-level data are used, the formulas have to be adjusted by a weight w_i, which represents household size times the share of livestock income in total income and a sampling expansion factor for every household i.

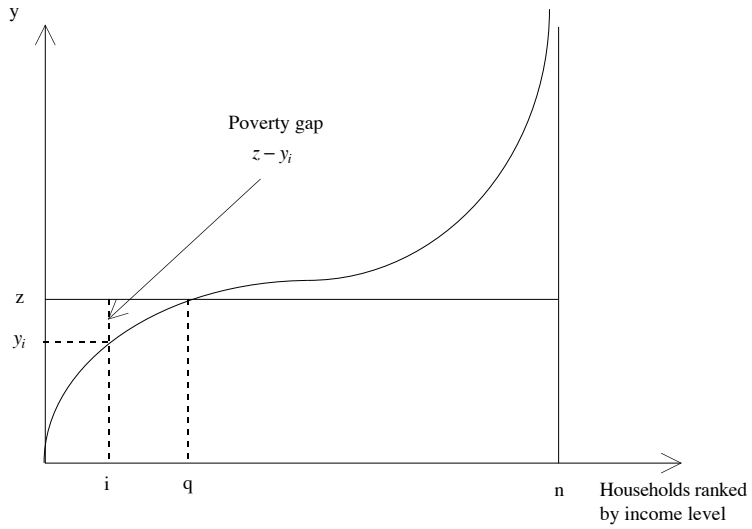


Figure 1. Poverty profile

Data resources

When based on the $1 a day poverty line, this indicator is calculated by the World Bank. When based on national poverty lines, the indicator is commonly calculated by national agencies. The data required are the same as those for indicator 1.1.

LSDI 1.4: Share of poorest LD quintile in national consumption

Definition

Share of the poorest LD quintile in national consumption is the income that accrues to the poorest fifth of the population. This indicator provides information about the distribution of consumption or income of the poorest fifth of the population. Because the consumption of the poorest fifth is expressed as a percentage of total household consumption (or income), this indicator is a 'relative inequality' measure. Therefore, while the absolute consumption of the poorest fifth may increase, its share of total consumption may remain the same (if the total goes up by the same proportion), decline (if the total goes up by a larger proportion) or increase (if the total goes up by a smaller proportion).

Method of computation

Household income and its distributions are estimated from household surveys. Household income is adjusted for household size to provide a more consistent measure of per capita income for consumption. Household income is divided by the number of people in the household to establish income per person. The population is then ranked by income. The income of the bottom fifth is expressed as a percentage of aggregate household income. The calculations are made in local currency, without adjustment for price changes or exchange rates or for spatial differences in cost of living within countries, because the data needed for such calculations are generally unavailable.

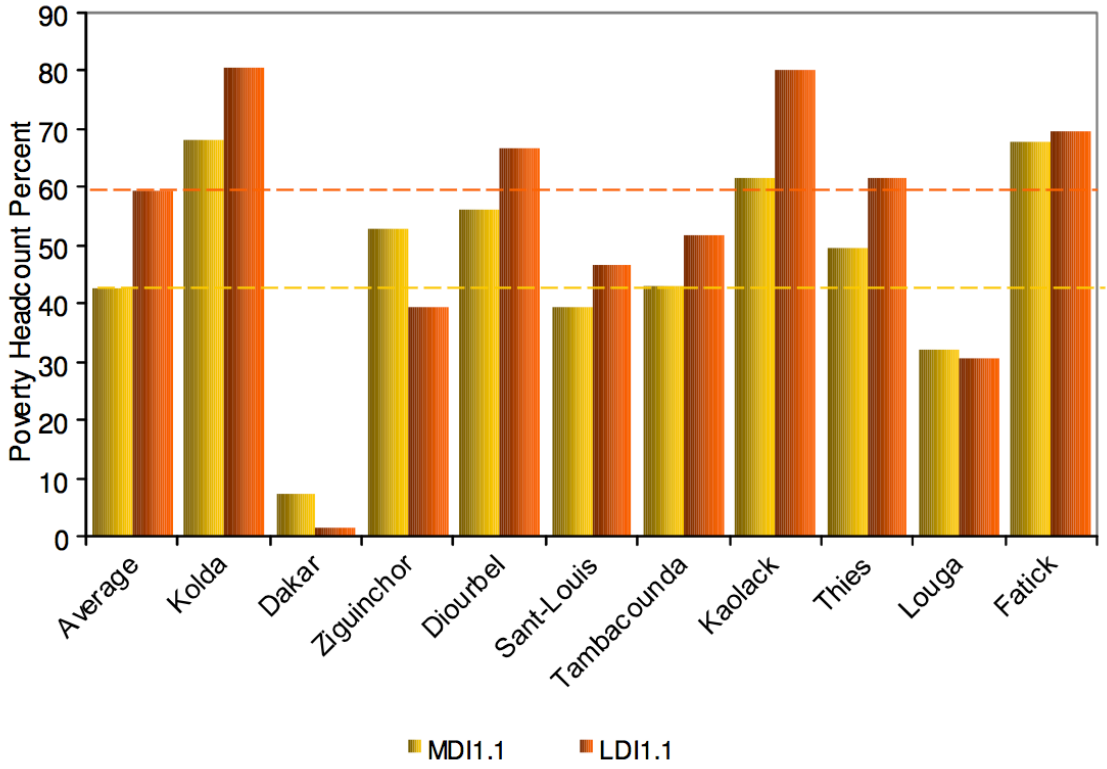
Data resources

For international purposes, this indicator is calculated by the World Bank, but it may also be calculated by national agencies. The World Bank Group's Development Research Group produces the indicator based on primary household survey data obtained from government statistical agencies and World Bank country departments.

Data on household income or consumption come from household surveys. Because underlying household surveys differ across countries in methods and

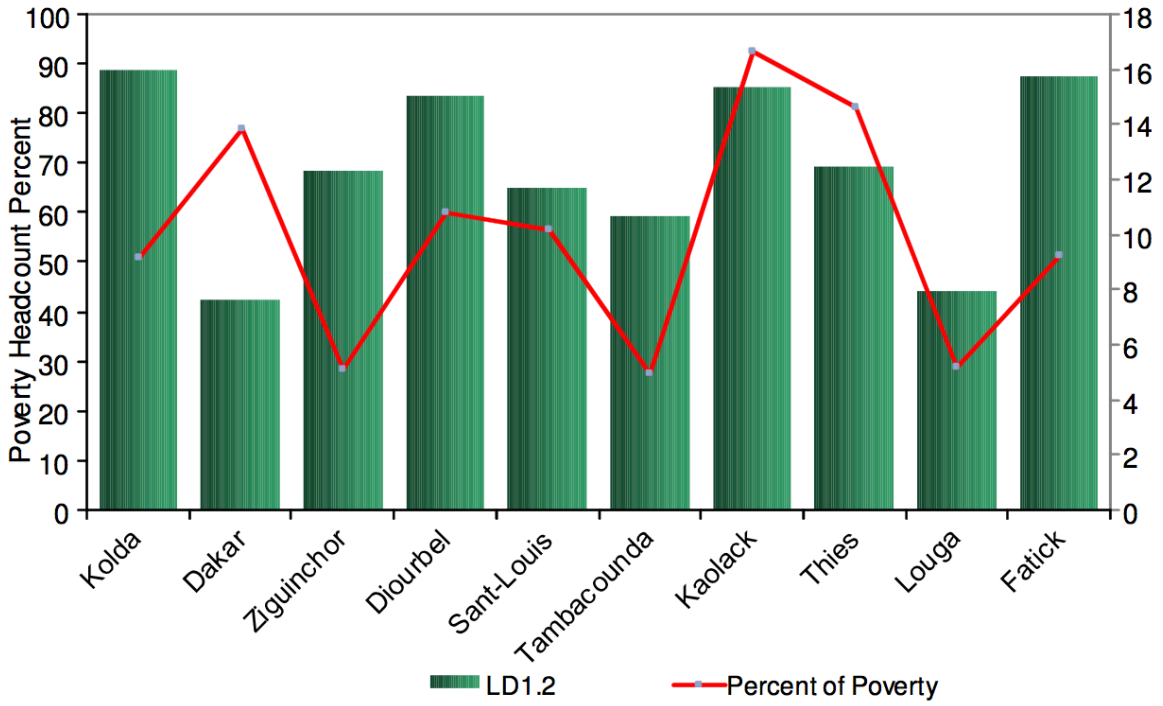
type of data collected, the World Bank tries to produce comparable data for international comparisons and for analysis at the aggregated level (regional or global). Survey data provide either per capita income or consumption. Whenever possible, consumption data are used rather than income data. Where the original household survey data are not available, shares are estimated from the best available grouped data.

Example 1.1: Overall Population (MDG) and Livestock Dependent (LSDI 1.1) Poverty Headcount in Senegal



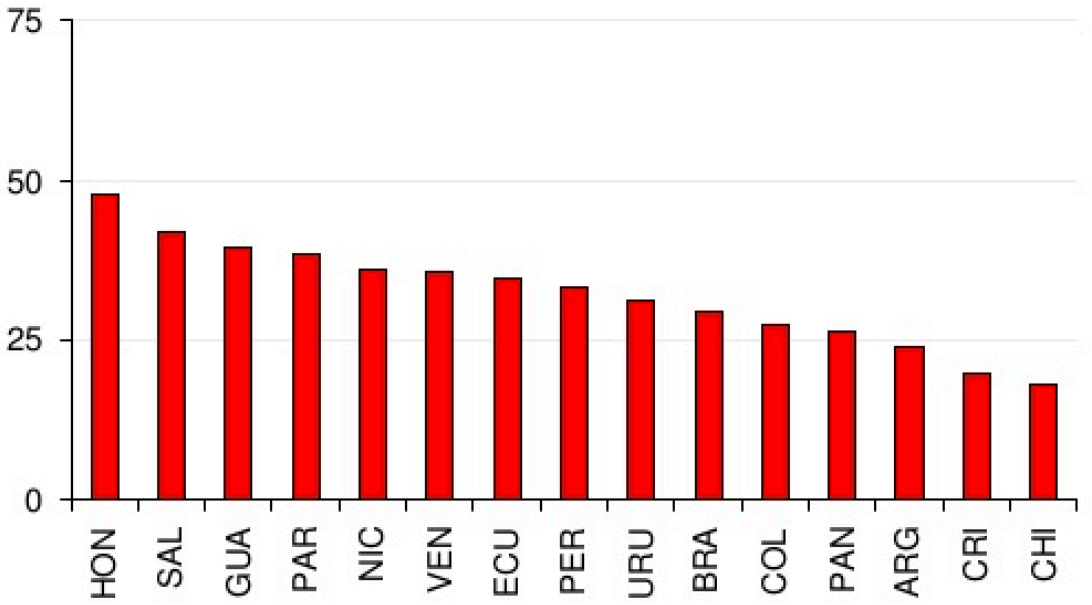
Source: Otte and Roland-Holst: 2008

Example 1.2: Livestock poverty headcount and density by province, Senegal national poverty lines



Source: Otte and Roland-Holst: 2008

Example 1.3: Percent of the Rural Poor Holding Livestock (Latin America)



Source: Otte and Pica-Ciamarra: 2008

End hunger, achieve food security and improved nutrition and promote sustainable agriculture

2.1 Livestock and Hunger

Roughly one in nine people suffer from hunger worldwide, with the vast majority living in developing countries. Within developing countries, 12.9 percent of the population is undernourished. With enough food to feed everyone on the planet, the persistence of hunger and malnutrition calls for a major change of global food and agriculture systems. SDG 2 takes a system wide approach to ending hunger with an emphasis on achieving food security and improved nutrition, and promoting sustainable agriculture. SDG 2 targets include ensuring universal access to safe, nutritious and sufficient food all year round, improving productivity of small-scale food producers, promoting sustainable and resilient food production systems, and maintaining the genetic diversity of farmed animals.

Livestock and animal source foods (ASFs) can make important contributions to achieving SDG 2. ASFs, such as meat, milk, and eggs, are energy dense and provide a spectrum of critical nutrients and readily digestible protein. ASFs are typically available to the rural poor through subsistence animal production, and distribution across networks of small and household enterprises. Strengthening these production systems and distribution channels, as well as smallholder market access, contributes to several SDG 2 targets in terms of: ensuring access by all to safe, nutritious and sufficient food year round; doubling agricultural productivity and incomes of small-scale food producers; and building resilient food production systems. Within these targets, SDG 2 emphasizes serving the most vulnerable groups, such as children, adolescent girls, and pregnant and lactating women, in ensuring food security and improved nutrition is widely accessible.

Animal production at the household level can lead directly to increased consumption of ASFs, and indirectly through increases in income and household purchasing power (Jin and Iannotti, 2014). Multiple studies have found evidence supporting the importance of ASF consumption for family nutrition levels

(Begum, 1994; Leroy and Frongillo, 2007; Yigrem et al., 2015), however, data is often collected at the household level, and further research on intra-household gender dynamics is needed to better understand how ASF resources are allocated to ensure livestock interventions are effective and all household members benefit equally (Gittelsohn and Vastine, 2003; Ruel and Alderman, 2013).

Urban livestock keeping contributes to food security by providing nutritionally dense sources of energy, protein and essential micronutrients in locations where limited transport infrastructure, such as cold chain storage, pose challenges for transporting perishable livestock products. Livestock products are commonly sold in the form of street food in urban settings, which provides a source of inexpensive and convenient food for consumers with limited alternatives. Research has shown poor consumers are typically more dependent on street food than high-income consumers. (Maxwell et al., 2000; Grace at al., 2015). Encouraging farming in cities and investing in local supply chain infrastructure are strategies for supporting safe, accessible, and cost effective food systems at local levels that serve low-income consumers. In addition to supporting food security, ASFs such as meat, milk and eggs have been linked to improved growth and nutrient intake among children, and offer an effective tool for fighting child malnutrition (Neumann and Harris, 2002).

Feeding the world's growing population is a major task, and one that is burdened with a significant environmental footprint. Ensuring sustainable food production systems that increase productivity and output while supporting ecosystems and climate change adaptation is one of the targets for SDG 2. There is great potential within the livestock sector to achieve high levels of food production, while reducing pollution and environmental degradation. Utilizing local feed resources, native livestock breeds, and mixed crop-livestock systems are all strategies to intensify food production for farmers at small and large scales, while mitigating

waste and environmental impact.[10, 11] Utilizing the local supply of manure produced in livestock systems, for instance, can replace synthetic nitrogen fertilizer and offset methane emissions (Alexandratos and Bruinsma, 2012; IFAD, 2010).

2.2 LSDG 2: Increase livestock's sustainable contribution to global nutrition and food security

Objective: By 2030, raise the minimum incomes of all livestock-dependent (LD) people above the global poverty line.

Indicators:

LSDI 2.1: Proportion of LD population below minimum level of dietary energy consumption

LSDI 2.2: Prevalence of underweight in LD children (under five years of age)

[10] Production of livestock feeds is one of the world's largest uses of agricultural water. In response to rapidly growing and intensifying livestock production, livestock systems depend less on locally available feed resources, and instead turn to domestically and internationally traded grain (Steinfeld et al., 2006). Estimated 36% of global cereal production goes to feed livestock (Alexandratos and Bruinsma, 2012; Pelletier and Tyedmers, 2010). This is challenged as a highly inefficient use of food stocks, and reducing food usage on livestock feed could improve food security (Tscharntke et al., 2012). There is significant variation, however, among livestock feed production systems, and much of the grassland livestock feed on could not be easily converted to arable land. Furthermore some livestock species, such as pigs and poultry, are often fed on human food waste, not grains (Godfray et al., 2010).

[11] Yield gaps in livestock production tend to be higher than in crops. There is extensive literature on estimating yield gap in crops (Neumann et al., 2010; Ittersum et al., 2013), but limited amount on livestock. More research is needed to measure the impact of productivity developments in livestock sector yields (Gerssen-Gondelach et al, 2015). Henderson et al. looks at yield gaps for both crops and livestock in East and West Africa, and the impact of closing these gaps on increasing food production and reducing GHG emission intensity (Henderson et al., 2016). Limited access to technical knowledge and skills to increase production, finances to invest in higher value production, livestock varies that maximize yields, and post-slaughter storage are all causes for low yields in livestock production (Godfray et al., 2010).

LSDI 2.1: Proportion of LD population below minimum level of dietary energy consumption

Definition

The proportion of the population below the minimum level of dietary energy consumption is the percentage of the population whose food intake falls below the minimum level of dietary energy requirements. This is also referred to as the prevalence of under-nourishment, which is the percentage of the population that is undernourished.

This indicator measures an important aspect of the food insecurity of a population. Sustainable development demands a concerted effort to reduce poverty, including finding solutions to hunger and malnutrition. Alleviating hunger is a prerequisite for sustainable poverty reduction since under-nourishment seriously affects labor productivity and earning capacity. Malnutrition can be the outcome of a range of circumstances. In order to work, poverty reduction strategies must address food access, availability (physical and economical) and safety.

Method of computation

Estimation of the proportion of people with insufficient food (under-nourishment) involves specification of the distribution of dietary energy consumption, considering the total food availability (from national global statistics) and inequality in access to food (from national household surveys). The distribution is assumed to be unimodal and skewed. The log-normal function is used in estimating the proportion of the population below a minimum energy requirement level or cut-off point. The cut-off point is estimated as a population per capita average value, based on dietary energy needed by different age and gender groups and the proportion of the population represented by each age group.

The estimates are not normally available in countries. The Food and Agriculture Organization of the United Nations (FAO) prepares these estimates at the national level. These are then aggregated to obtain regional and global estimates.

Data resources

The main data resources are country statistics on local food production, trade, stocks and non-food uses; food consumption data from national household surveys; country anthropometric data by gender and age and UN country population estimates, total and by gender and age.

LSDI 2.2: Prevalence of underweight in LD children (under five years)

Definition

Prevalence of (moderately or severely) underweight children is the percentage of children under five years old whose weight for age is less than minus two standard deviations from the median for the international reference population ages 0–59 months. The international reference population was formulated by the National Center for Health Statistics as a reference for the United States and later adopted by the World Health Organization (WHO) for international use (often referred to as the NCHS/WHO reference population).

Child malnutrition, as reflected in body weight, is selected as an indicator for several reasons. Child malnutrition is linked to poverty, low levels of education, and poor access to health services. Malnourishment in children, even moderate, increases their risk of death, inhibits their cognitive development, and affects health status later in life. Sufficient and good quality nutrition is the cornerstone for development, health and survival of current and succeeding generations. Healthy nutrition is particularly important for women during pregnancy and lactation, so that their children set off on sound developmental paths, both physically and mentally. Only when optimal child growth is ensured for the majority of their people will governments be successful in their efforts to accelerate economic development in a sustained way.

The under-five underweight prevalence is an internationally recognized public health indicator for monitoring nutritional status and health in populations. Child malnutrition is also monitored more closely than adult malnutrition.

Method of computation

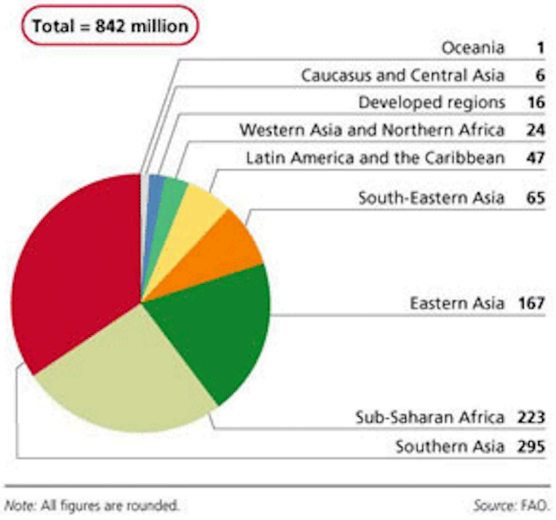
The weights of the under-five child population in a country are compared with the weights given in the NCHS/WHO table of child weights for each age group. The percentages of children in each age group whose weights are more than two standard deviations less than the median are then aggregated with their household livestock dependency rates to form the LD-weighted percentage of children under five who are underweight.

Data resources

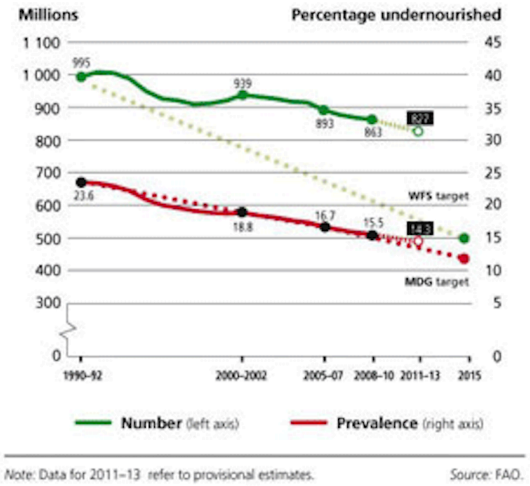
At the national level, data are generally available from national household surveys, including Demographic and Health Surveys, Multiple Indicator Cluster Surveys and national nutrition surveys.

For international comparisons and global or regional monitoring, the United Nation's Children's Fund (UNICEF) and WHO compile international data series and estimate regional and global figures based on data from national surveys.

Example 2.1: Undernourishment by Region



Example 2.2: Undernourished in Developing Regions



Ensure healthy lives and promote well-being for all at all ages

3.1 Livestock and Healthy Lives

SDG 3 ensures healthy lives and promotes the well-being for all at all ages with an emphasis on ending preventable child and maternal mortality, and improving prevention and treatment of a wide range of diseases including neglected tropical diseases and non-communicable diseases.

While there are many noted economic and nutritional benefits to livestock production at the household, national, and global levels, if not managed properly livestock can be a source of human disease. A fair share of microorganisms harbored by livestock can be transmitted to humans directly, via the environment or through ASF. The burden of these zoonotic diseases falls heavily on the poor, causing health care expenses and reducing their income earning potential, at times for the remainder of their lives. Due to limitations in health services in many developing countries, zoonotic diseases tend to be under-diagnosed. They are not prioritized by the national or international health system, and most fall under the 'neglected tropical disease' (NTD) category. Many of these zoonotic diseases can be prevented by raising awareness and by promoting hygienic livestock production and food preparation practices.

Increasing livestock numbers, accelerating animal turnover, confinement of large numbers of animals in small spaces as well as habitat fragmentation through expansion of livestock production raise the risk of emerging zoonoses, some of which may have pandemic potential. Furthermore, inappropriate use of antimicrobials in animal production contributes to the rising trends in antimicrobial resistance (AMR) of human infections across the globe.[12] Finally,

[12] Evidence has shown agricultural use of antimicrobials lead to risk in human health, with children in particular bearing high risk of infection due to drug-resistance induced by agricultural use of antimicrobials (Cohen, 1992; Shea, 2003). Conventional dairy cattle have been found to have the highest level of AMR compared to organic dairies and beef-bred cattle (Douglas et al., 2008). The complex ecology of antimicrobial resistance presents a challenge for

overconsumption of ASF leads to an increase in non-communicable human disease burden by the fostering development of ischemic heart disease.

Ensuring collaboration between animal health and human health sectors through the One Health approach is crucial for achieving an integrated and preventative strategy to control livestock-associated health risks and contribute to achievement of SDG 3 in ensuring healthy lives and promoting well-being for all.

A major global component of this SDG is improving child health. The relationship between livestock keeping and child health is complex, with multiple channels enabling positive or negative impacts.[13] On the one hand, living in proximity to livestock, especially in settings lacking basic sanitation facilitates, can prompt the transmission of disease from animals to humans. Children, who commonly share the task of taking care of household livestock, are at greater risk of exposure, and children under the age of 5 have the highest risk of severe illness from zoonoses once contracted.[14] On the other hand, however, in low-income settings, livestock ownership can improve child nutrition and immune competence.[15] Small amounts of ASF in early childhood have been shown to have remarkable impacts on physical and cognitive development hugely enhancing

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understanding and preventing the selection and spread of AMR, which involves a host of domestic and wild animals and pathways for transporting resistant strains of bacteria (USDA, 2014). Calls for intergovernmental efforts combining epidemiology and veterinary medicine with health economics and international law to address AMR are supported by AMR's global and cross-sector applications (Woolhouse et al., 2015).

[13] Mosites et al (2015) conducted a study using Demographic and Health Survey (DHS) datasets from three African countries, Ethiopia, Kenya, and Uganda, to compare child-stunting status across levels of livestock ownership. The analysis suggests animal ownership alone may only have a small influence on child stunting status, and greater context-specific research is needed with an emphasis on feeding practices, animal health, and livestock sanitation.

[14] Household keeping livestock have been found to have higher risk for contracting zoonotic disease (Kagira and Kanyari, 2010). Fecal contamination is another prevalent channel for child exposure to zoonotic diseases (Marquis et al., 1990).

[15] A study in Ethiopia presents empirical evidence on the importance dairy product consumption has for family nutrition levels (Yigrem et al., 2015); and a study conducted in India found children belonging to families who were part of dairy cooperatives had better nutrition than those from families who did not join (Begum, 1994).

human capital.[16] Livestock health and productivity, access to sanitation services, and nutrition education are all variables that likely play a role in the channels of causality and will factor into improving the relationship between livestock and child and human health outcomes.

3.2 LSDG 3: Promote global human health through higher standards for animal health and husbandry, including hygienic and humane production and processing practices

Objectives

Promote higher standards for animal health (and welfare?), including hygienic and humane production and processing practices. Avert major epidemics and reduce the incidence of transboundary animal diseases and zoonoses by 1/2 by 2015.

Indicators

LSDI 3.1: Livestock health indicator

LSDI 3.2: Smallholder livestock health indicator

LSDI 3.3: Smallholder animal health adversity

LSDI 3.4: Smallholder animal health gap

LSDI 3.5: Smallholder animal health severity

LSDI 3.6: Epidemic and zoonotic animal disease prevalence indicator

LSDI 3.7: Animal disease outbreak indicator

LSDI 3.8: Veterinary extension indicator

[16] The contribution of animal source foods in improving diet quality, health, and physical and mental development in children in the developing world is thoroughly reviewed and presented in Neumann, Harris, and Rogers (2002), which concludes ASF has a positive impact on the quality and micronutrient enhancement of the diet of women and children.

LSDI 3.9: Vaccination Coverage

LSDI 3.1: Livestock health indicator

Definition

This index is an overall measure of animal health and represents a composite of standard indicators from animal husbandry and veterinary practice. This indicator resembles the family of human development indices promulgated by UNDP.

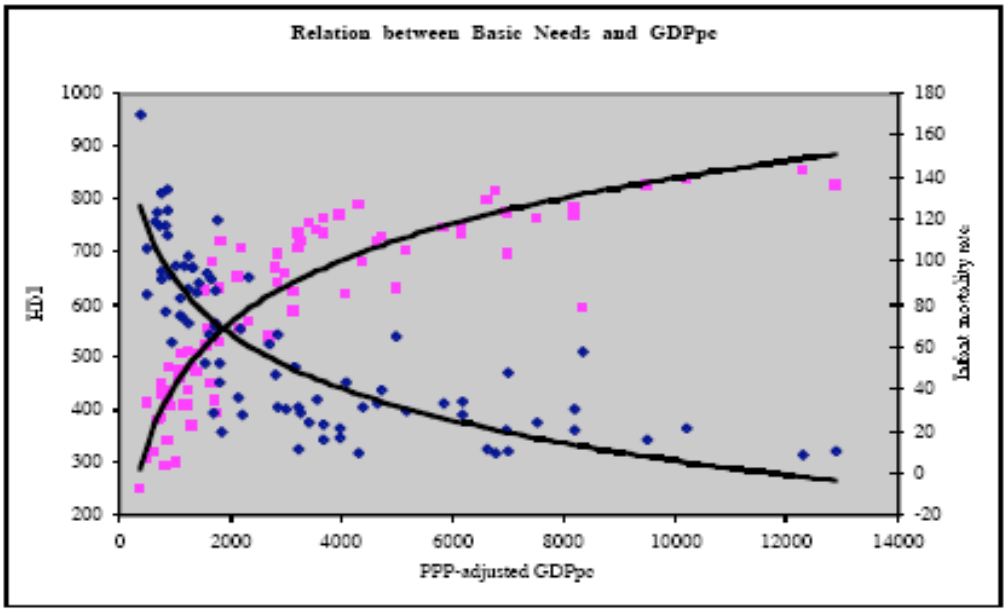
Method of computation

Formally, we define the indicator as follows:

$$LDSI\ 4.1\ (s,k) = 1 - \frac{1}{n}\sum_{i=1}^{n}\frac{L_{i,s,max} - L_{i,s,k}}{L_{i,s,max} - L_{i,s,min}}$$

for livestock variety s and a given village, region, or country k. In this formula, L_i denotes one of n animal health indicators. The universe of comparison (i.e. for determining max and min values) depends on the application at hand. Where k denotes villages or regions, the universe is national, but where k is an entire country the universe is a global or regional (e.g. West Africa) grouping.

Generically, we expect to see a relationship between this indicator and living standards as depicted in the following figure.



Data resources

LSDI 3.2: Smallholder livestock health indicator

Definition

This indicator is completely analogous to LDI 4.1, but its sampling is confined to smallholder livestock producers.

Method of computation

Data resources

LSDI 3.3: Animal health adversity

Definition

Beginning with a minimum standard for the animal health indicator LDI 4.1, smallholder animal health adversity measures the smallholder livestock headcount for those producers whose stocks fall below the minimum standard. In addition to measuring national, regional, or local prevalence of animal health

challenges, this indicator is of special relevance to targeting of extension services and other smallholder assistance.

Method of Computation

Using the notation above, we define

$$LSDI\ 4.3\ (s) = \frac{q_s}{n_s}$$

where n_s denotes the total headcount of livestock holdings for producers of livestock type s_s denotes the number whose stocks are below minimum average health status.

Data resources

LSDI 3.4: Smallholder animal health gap

Definition

The smallholder animal health gap is the mean distance separating the smallholder livestock population from the minimum health standard (with healthy stocks being given a distance of zero), expressed as a percentage of the minimum standard line. The indicator measures the "animal health deficit" of the entire population, where the deficit is the per capita amount of resources that would be needed to bring all animals to the minimum health threshold line through perfectly targeted veterinary expenditures.

Method of computation

The gap ratio is the sum of the health gap ratios for the population below the minimum health line, divided by the total population, which can be expressed as follows:

$$LSDI\ 4.4 = \frac{1}{n}\sum_{i=1}^{q}\frac{z - h_i}{z}$$

where z is the minimum health line, h_i is the income of individual household i, q is the number of animals below the minimum health standard in a total

population of n. The animal health gap can also be expressed (and thus calculated) as the product of the average health gap ratio below z and the headcount ratio, that is,

$$HR = \frac{q}{n}$$

where

q = number of animals below minimum health status line

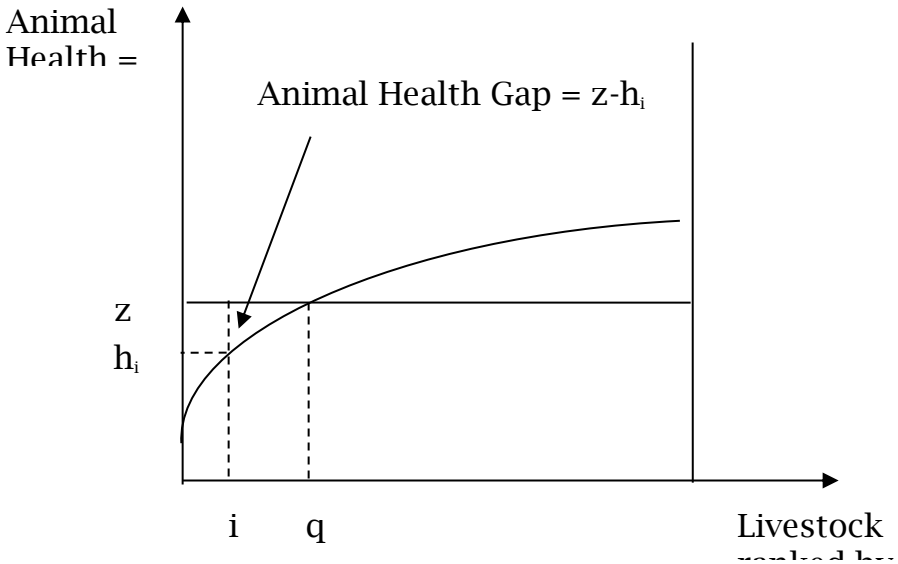
n = total animal population size

Note that

$$\sum_{i=1}^{q}(z - h_i)$$

denotes total animal health deficit of the poor

All these formulas are calculated based on data on individuals (y_i as individual income or consumption). If household-level data are used, the formulas have to be adjusted by the weight w_i, which is the household size times the share of livestock income in total income and a sampling expansion factor for every household i.



Data resources

LSDI 3.5: Smallholder animal health adversity

Definition

This indicator measures the extent to which animal health status varies within smallholder livestock populations. For example, smallholders in the urban periphery might have relatively high animal health indicators, while subsistence farmers in the hinterlands contend with high rates of animal health problems and their many attendant costs. High adversity rates pose a significant barrier to extending market access and increasing livestock net income across national poor constituencies.

Method of Computation

Using the previous notation, smallholder animal health adversity is measured as follows

$$LSDI\ 4.5 = \frac{1}{n}\sum_{i=1}^{q}\frac{(z-h_i)^2}{z}$$

which measures inequality of animal health status among the poor.

Data resources

LSDI 3.6: Animal disease prevalence indicator

Definition

Prevalence of animal disease, by disease and animal type, is the number of cases as a percent of the stock under consideration (national, regional, or local). Stock mortality rates are also of interest.

The indicator allows highly endemic countries to monitor disease and death from malaria, which have been increasing over the last two decades due to deteriorating health systems, growing drug and insecticide resistance, periodic changes in weather patterns, civil unrest, human migration and population displacement.

Method of computation

Prevalence is expressed as infected and/or lost animals measured in proportion to a reference population. At the national level, this could be per 100,000 animals, while at the local level it would be an average percent of household or village stocks.

Data resources

Data come from administrative sources, household surveys, and animal health statistics registrations.

LSDI 3.7: Animal disease outbreak indicator

Definition

The scope of animal disease outbreaks is an important indicator of contagion risk and the efficacy of monitoring/reporting systems. This indicator measures the relative headcount radius of disease outbreaks in a given time period. The larger is the value of the indicator, the greater the risk of widespread contagion. In the case of epizootic diseases, this risk extended automatically from the animal to human populations. In the case of potential epizootic diseases (e.g. HPAI), higher values of LDI 3.7 indicate higher risk from mutagenic incubation, i.e. increased risk for mutation to homo-contagious disease varieties.

Method of computation

Formally, we define the indicator as follows:

$$LSDI\ 3.7\ (d, s, k) = \frac{1}{n}\sum_{i=1}^{q} H_{i,d,s,k}$$

for livestock variety s and a given village, region, or country k. In this formula, H_i denotes the infected livestock headcount for household, commune, or village i in a sample universe k of n such reporting episodes. The universe of comparison.

Data resources

LSDI 3.8: Veterinary extension indicator

Definition

This indicator measures total domestic and foreign spending on veterinary services for livestock production and maintenance.

Method of computation

Expenditures on livestock veterinary extension services, expressed as a percent of livestock GDP and/or livestock value of output, at the national, regional, or local level. Expenditures include public and private outlays to initiate, deliver, and sustain fee-based and free services.

Data resources

LSDI 3.9: Vaccination Coverage

Definition

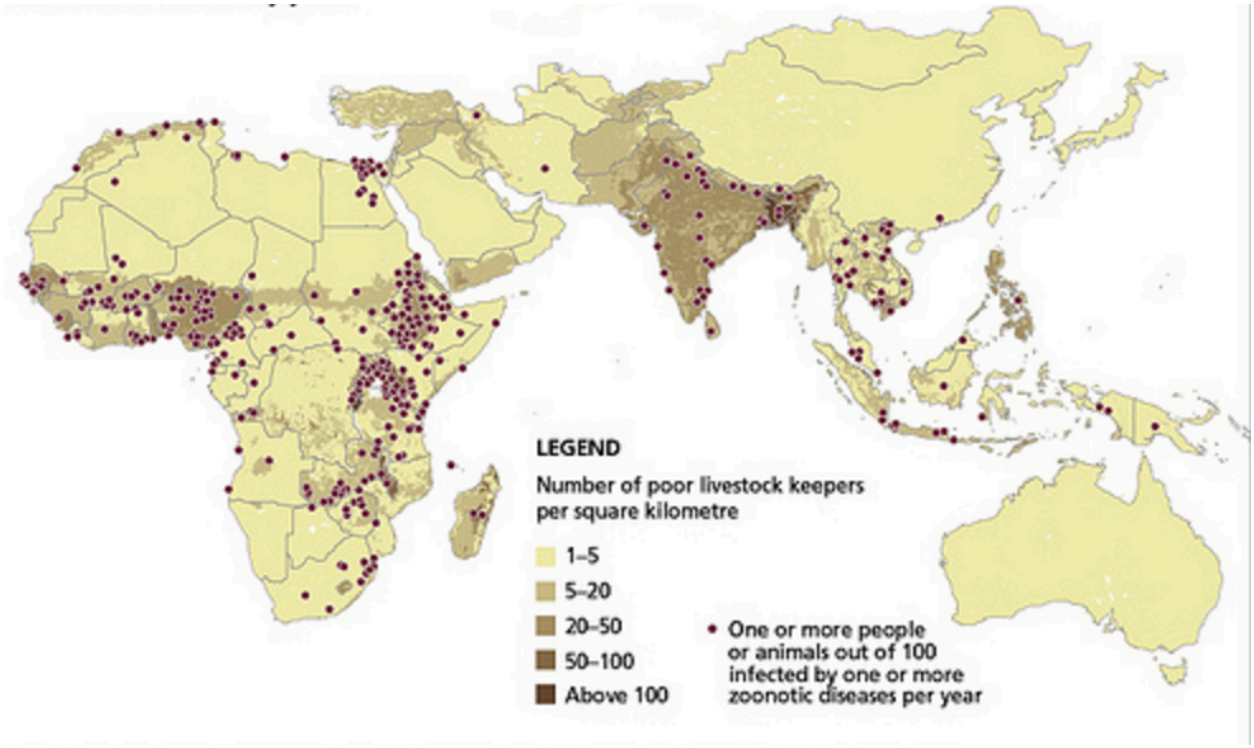
This indicator measures the scope of immunization across agricultural animal populations.

Method of computation

Based on representative livestock surveys across production systems, this indicator would measure headcount percentages of covered animals by major immunization category.

Data resources

Example 3.1: The greatest burden of zoonoses falls on one billion of the world's smallholder livestock keepers



Source: ILRI, 2014.

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

4.1 Livestock and Education

Consumption of ASFs, such as meat, milk and eggs, has been linked to improved growth and nutrition among children, as well as cognitive development (Neumann, Harris and Rogers, 2002). While this has immediate benefits for child health, improved nutrition is also linked to higher school enrollment, attendance, and performance rates (Alderman et al., 2001; Glewwe et al., 2001). Integrating school milk programs and other ASF-rich supplementary meal schemes into education systems can be a valuable strategy for ensuring access to nutritious foods, and aligns with SDG 4 in ensuring quality education and promoting lifelong learning.[17] SDG 4 targets identify early childhood development and quality technical and vocational education as important components to achieving an inclusive and effective education system.

The links between livestock and education are often indirect, but can be quite important to rural society. One of the primary barriers to higher livestock productivity and associated livelihood improvements, particularly among smallholders, is lack of knowledge and relevant information about best practices, technology of all kinds (genetic improvement, SPS, ICT, etc.). Farmer education and extension services can be potent catalysts for improved rural livelihoods and national food security, and livestock practices in particular have among the highest prospects for growth of productivity and value added.

From another dimension, traditional labor-intensive animal husbandry can sometimes undermine school attendance and retention among children and

[17] A number of studies have linked milk consumption to improved child growth including: milk consumption of children in pastoral and settled communities in northern Kenya (Fratkin et al., 2004); milk consumption in Latin America (Ruel, 2003); and generally (Moore et al., 2008).

young adult females.[18] Extension service programs should be targeted to husbandry practices that reduce the need for extensive labor inputs, with a double dividend of higher productivity and freeing children and women for more extended schooling and more skill intensive activities.

4.2 LSDG 4: Promote extension services, agribusiness education, and technology transfer across smallholder livestock supply chains.

Objective

Promote vocational and general education for livestock producers and livestock-dependent communities.

Indicators

LSDI 4.1: Livestock extension services indicator

LSDI 4.2: Livestock-dependent community education spending

LSDI 4.1: Livestock extension services indicator

Definition

This indicator measures total domestic and foreign spending on livestock extension services for production, processing, marketing, maintenance, etc.

Method of computation

Expenditures on livestock extension services, expressed as a percent of livestock GDP and/or livestock value of output, at the national, regional, or local level. Expenditures include public and private outlays to initiate, deliver, and sustain fee-based and free services. Indicators can aggregate or disaggregate individual service categories (i.e. production, processing, marketing, etc.).

[18] The relationship between child education and household livestock ownership requires greater research. A study conducted in Ethiopia finds children in households with livestock wealth have lower school attendance due to herding obligations (Fafchamps et al., 2009). Research conducted in Ethiopia, Kenya and Uganda suggests livestock ownership alone is not enough to heavily influence child nutrition, and other factors including household gender dynamics and livestock health and production likely influence outcomes (Jin and Iannotti, 2014; Mosites et al., 2015).

Data resources

LSDI 4.2: Livestock-dependent community education spending

Definition

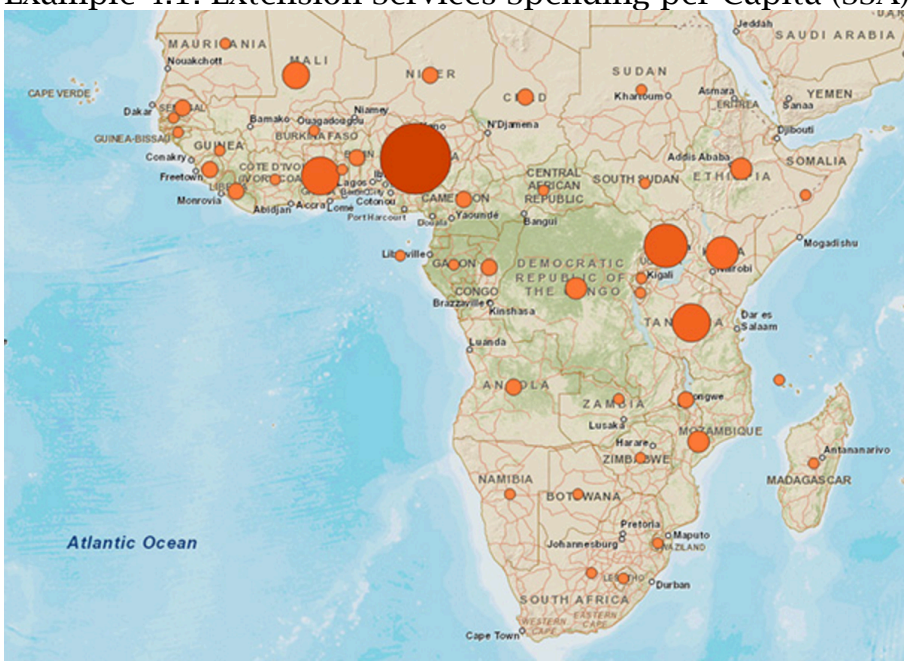
This indicator measures total domestic and foreign spending on general education for children and adults in livestock-dependent communities.

Method of computation

Expenditures on general education for children and adults in livestock-dependent communities, expressed as a percent of community income, per captia, and/or per active student. Expenditures include public and private outlays in formal (classroom) education, vocational/business development, and subsidies for on-the-job training.

Data resources

Example 4.1: Extension Services Spending per Capita (SSA)



Source: World Bank, 2013

Achieve gender equality and empower all women and girls

5.1 Livestock and Gender Equality

Livestock keeping and production can make a significant contribution to SDG 5 in achieving gender equality and empowering women and girls. Women and girls are heavily involved in livestock rearing and production throughout the world, however, gender norms and power dynamics have been shown to limit women's ability to access high-value markets and profit from livestock production. Developing programs and extension services tailored to local conditions that target women farmers, and women in general, can contribute to several of SDG 5's targets such as: ending discrimination against women and girls, recognizing and valuing unpaid care and domestic work through the provision of public services and infrastructure, and promoting equal rights for women to resources and services overall.

Women make up an average of 43 percent of the agricultural labor force in developing countries.[19] Labor force statistics, however, may significantly underestimate the amount women do in agriculture and livestock, since a lot of the work may not be reported or considered part of the labor force.[20] As men

[19] This figure ranges from 20 percent in Latin America to nearly 50 percent in parts of Africa and Asia, and exceeds 60 percent in a few countries including Lesotho, Mozambique and Sierra Leone (FAO 2010, FAO, 2011a).

[20] Estimated two thirds of the world's 600 million poor livestock keepers are rural women (Thornton et al., 2003). Further statistics on women livestock keepers and population are presented in *The State of Food and Agriculture* report for 2009 (FAO, 2009a; FAO, 2011), and a 2012 FAO report, *Invisible Guardians*, which gives a comprehensive overview of the role of women in livestock systems (FAO, 2012b). Both reports state women are found to be just as likely as men to keep livestock, however, women tend to keep a smaller number of animals, and different species than men. Although ownership and power dynamics vary by region, many studies show women are more likely to own smaller livestock such as poultry, pigs, and goats, while men are more likely to own cattle and large animals (Valdivia, 2000; Thornton et al., 2002; FAO, 2012b) Case studies where this is studied include Southern Nigeria (Edit and Etim, 2014), and Ecuador (Doss et al., 2011). In general, animal care, feeding, and milking are all tasks commonly

migrate to urban locations and seek off-farm employment, rural women's' involvement in smallholder production has grown, a trend that is expected to continue (Deere, 2005; Upadhay, 2005; Johnson et al., 2013). Practical strategies such as training female extension officers, strengthening horizontal linkages between women producers through cooperatives, and conducting trainings at the individual as opposed to household level can ensure women have access to services and benefit equally from production-improving technology interventions.[21]

While women play a large role in smallholder livestock production, women livestock keepers typically face greater challenges than men in overcoming economic and technical barriers due to poorer access to land, credit, markets, and technical information (Deere, 2006; Quisumbing et al., 2015). Gender disparity in land ownership can pose significant barriers for women livestock keepers, hindering their ability to access feed or increase production. Embedded power dynamics can also constrain income-earning opportunities for women, who, in many regions, report having to consult their husbands before selling animals. [22] Understanding and addressing these social, legal, and financial constraints is key to developing policies and interventions that improve productivity and market access for women livestock keepers, and result in poverty reducing impacts.[23] Further research on what livestock products and markets have the greatest benefits for women are needed to inform these interventions.

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associated with women, while fodder collection and market decisions are more often associated with men (Upadhyay, 2005; Lo Bianco, 2007).

[21] When the beneficiary is defined as the household, women are commonly excluded from receiving the benefits (Alderman et al., 1998; Upadhayay, 2003). Using an alternative approach such as offering training for two individuals per household has been shown to be an effective strategy in increasing women participation in livestock training (Johnson et al., 2013).

[22] Galie et al. (2015) look at Tanzania, Ethiopia, and Nicaragua and shows ownership arrangements and dynamics vary by location, gender, and household. In many cases ownership does not equate with having full authority of livestock, and women often stated not having control over selling animals. Similar power dynamics are found in Mozambique (Valdiva, 2001), and explored throughout Eastern and Southern Africa (Njuki and Sanginga, 2013)

[23] Improving the control women have over livestock proceeds could also improve child nutrition, and education outcomes, since women empowerment has been shown to promote child health (Smith, 2003; Allendorf, 2006)

Key areas for policy intervention aiming to empower women livestock keepers include developing gender aware extension services and training programs, utilizing participatory decision-making processes and improving access to credit and loans in rural areas. Access to finance is a major barrier facing poor female livestock keepers from increasing production and taking advantage of market opportunities. Research conducted in Ethiopia, Ghana and Bangladesh have shown women with access to credit choose to invest in livestock purchases, and have leveraged credit access to grow operations from poultry production up to goats and dairy cattle (Rubin et al., 2010; Todd, 1998).

5.2 LSDG 5: Promote gender balanced livestock production, processing, and management practices and increase investment in female-centered livestock related activities

Objective

Promote gender equality and productivity based compensation and management authority in livestock related enterprises..

Indicators

LSDI 5.1: Headcount of women and girls in livestock extension service enrollment.

LSDI 5.2: Headcount female employment in formal sector livestock production, processing, and marketing enterprises.

LSDI 5.3: Average per capita income of females working in formal sector livestock enterprises, as a percentage of male per capital income.

LSDI 5.4: Share of extension service spending on female-centered livestock related activities, e.g. small animal husbandry/processing/marketing, eggs, dairy, furs, etc.

LSDI 5.5: Share of formal, informal, and public livestock related enterprise credit extended to females.

LSDI 5.1: Headcount of women and girls in livestock extension service enrollment

Definition

This indicator measures the extent of access to extension services for female household members.

Method of computation

Estimates of FTE enrollment and attendance of female as a percent of all FTE extension students. Distributions by age, marital/family status, formal education level, and other demographic characteristic would also be desirable.

Data resources

Extension service program records, household and education surveys, project performance evaluations.

LSDI 5.2: Headcount female employment in formal sector livestock production, processing, and marketing enterprises

Definition

This indicator measures

Method of computation

Estimates of FTE female formal sector livestock employment as a percent of all FTE employees. Distributions by age, marital/family status, formal education level, and other demographic characteristic would also be desirable.

Data resources

Enterprise and employment surveys, project performance evaluations.

LSDI 5.3: Average per capita income of females working in formal sector livestock enterprises, as a percentage of male per capital income

Definition

This indicator measures the levels and equity of compensation of females working in livestock enterprises.

Method of computation

Estimates should include compensation by production, processing, and product type, per unit of time, output (for piecework), and any available productivity indicators. Also desirable would be comparable data for male employees.

Data resources

Enterprise, household, and census surveys.

LSDI 5.4: Share of extension service spending on female-centered livestock related activities, e.g. small animal husbandry/processing/marketing, eggs, dairy, furs, etc.

Definition

This indicator measures the extent to which extension services target and promote livestock production/processing/marketing activities traditionally d by females. These would include, but not be limited to, small animals, livestock by products (e.g. dairy, eggs, fur, etc.).

Method of computation

Estimate shares of extension service spending that target female-centered agricultural activities generally and livestock activities in particular.

Data resources

Data from extension service budgets and project evaluations.

LSDI 5.5: Share of formal, informal, and public livestock related enterprise credit extended to females

Definition

This indicator measures the share of formal and informal credit extended to females as individuals, household heads, and enterprise owner/managers.

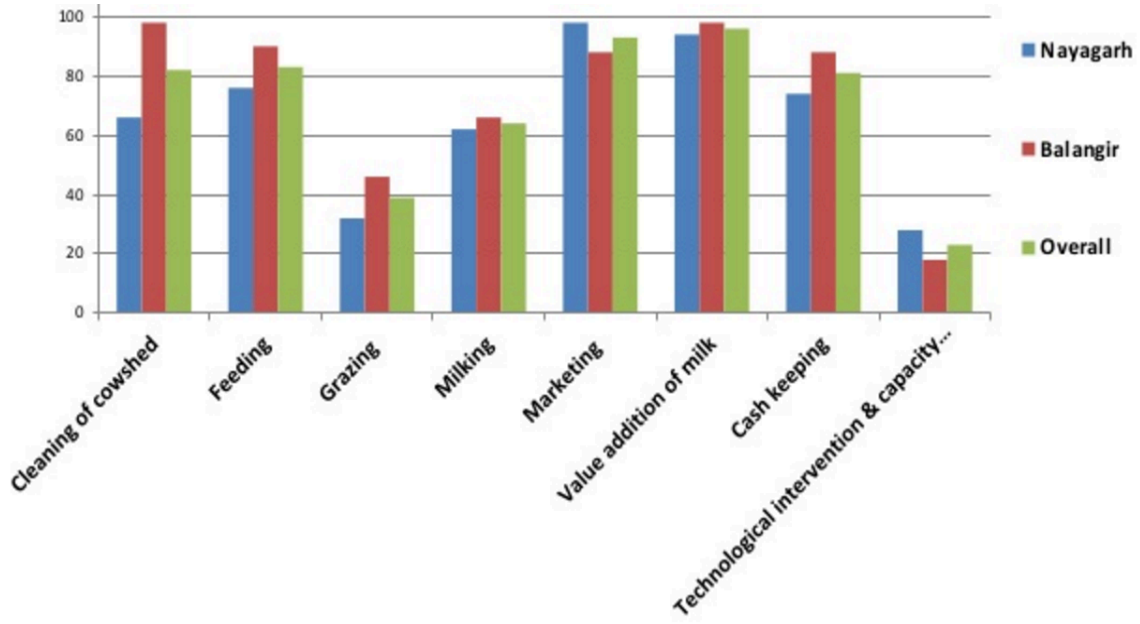
Method of computation

Calculate the levels and percentages of all credit extended to females, by lending and borrowing institution, and sector of primary activity. Include full financing costs, collateral terms, credit duration, and loan performance.

Data resources

Records of banks, credit unions, microfinance institutions, and other private and public lenders.

Example 5.1: Percent of Female FTE Employment in Livestock Activities, by Community



Source: Jena and Behura (2016).

Example 5.2: Females as a Percent of Agricultural Workers and Extension Staff

Example 5.3: Impact of Microfinance Eligibility on Status of Women

(n=56)

Sl.No	Variable	Number	Percentage
1	Women are economically empowered	39	69.64
2	Microfinance reduce poverty	37	66.07
3	Microfinance improve rural savings	38	67.85
4	Increased employment opportunities	34	60.71
5	Created assets in rural areas	28	50.00
6	Increase the standard of living	26	46.42

Source: Gopala, 2014.

Ensure availability and sustainable management of water and sanitation for all

6.1 Livestock, Water, and Sanitation

Agriculture uses approximately 70% of the available freshwater supply, and roughly 30% of global agricultural water use is linked to livestock production (Ran et al., 2016), one third of which supports beef cattle.[24] To meet the rising demand for animal products, global livestock sector expansion is intensifying agricultural water use, increasing competition with other human water needs and environmental services. [25] Given the large, and growing, water footprint associated with livestock production, improving water use efficiency throughout the production system is an important contribution to achieving SDG 6 in ensuring access to safe water sources and sanitation for all. In addition to universal water access, SDG 6 targets emphasize substantially increasing water-use efficiency across all sectors to address water scarcity.

While water is used at all stages of the livestock production process, from animal drinking water to dairy and meat processing, feed production accounts for the greatest use of water.[26,27] Mitigation options to improve water-use efficiency can

[24] Beef has the largest per calorie water footprint: 20 times larger than cereals (Mekonnen and Hoekstra, 2012).
[25] Numerous studies report on an on-going shift towards industrial farming systems to meet rising demand for animal products (Bouman et al., 2005; Naylor et al., 2005; Galloway et al., 2007; Thornton, 2010), and resulting environmental consequences of intensified production (Naylor et al., 2005; McMichael et al., 2007; McAlpine et al., 2009; Sutton et al., 2011).
[26] Improving global livestock water productivity will require sustainable sourcing of animal feed (Peden, 2007). Research conducted in the tropics found dried cassava roots, dried cassava leaves, and cassava hay all serve as successful energy and protein sources in ruminant feed, and are readily available year-round (Wanapat, 2013). Many other available feed resources in tropics benefit animals, humans, and environment, including perennial forage shrubs (Speedy and Pugliese, 1991; Wanapat, 2008).
[27] In developing countries, water cost of animal production may be less than global predictions due to different production systems. Most African livestock,

be broken down into three main strategies: reduced water use, reduced depletion process and improved replenishment of water resources (Steinfeld, 2006). Reduced water use initiatives include upgrading irrigation technology to improve efficiency, and shifting towards mixed crop-livestock systems, which use lower levels of water while increasing productivity . [28] Complementary land management practices can also impact water use: overgrazing, for instance, can affect water filtration and retention capacity of grasslands, and significantly compromise an area's water cycling functionality.

One of the central water-related challenges facing the livestock sector is waste management and disposal. Nutrient runoff and leaching from concentrated sources of livestock waste is harmful for freshwater sources and ocean and marine environments. If not properly managed, nutrient run off such as nitrogen can be detrimental to surrounding ecosystems and coastal fisheries. [29] Many technical solutions are in place in industrialized production systems, such as improved manure collection and storage facilities, and processing methods utilizing physical and chemical treatment options. The major task is applying and adapting existing technologies to local conditions within developing countries to reduce nutrient pollution and conserve marine resources.

6.2 LSDG 6: Promote sustainable water use and water quality management in livestock production and processing systems.

Objective

for instance, depend on crop residues, for which water was already allocated in terms of crop production (Peden et al., 2011).

[28] Competing uses of water between livestock and crop production, as well as environmental services, will be a challenge for increasing production in both sectors, and necessitates continuing use of mixed crop-livestock systems (Thornton, 2010, Herrero et al., 2012). In the face of climate change and population growth, Herrero et al. (2012) suggests policy should prioritize farmers to utilize mixed crop-livestock systems to intensify production while using low levels of fertilizer and water, mitigating waste and environmental impact.

[29] Animal products produced from industrial systems consume and pollute more ground and surface water resources than animal products from grazing or mixed systems (Mekonnen and Hoekstra, 2012).

Promote sustainable water use in all livestock production systems, as well as PPaM practices that are consistent with direct and indirect water quality management.

Indicators

LSDI 6.1: Direct water us in livestock Production, Processing, and Marketing

LSDI 6.2: Proportion of animal production and processing waste subject to containment and biosecure processing.

LSDI 6.1: Direct water us in livestock Production, Processing, and Marketing

Definition

This indicator measures all direct water consumption in livestock PPaM, calculated at all stages of the supply chain, but disaggregated by enterprise scale, species, and location.

Method of computation

Estimate direct applications of water in animal and animal product PPaM, by animal type, enterprise size, and location.

Data resources

Detailed farm and livestock supply chain audits.

LSDI 6.2: Proportion of animal production and processing waste subject to containment and biosecure processing

Definition

This indicator measures the physical share of waste products from livestock production and processing (including manure, offal, etc.) that are directly contained and subject to biosecure processing, minimizing adverse impacts on the quality and safety of local surface and groundwater.

Method of computation

Estimate the volume of animal waste in livestock production (manure, urine, dander, biogas, etc.) and processing (offal, blood, etc.) and calculate the share that is contained for diversion to biosecure alternative uses. The latter include

reprocessing, composting, fermentation for biogas use (not including venting/flaring).

Data resources

Detailed livestock supply chain audits.

Example 6.1: Reasons to Invest in Water for Developing Country Livestock

	Country group	Annual growth (%)
Meat	Developed	0.6
	Developing	2.8
	SSA	**3.5**
Milk	Developed	0.2
	Developing	3.3
	SSA	**3.8**

Source: Delgado et al: 1999.

Ensure access to affordable, reliable, sustainable and modern energy for all

7.1 Livestock and Energy

SDG 7 works to ensure access to affordable, reliable, sustainable and modern energy for all. In addition to striving for universal energy access, SDG 7 targets highlight the importance of investing in renewable energy, and expanding infrastructure to supply sustainable energy services in developing countries, where the greatest number of people are living without electricity.

Converting livestock manure into biogas could be an important domestic renewable fuel source, and contribute to SDG 7 in improving access to affordable, reliable, and sustainable energy sources. Rural villages and remote areas often lack direct connections to national electricity grids in many developing countries, especially in Sub-Saharan Africa and Southern Asia. Decentralized bioenergy applications provide a cost-effective and sustainable alternative to grid electricity. The abundance of livestock manure present in regions characterized by low electrification rates is a major opportunity for generating biomass energy, and furthermore, could be a source of income for farmers selling their agricultural byproducts such as manure and feed crop residue (Mohammed et al., 2013). Processing animal manure into biogas produces additional valuable byproducts, such as quality fertilizer through anaerobic digestion, and 'biochar' through pyrolysis, both of which offset the use of synthetic fertilizers and enhance soil fertility and carbon sequestration (Holm-Nielsen et al., 2009; Schouten et al., 2012).[30]

As livestock production systems grow and intensify, controlling pollution from farms will be an increasingly important issue, and biogas production, in addition to being a source of fuel, presents a valuable waste management solution.[31]

[30] The efficiency and impact of manure source on biochar production is analyzed in Ro et al (2010) and Cantrell et al (2012).

[31] A number of studies have used various tools to analyze the potential benefits of converting manure into energy as an environmentally acceptable waste

Biogas conversion could assist countries in meeting renewable portfolio standard requirements, while simultaneously reducing pollution and greenhouse gas emissions.[32] (Cuellar and Webber, 2008).

7.2 LSDG 7: Promote energy efficiency and lower carbon technologies (including gas and biomass recycling) in livestock production and processing

Objective

Promote vocational and general education for livestock producers and livestock-dependent communities.

Indicators

LSDI 7.1: Proportion of smallholder energy from renewable sources

LSDI 7.2: Recycling Index for Livestock Related Biomass and Biogas

LSDI 7.1: Proportion of smallholder energy from renewable sources

Definition

This indicator measures the proportion of smallholder farm household energy use, including production and consumption activities.

Method of computation

Based on a full auditing of local (direct rather than lifecycle) energy use in production and consumption, estimate the share of energy (in comparable units) obtained from renewable sources, by category. Conventional fuels can be aggregated, but renewable sources should be disaggregated with estimates of their individual contribution to total energy use, including biomass, biogas,

disposal solution. Dagnall, Hill and Pegg (2000) look at how resource mapping can assist in identifying priority sites for biomass-to-energy schemes, and Batzias, Sidiras and Spyrou (2004) use GIS to evaluate and compare the energy and biogas potential of different livestock manures.

[32] The potential for converting livestock manure into a domestic renewable fuel source as a tool for meeting renewable portfolio standard requirements and reducing greenhouse gas emissions is analyzed in Cuellar and Webber (2008) and Holm-Nielsen, Seadi and Oleskowicz-Popiel (2009).

hydro, solar, and wind. Household estimates can be aggregated to the community, district, provincial, and national levels.

Data resources

Household LSMS data, enterprise accounting, agronomic, and energy audits.

LSDI 7.2: Recycling Index for Livestock Related Biomass and Biogas

Definition

This indicator measures the extent of biomass and biogas recycling at the farm, community, and sector level.

Method of computation

For individual biomass categories (crop and food waste, manure, etc.), the quantity and proportion recycled into productive on-farm or community use, including soil amendment, energy production, building material, etc. For biogas, the volume and share captured and redirected to productive use for heat, mechanical and electric power, and other productive use.

Data resources

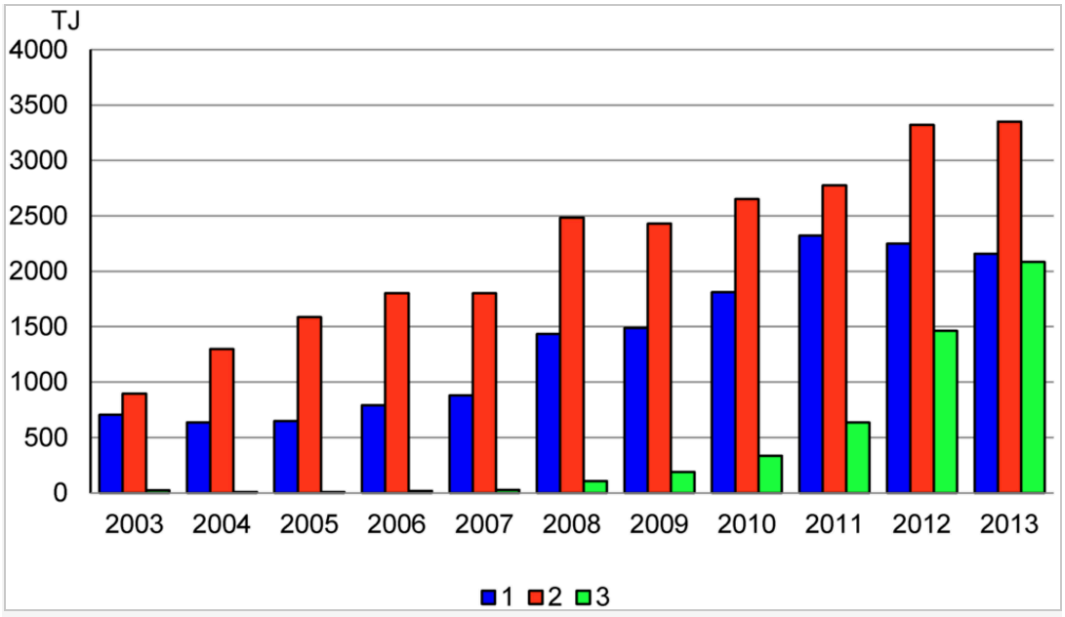
Household enterprise production accounting, agronomic and energy audits.

Example 7.1: Livestock-based biogas potential for electric power generation

Criteria	Quantity	Performance	Quantity
Volume of PVC bag	200 m^3	volume of the digester in use	37.2 m^3
Expected feeding rate	1830 kg/day	Current feeding rate	257 kg/day
Expected gas production per day	62.1 m^3	Total gas production	11.6 m^3/day
Expected electricity per day	97 kWh	Electricity generated per day	18.0 kWh
Expected electricity per month	29 MWh	Electricity generated per month	541 kWh
Expected electricity per annum	35 MWh	Electricity generated per annum	6.5MWh

Source: Tuhairwe (2016).

Example 7.2: Biogas Utilization in Poland, by Source



Notes: 1) Landfill; 2) Wastewater treatment; 3) Agriculture/livestock

Source: Szymańska and Lewandowska, 2015.

Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

8.1 Livestock and Inclusive Growth and Employment

Livestock is one of the fastest growing economic subsectors in developing countries. The global demand for animal-source foods is predicted to increase by 70 percent to feed a population estimated to reach 9.6 billion by 2050, with the majority of increase in production and consumption expected to take place in developing countries (Alexandratos and Bruinsma, 2012; Gerber et al., 2013). Given these significant growth rate predictions, the livestock sector has tremendous potential to create jobs and reduce inequality, directly contributing to SDG 8 in promoting inclusive and sustainable economic growth, employment and decent work for all.

While livestock production can be highly profitable for commercial and large-scale producers in developing countries, strategic interventions and policy initiatives are necessary to ensure the benefits derived from the livestock sector reach smallholder producers as well. The potential for a significant increase in the export of meat and meat products have prompted policy in many developing economies to focus on livestock produced for trade and export; however, policy and market solutions are also needed at the smallholder level (Scoones and Wolmer, 2006). Investments in rural infrastructure, extension services, and disease management are all practical solutions to ensure benefits reach smallholder farmers and are in alignment with SDG 8 targets in promoting per capita economic growth and higher levels of productivity.[33]

SDG 8 targets also emphasize promoting decent job creation, entrepreneurship, and productive employment for all women and men. In addition to on farm employment, livestock production systems also offer a source of off farm employment including processing, distribution, and retail. Because of livestock's superior growth potential and the labor intensity of higher value ASFs,

[33] Recommended policy and market solutions to ensure benefits reach smallhodler farmers are further explored in Tarawali et al (2011).

employment returns to investment in this sector are higher than average, with more diverse recruitment including women and older adults. This is true in both rural (production) and urban (processing/marketing) areas. In locations where smallholder agriculture persists, value added opportunities are substantial and largely unrealized. Increasing the marginal productivity of labor in the livestock sector through training, technological upgrading and innovation may lead to substantial and sustained value creation across developing country ASF value chains.

Informal supply chains, which continue to persist in many developing countries, currently provide a valuable means for employment, and should be considered in any policy initiative. Dairy markets, for instance, contribute a range of rural and urban employment opportunities ranging from dairy farmers and raw milk traders to processors and traders in processed dairy products (Omore et al., 2004). Rather than policing informal markets, developing policies and training activities that support successful entrepreneurs to scale up and grow in response to increasing consumer demand for livestock products can be a strategy for job creation and consequential poverty reduction.

8.2 LSDG 8: Double public investments for enhancing smallholder access to extension services and markets by 2030, with emphasis on public actions that increase smallholder value and employment.

Objective

Promote vocational and general education for smallholder livestock producers and livestock-dependent communities.

Indicators

LSDI 8.1: Total public outlays on smallholder and LD community extension services, as a percent of smallholder income.

LSDI 8.2: Smallholder and LD community value added as a percent of sector value added

LSDI 8.3: Increase spending on research to improve smallholder and LD community agricultural profitability

LSDI 8.1: Total public outlays on smallholder and LD community extension services, as a percent of smallholder income

Definition

This indicator measures the proportion of value smallholders capture from the entire value chain extending from their own enterprise to final retail consumption of products derived from their own livestock.

Method of computation

Data resources

LSDI 8.2: Smallholder and LD community value added as a percent of livestock and agriculture sector value added

Definition

Value added comprises all labor, capital, and resource costs used in production, and is the primary determinant of income to producers. This indicator measures the share of smallholder value added in individual sectors of an economy. For developing countries, agriculture and services are the primary economic activities of small enterprises. However, constraints on market access, bargaining power, access to credit, and agrifood price controls can limit smallholder value added.

Method of computation

Calculate the difference between input costs and producer prices. This measures the earnings to factors for producers, assuming they retain these earnings, above rents, taxes, and other fees.

Data resources

Household, farm, and small enterprise surveys.

LSDI 8.3: Smallholder and LD community agricultural profitability with Respect to Emerging Product Varieties, Production and Marketing Practices

Definition

This represents a family of profitability indicators to better inform smallholders regarding economic opportunities from new raw and processed agrifood products, as well as production and marketing practices. These indicators would

ideally be packaged in accessible information services, like current initiatives in weather and price reporting.

Method of computation

Increase public spending to improve public information on emerging, smallholder appropriate livestock varieties and products. In addition to product and practice information, research should be financed and reported on profitability and best practices.

Data resources

Data can be obtained from original, publically financed research, as well as dissemination of private research and development data.

Example 8.1: Backyard Chicken Profitability in Vietnamese Urban Markets

Source: Otte and Roland-Holst: 2010.

Average Return per Hen and Year
(Monetary Values in 1,000 VND)

Item	
Eggs consumed/sold (nr)	35.0
Birds consumed/sold (nr)	6.7
Value of eggs consumed/sold	49.0
Value of birds consumed/sold	244.7
Depreciation of hen	6.3
Gross revenue/hen	287.4
Investment/hen	50.0
Return on investment (%)	**575.0**

Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

9.1 Livestock, Innovation, and Infrastructure

Livestock related employment extends far beyond animal production including jobs in slaughterhouses, dairy plants, research in animal agriculture, transport, retail markets, and more. With a higher growth rate than other agricultural sub-sectors, expected to reach 3%/year in the coming decades, the processing industry of animal products is one of the fastest growing in emerging economies. At the same time, however, the industry is becoming more concentrated. This trend limits enterprise inclusion, diversity, choice, and other indicators of market openness. The absence of basic infrastructure in rural regions where the majority of smallholder producers live, such as roads, information and communication technologies, sanitation, and electrical power, further constrain the capacity of smallholders to expand production and generate market growth.[34]

SDG 9 calls for resilient infrastructure, sustainable industrialization, and innovation with targets emphasizing technological progress and the integration of small-scale enterprises into value chains and markets. Public investments in quality infrastructure and policies related to the processing industry of animal products should promote more inclusive market access for the smallholder

[34] While there has been significant investment in major highways and railways, lower level networks in rural regions have not experience similar advances. Without reliable feeder roads, rural farmers can be cut off from markets during rainy seasons when road conditions are impassible (Thorpe, 2014). In addition to poor roads, high transportation costs can further constrain smallholder production capacity. Evidence from Myanmar's dairy sector shows the price farmer receive varies significantly in response to transport and transaction costs. Dairy farmers around Yangon with direct access to milk processors receive a significantly higher price for milk than producers who are further away from milk processors and rely on milk collectors who face high transport costs (Hinrichs, 2014).

producer majority that is endemic to most of these economies. Doing otherwise will only contribute to more persistent poverty and greater inequality.[35]

In addition to public investments, partnerships between commercial enterprises and smallholder producers can contribute to poverty reduction and create employment opportunities at various stages through ASF value chains. Small-scale producers can benefit from partnering with the private sector by gaining improved access to financial services, quality inputs, and markets. Consumers can also benefit from greater access to safe products.[36]

9.2 LSDG 9: Promote inclusive investment and market participation at all stages of livestock production, processing, and marketing systems.

Objective

Promote vocational and general education for livestock producers and livestock-dependent communities.

Indicators

LSDI 9.1: Total factor productivity growth in smallholder and LD community livestock production

LSDI 9.2: Investment in livestock processing and market infrastructure serving smallholder rural and LD communities

LSDI 9.3: Marketing extension services and commercial microcredit for smallholder rural and LD communities

LSDI 9.1: Total factor productivity growth in smallholder production

Definition

[35] Livestock production can be highly profitable for the "not so poor" in developing countries, however, it is uncertain how much of the benefits derived from the commercial livestock sector trickle down to the poorest livestock holders (Upton & Otte, 2004; Perry and Grace, 2009).

[36] Perry and Grace (2009) identify several models that exemplify innovative partnerships between commercial enterprises and smallholder producers such as: Farmers Choice in Kenya (http://www.farmerschoice.co.ke/) and Kalahari Kid in South Africa (http://www.kalaharikid.co.za/)

This indicator measures productivity of labor, capital, and resources in production of livestock and livestock products, with special reference to smallholder production and enterprises that employ lower income workers.

Method of computation

Econometric estimation of productivity trends for labor, capital, and resources in production of livestock and livestock products, individually and in the aggregate.

Data resources

Data come mainly from farm level and enterprise surveys. For smallholder production, household survey and LSMS data can be used.

LSDI 9.2: Investment in livestock processing and market infrastructure serving smallholder rural and LD communities

Definition

This indicator measures the level of private and (especially) public investment in new infrastructure for livestock processing and marketing that serve smallholder and LD communities.

Method of computation

This can be measured in absolute terms and as shares of all such investment in the livestock sector, all agriculture, and as corresponding income shares.

Data resources

Public and private investment data, including fiscal accounts, enterprise surveys, and agricultural census information

LSDI 9.3: Marketing extension services and commercial microcredit for smallholder rural and LD communities

This indicator measures the degree to which extension services are targeting inclusive and sustainable industrialization and innovation in the livestock sector.

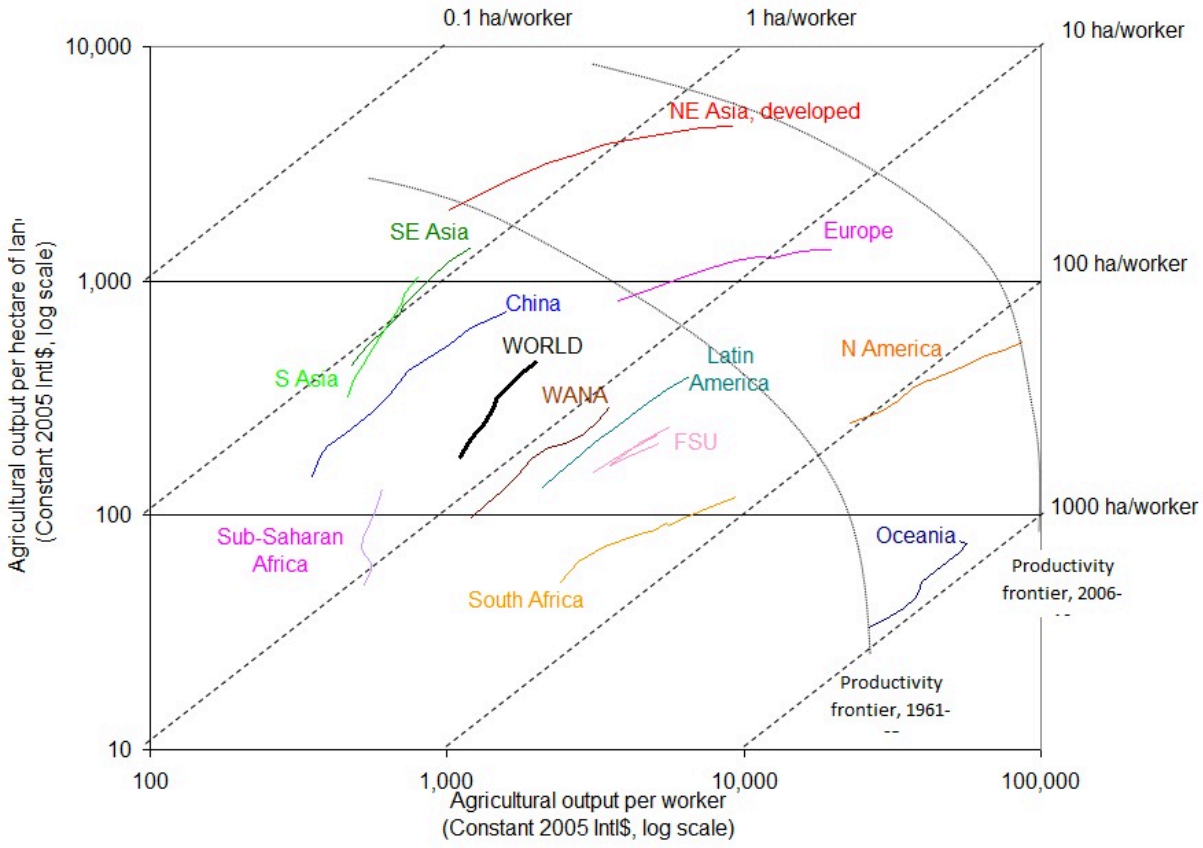
Method of computation

Estimate the levels and shares of extension service expenditure (by domestic and international agencies) that are targeted to livestock marketing and innovation generally and toward smallholders and LD communities in particular.

Data resources

Extension service budgets of local, provincial, national, and development partner agencies.

Example 9.1: Agricultural land and labor productivity have steadily improved, but developing countries lag decades behind developed countries



Source: Fuglie and Wang: 2012.

Reduce inequality within and among countries

10.1 Livestock and Inequality Reduction

With the objective of reducing inequality within and among countries, SDG 10 sets targets to achieve inclusive economic growth and social and political inclusion. Livestock promotion contributes to inequality reduction from both the supply and demand sides of agrifood markets. Livestock husbandry is a potent catalyst for smallholder income growth, with relatively low investment, input, and labor costs. Moreover, free range livestock are an effective strategy for resource use where property rights are limited, a chronic barrier to enterprise development for the rural poor. Globally, 70% of rural poor households rely on livestock for income, employment, and market participation (FAO 2012a). In addition to promoting self-directed poverty reduction, their market engagement sustains complex intermediary networks of low-income enterprises across developing country agrifood supply chains.[37] Weak or unequal property rights remain an important constraint on the capacity of smallholders to expand these production systems, but institutional reforms in this area can be very effective at arousing smallholder entrepreneurship and closing inequality gaps.[38]

10.2 LSDG 10: Advance sustainable smallholder livestock production, market access, and value creation

Objective

[37] The street-food sector, which is largely comprised of animal-sourced foods (Perry and Grace, 2009), employs a large number of people in developing countries, providing a source of income for vendors as well as inexpensive nutritional meals: it is considered the largest informal sector employer in South Africa (von Holy & Makhoane, 2006).

[38] Perry et al (2002) proposes a three pathway poverty-reduction framework for livestock keepers, based on: reducing vulnerability, improving productivity performance and improving market access.

Promote vocational and general education for livestock producers and livestock-dependent communities.

Indicators

LSDI 10.1: Livestock Income Gini Coefficient.

LSDI 10.2: Livestock and LD Community Terms of Trade.

LSDI 10.1: Livestock Income Gini Coefficient.

Definition

This indicator measures disparity between the observed distribution of livestock income from a uniform income distribution.

Method of computation

This is a standard Gini formulation, restricted to the livestock component of household income.

Data resources

Household and rural enterprise surveys can generally be relied upon for this kind of data.

LSDI 10.3: Livestock and LD Community Terms of trade

Definition

This indicator measures the value price of smallholder products relative to values of their input, resource, and consumption costs. At the individual (average) household, village, or tribal level, this relative price indicates how the market economy values local production relative to consumption, and also represents local purchasing power in formal sector markets.

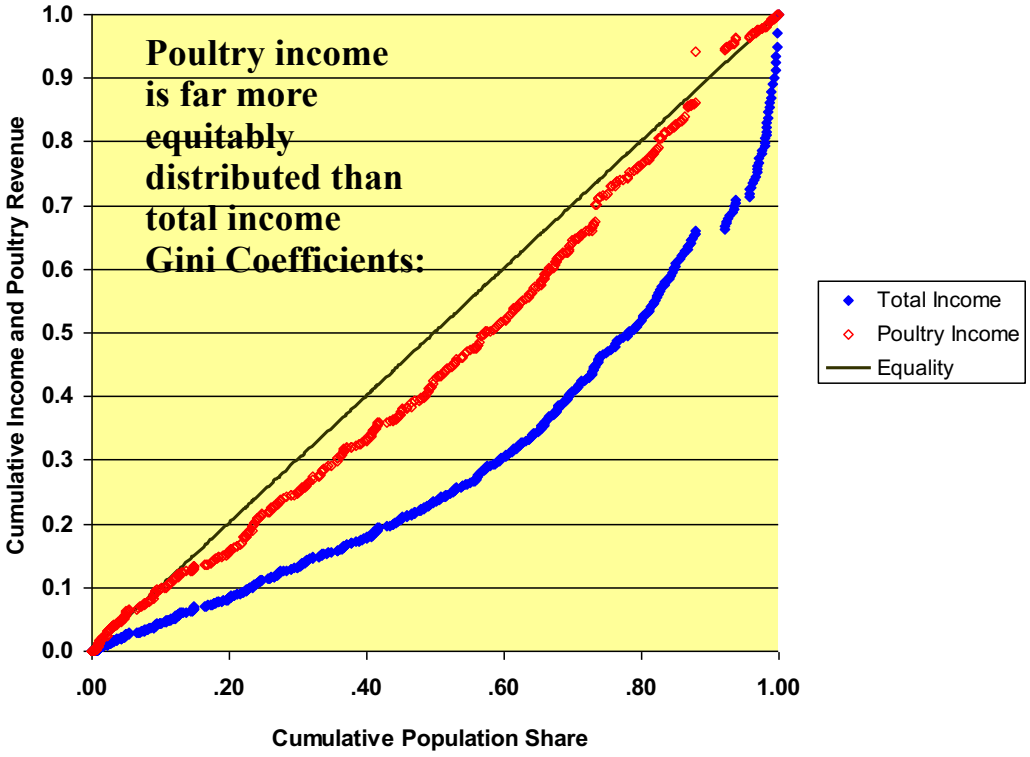
Method of computation

There is a large literature specifying many alternative measures of terms of trade or production purchasing power. Generally speaking, they all include in the numerator an index of prices for outputs of local goods and services, and in the denominator an index of prices representing formal economy input and consumption costs facing the local population.

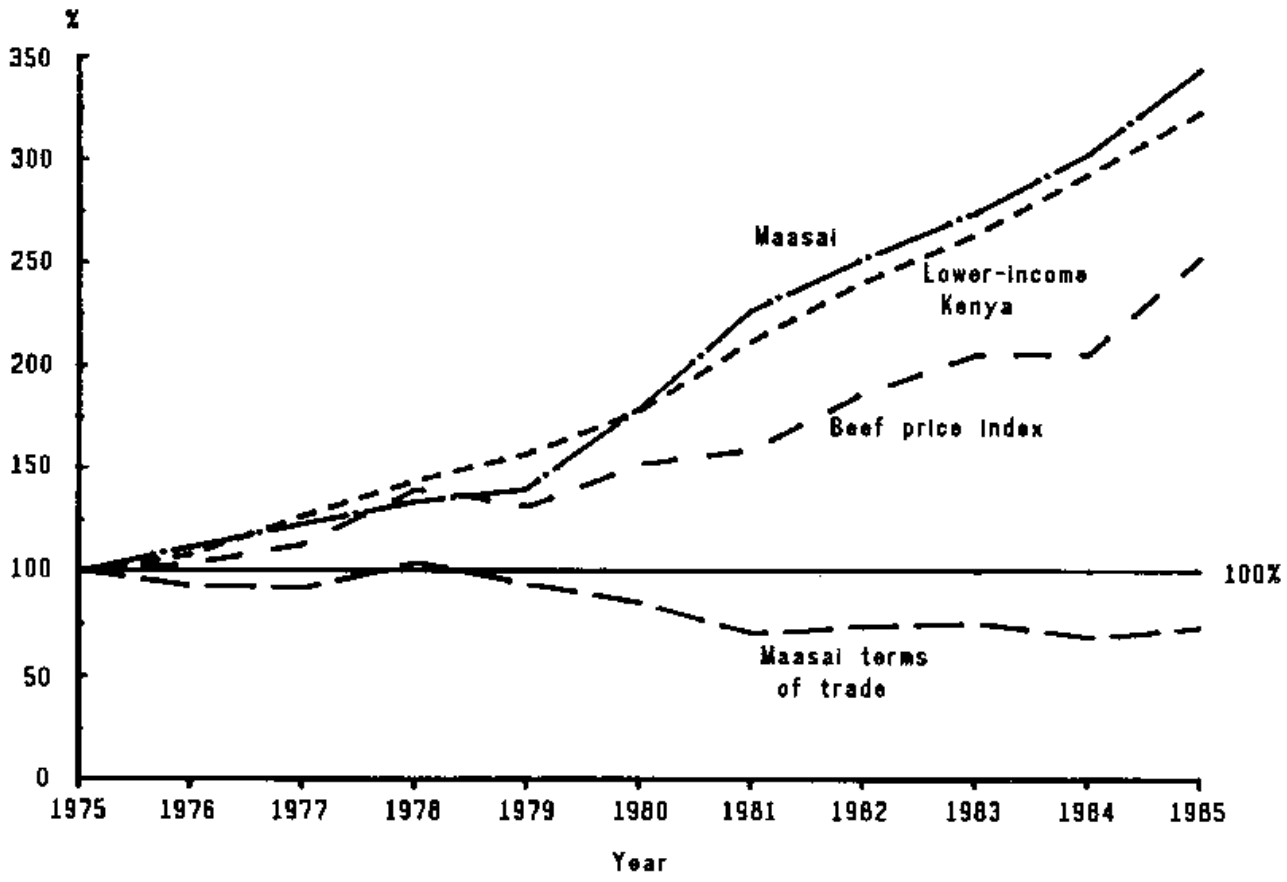
Data resources

Market price and household surveys are available in most developing countries for a wide variety of good and services, including detailed livestock product categories.

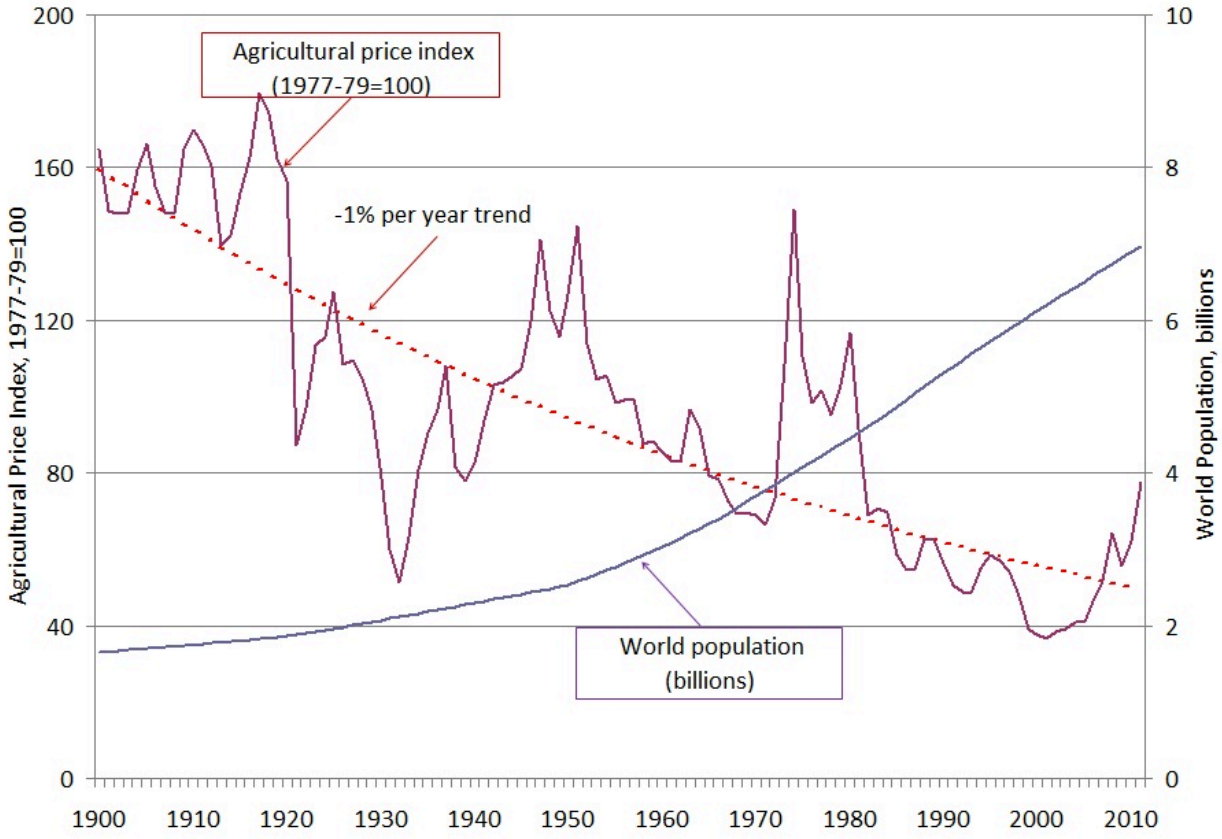
Example 10.1: Income Distribution and Poultry Production in Vietnam



Example 10.2: Livestock and related Terms of Trade for Maasai Communities (Bekure et al: 1991)



Example 10.3: Real Agricultural Terms of Trade have Fallen Dramatically since 1900, even as World Population has Soared



Source: Fuglie and Wang: 2012

Make cities and human settlements inclusive, safe, resilient and sustainable

11.1 Livestock and Safe & Resilient Cities

While cities offer many opportunities for social and economic growth, challenges in ensuring access to basic services, decent jobs, and quality infrastructure for all urban dwellers persist, prompting SDG 11 in the bid to make cities inclusive, safe, resilient and sustainable. SDG 11 targets include ensuring access for all to basic services, and reducing the adverse environmental impact of cities by addressing issues such as waste management.

At least one billion urban and peri-urban dwellers are estimated to take part in urban agriculture, with activities ranging from vegetable growing to poultry keeping and dairy operations (Grace et al., 2015). While there are great economic and consumer benefits to urban livestock production, building quality infrastructure and investing in basic sanitation services are crucial to mitigating risks associated with urban livestock keeping, and to achieving SDG 11 targets. The species of urban livestock kept in different cities varies by location, and corresponds to regional consumption patterns, implying that ultimately, successful policies and systems must be context specific.

Some of the major benefits of urban livestock keeping are profitable and nutritious food production, and readily available market access. As urban populations continue grow, so does demand for food products, which results in increased market opportunities for urban ASF producers. Despite these benefits, however, unsanitary conditions and weak infrastructure can pose major risks in urban livestock systems and result in high rates of pollution and the spread of disease among animals and humans. The spread of disease to humans results from people living in close corridors with livestock (due to limited space as well as a strategy to avoid theft), and from overall lack of sanitation facilities (Thys et al., 2005; Cole et al., 2008). High concentrations of nutrients in manure results in leaching to nearby waterways, and nutrient surpluses in associated vegetable or

crop cultivation, contributing to high levels of pollution.[39] Developing systems to facilitate animal and processing waste management, as well as implementing policies at the household level addressing slaughter and waste disposal is crucial to ensuring adequate and safe environments in areas with urban livestock keeping.

11.2 LSDG 11: Improve urban food and health security with investments in expanded and modernized local livestock production, processing, and marketing systems.

Objective

Promote food security and sustainable, modernized livestock production, processing, and distribution in urban and peri-urban areas.

Indicators

LSDI 11.1: Share of urban livestock production, processing, and marketing that is subject to consistent and credible food safety standards.

LSDI 11.2: Proportion of Urban Livestock Products Provided by Urban and Peri-urban Agriculture

LSDI 11.3: Incoming Food Safety Risks for Urban Markets

LSDI 11.1: Share of urban livestock production, processing, and marketing that is subject to consistent and credible food safety standards.

Definition

This indicator measures the share of sales for urban livestock PPaM that is subject to credible food safety monitoring, including public and private systems of inspection, certification, traceability, etc.

[39] A study looking at peri-urban agriculture in Niamey, Niger, finds high concentrations of N, P and K, leading to nutrient surpluses in vegetable/crop cultivation, and increased potential for nutrient leaching. Apart from environmental concerns, urban livestock keepers identified feed scarcity as the main problem they faced (Graefe et al., 2008). Another case study looking at urban livestock production in Addis Ababa, Ethiopia, finds disease (Mastistis in dairy cattle and Newcastle disease in chickens) is the most important threat to urban livestock production (Tegegne, 2004).

Method of computation

For established food safety surveillance systems, calculate headcount, product volume, or other quantities and convert to comparable valuations using concurrent (producer, intermediary, retail) prices. Calculate these as shares of corresponding total PPaM sales, but urban market, province, and nationally.

Data resources

Data on product volumes from surveillance systems, market surveys, and tax records. Price data from market surveys

LSDI 11.2: Proportion of Urban Livestock Products Provided by Urban and Peri-urban Agriculture

Definition

This indicator measures the degree of livestock security/self-sufficiency of urban areas, as well as implicitly revealing the degree of transport/emission intensity and other characteristics of food trade.

Method of computation

Calculate the share of urban consumption of livestock products that is met by production in urban or peri-urban areas. Calculations should be city-by-city, then averaged at provincial and national levels. Shipment of urban production between cities can be considered separately.

Data resources

Local market and enterprise surveys.

LSDI 11.3: Incoming Food Safety Risks for Urban Markets

Definition

This indicator measures the health risk characteristics of products coming to urban markets for final consumption.

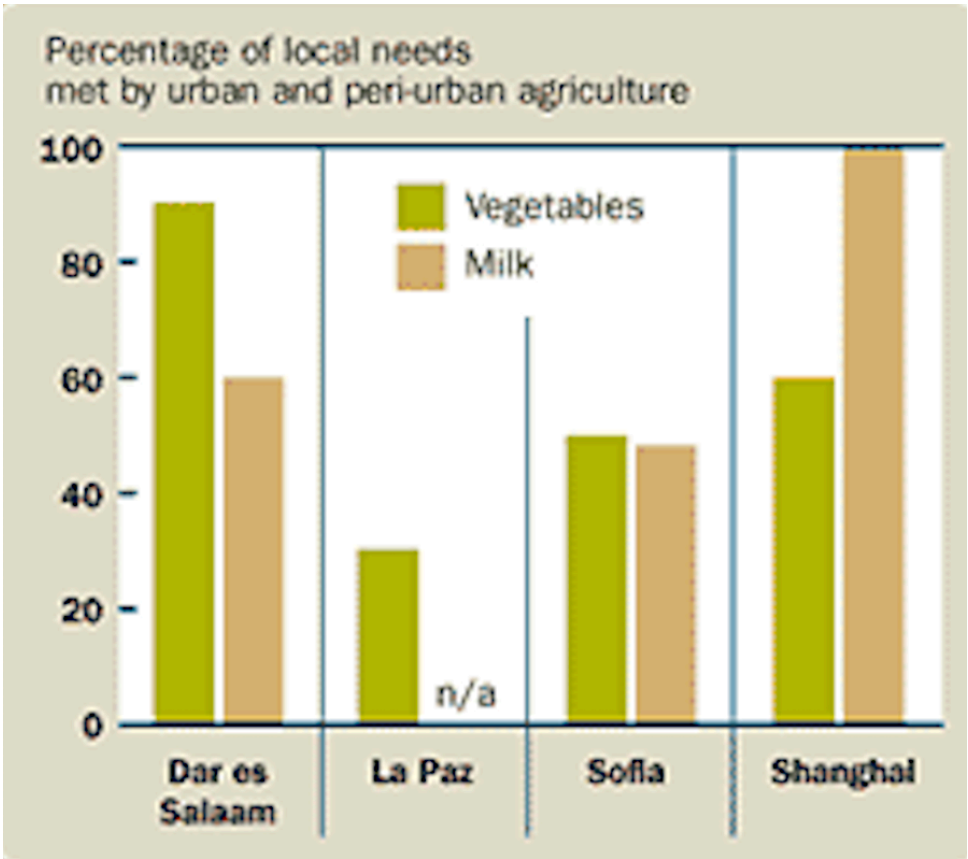
Method of computation

Using modern probabilistic methods (e.g. Batts and Morris: 2011), evaluate incoming risks from food supply chains to different urban markets. Indicators should capture both probabilistic (incidence, frequency) and severity characteristics.

Data resources

Data included historical information on local and comparable area outbreaks, statistics on origin-market food safety conditions, and international databases (WHO, WFO, CDC, EOI, etc.).

Example 11.1: Percent of Food Provided by Urban and Peri-urban Agriculture

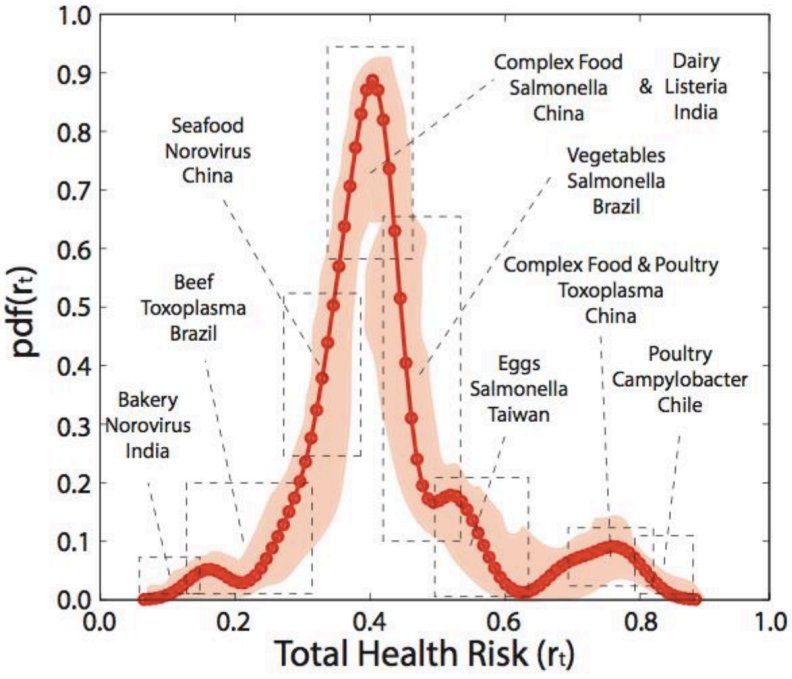


Source: FAO (2010)

Example 11.2: Number of ISO 22000 (food safety) Certificates by Country, 2005

Country	Number of ISO 22000 Certificates
China	5,575
Greece	1,197
Turkey	1,088
India	1,020
Taipei, Taiwan	949
Romania	641
Poland	626
Japan	482
Spain	364
Egypt	276

Example 11.3: Distribution of the potential health risk for the USA, and potential health risk versus supply chain variables



Source: Convertino and Liang: 2014.

Ensure sustainable consumption and production patterns

12.1 Livestock and Responsible Consumption

The world's livestock sector is growing at an unprecedented rate. The demand for livestock products is expected to continue to increase significantly over the next decade, with the majority of production and consumption taking place in developing countries. Ensuring this growth meets demand without jeopardizing the earth's climate and resources aligns with SDG 12 in ensuring sustainable consumption and production patterns. To help reach this goal SDG 12 targets include achieving sustainable management and efficient use of natural resources, reducing food losses along production and supply chains, and encouraging developed countries to take the lead in implementing programs to facilitate sustainable consumption and production patterns.[40]

Sustainable livestock production depends on improved management and resource efficiency in order to produce more output using less resources and mitigating environmental impact. There are many opportunities and existing technologies to increase the sustainability of livestock production, however, adapting and enforcing new technologies in local environments and instituting supporting policies and infrastructure to encourage adoption will be the greater challenge.

Sustainable consumption is closely linked to livestock diversity. Countries report that a strategy of crossbreeding locally adapted breeds with exotic breeds is being widely pursued in developing countries. In many cases this strategy is promoted by the national government as a means of rapidly increasing national output of livestock products. However, there is evidence that breed influences

[40] SDG 12 targets include implementing the 10-year framework of programmes (10YFP), a global framework of action to support regional and national policies and initiatives to achieve sustainable consumption and production patterns in both developed and developing countries. Further information can be found on the 10YFP website: http://unep.org/10yfp/

the composition of ASFs (FAO, 2015).[41] The implementation of the Global Plan of Action for Animal Genetic Resources, adopted in 2007 (FAO, 2007), is improving the sustainable use, development and conservation of the world's livestock diversity. However, efforts still need to be made to strengthen the management of these resources.

While achieving environmentally responsible and resource efficient production systems is a key component, fundamental changes in the ways societies consume livestock products is equally important to achieving global sustainable development. Appropriate amounts of meat and other ASFs in the diet have high nutrition returns (Bender, 1992), however, over-consumption of meat and other products of animal origin can be harmful leading to high rates of cardiovascular disease, diabetes, and some cancers. The consumption of meat and saturated fat in many high-income countries, for instance, far exceeds nutritional needs and has negative health impacts (Walker et al., 2005; McMichael et al., 2007; Daniel et al., 2011). Developing sustainable consumption patterns requires balancing between the nutritional benefits of ASF products in achieving food security and improved nutrition with the harmful health outcomes of over-consumption.

Finally, reducing food losses along ASF supply chains is another area for achieving sustainable production and consumption patterns. Roughly one fifth of each kilogram of meat and meat product gets lost or wasted globally. Meat losses and waste in industrialized regions are most severe at the end of the food supply chain, explained by a high per capita meat consumption combined with

[41] The most important contribution of livestock diversity to current food production and food security – both at household and national level – probably lies in its role in enabling livestock to be raised in a wide range of production environments and in enabling production systems to better withstand shocks such as droughts and disease outbreaks (FAO, 2015). However, livestock genetic diversity is threatened by various factors including the trend towards greater homogeneity in the world's livestock production systems and a lack of appropriate management strategies and policies. Planning measures to promote the sustainable use, development and conservation of animal genetic resources requires information on the diversity of these resources nationally and internationally. In the absence of direct measures at the genetic level, the main method used to monitor trends in the diversity of terrestrial domesticated animals is to monitor aggregate changes in breed risk status, i.e. changes in the proportion of breeds categorized as being at risk of extinction. This is done using data from the Domestic Animal Diversity Information System (DAD-IS at http://www.fao.org/dad-is/), maintained by the Food and Agriculture Organization of the United Nations (FAO).

large waste proportions by retailers and consumers, especially in Europe and the U.S. Waste at the consumption level makes up approximately half of total meat losses and waste (FAO, 2011b). Significantly, much more food is wasted (per capita) in industrialized than in developing countries. Most estimates suggest that OECD per capita food waste is an order of magnitude higher than in developing countries.

Food losses in the developing world tend to be related to financial, managerial, and technical limitations of food distribution between the farmer and the consumer. In contrast, food losses and waste in the developed world mainly relate to consumer behavior and coordination or information failures in agrifood supply chains. An example of the latter is much food is wasted because of quality standards that reject produce on the basis of size, shape, or color—factors that have nothing to do with safety.

12.2 LSDG 12: Ensure sustainable livestock production at all enterprise scale, while promoting more resource-efficient products and consumption practices.

Objective

Promote vocational and general education for livestock producers and livestock-dependent communities.

Indicators

LSDI 12.1: Land Use Intensity of Livestock Production

LSDI 12.1: Proportion of Food Wasted from Livestock Sources

LSDI 12.1: Land Use Intensity of Livestock Production

Definition

This indicator measures the amount of land resources committed for livestock production, in terms of both physical product and value.

Method of computation

For leading livestock varieties, estimate land use years (hectares*years in production) per head, per pound of final product, and per dollar of value at the farm gate, wholesale after processing, and retail prices.

Data resources

Market surveys.

LSDI 12.2: Proportion of Food Wasted from Livestock Sources

Definition

This indicator measures the proportion of livestock products wasted in production and consumption processes.

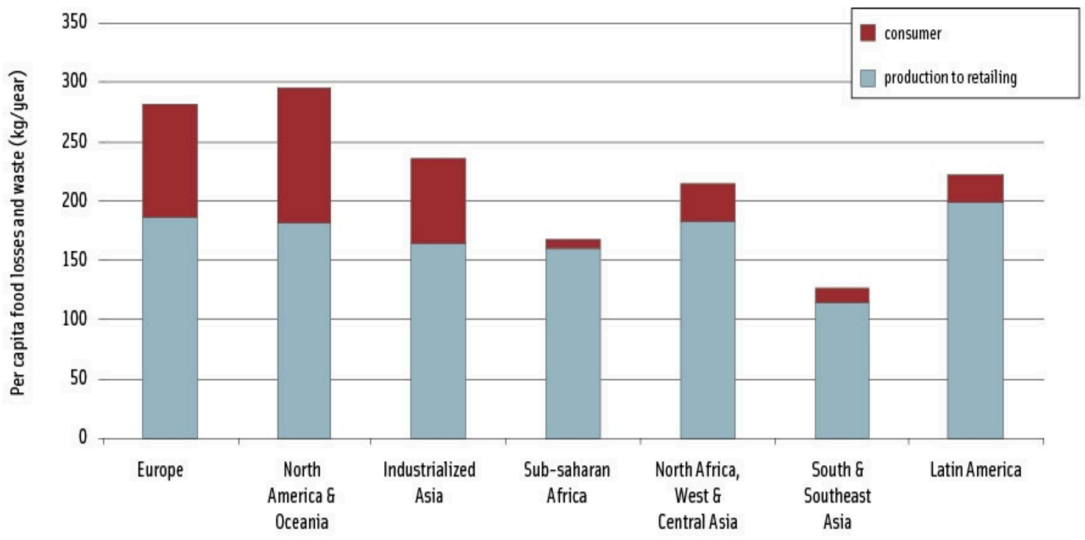
Method of computation

Estimates

Data resources

Data

Example 12.1: Proportion of Food Wasted by Region and Stage of Production/Consumption



Source: Marsh, 2011.

Take urgent action to combat climate change and its impacts

13.1 Livestock and Climate

Livestock production, including transport of livestock and feed, accounts for nearly 80% of the agriculture sector's greenhouse gas emissions, including methane, nitrous oxide, and carbon dioxide (McMichael et al., 2007). These high levels of emissions can be curtailed by improved production practices, which will be crucial to achieving SDG 13 in mobilizing urgent action to combat climate change and its impacts.

Livestock's largest carbon emissions come from changes in land use and land-degradation due to the clearing of forests to make room for feed crop production and grazing land as well as livestock-induced desertification of pastures. Land use change emissions far outweigh emissions due to livestock food chains. Strategies for mitigating future carbon emissions should, therefore, focus on land use to have the greatest impact. Mitigation initiatives to promote carbon sequestration include reducing deforestation through agricultural intensification, improving grassland management, adopting agroforestry techniques, and incentivizing conservation. Additional adaptation strategies to respond to a warming climate may include shifting to more heat tolerant livestock and crop species, and diversification of income generating activities to mitigate risk.[42] Genetic diversity in livestock species enables livestock to be raised in a wide range of production environments and to provide a wide range of products and services (food, fibers, manure, draught power, etc.). It also provides the basis for adapting livestock populations to future changes in environmental conditions.

Many local and native livestock breeds have developed adaptations and genetically favorable traits including resistance to disease and increased resiliency to environmental cycles such as droughts (Geerlings et al., 2002;

[42] Livestock's Long Shadow, released by FAO (2006), gives a thorough account of livestock's role in climate change and detailed explanations of mitigation options (Steinfeld, 2006).

Sejian et al., 2015).[43] As populations around the world continue to experience the impacts of climate change, such as changing weather patterns and more extreme weather events, implementing breeding programs that target native breeds can be a strategy for strengthening resilience and adaptive capacity among livestock farmers in the face of climate-related hazards.

The rapidly growing and intensifying global livestock sector is responsible for substantial contributions to land, soil and water degradation, and the reduction of biodiversity. The livestock sector as a whole covers a variety of production systems ranging from small to large and urban to rural. It is no surprise then that the technical and policy-related actions needed to mitigate future environmental impact and achieve sustainable development are equally varied in nature, and must be adapted to context specific locations with regards to climate, local production systems, and socioeconomic factors. Given the livestock sector's large footprint, advances in sustainable production practices can make significant contributions to achieving the SDG targets related to increasing water-use efficiency (SDG 6), protecting the marine environment from nutrient pollution (SDG 14), and restoring degraded landscapes and forests (SDG 15).

13.2 LSDG 13: Promote livestock production, processing, and marketing practices that explicitly address climate mitigation and adaptation needs.

Objective

Promote vocational and general education for livestock producers and livestock-dependent communities.

Indicators

LSDI 13.1: Emissions Intensity of Livestock Production

[43] Many local breeds have genetic traits that are valuable for the poor, such as African Zebu cattle, which have a native resistance to vector-borne diseases (IFAD, 2004). Native livestock also tend to be smaller in size, which can be advantageous for resource-poor farmers since they require fewer inputs (feed, medicine, etc), and are easier to handle for women and children (Kohler-Rollefson, 2010; FAO, 2012b). *Invisible Guardians: Women manage livestock diversity* draws from a number of cases to illustrate the strong relationship between women and locally adapted livestock breeds, and concludes women are the main users and caretakers of locally adapted livestock breeds (FAO, 2012b).

LSDI 13.2: Percentage of Indigenous, Crossbred, and Adapted Species in Livestock Production

LSDI 13.1: Emissions Intensity of Livestock Production

Definition

This indicator measures the lifecycle emissions associated with the livestock sector, including lifecycle emissions associated with inputs, production, processing, and marketing of livestock and livestock products.

Method of computation

To calculate LCA emissions for this sector, detailed auditing is needed for feed production, emissions from live animals, animal waste, processing, and product distribution.

Data resources

Data are needed for the complete agrifood supply chain, including fodder/feed farming, animal husbandry, waste management, processing, transportation and distribution services.

LSDI 13.2: Percentage of Indigenous, Crossbred, and Adapted Species in Livestock Production

Definition

Livestock breeding for climate resilience includes expanding stocks of animals with legacy adaptation capacity for local conditions. This indicator measures the degree to which local stocks of animals incorporate indigenous characteristics.

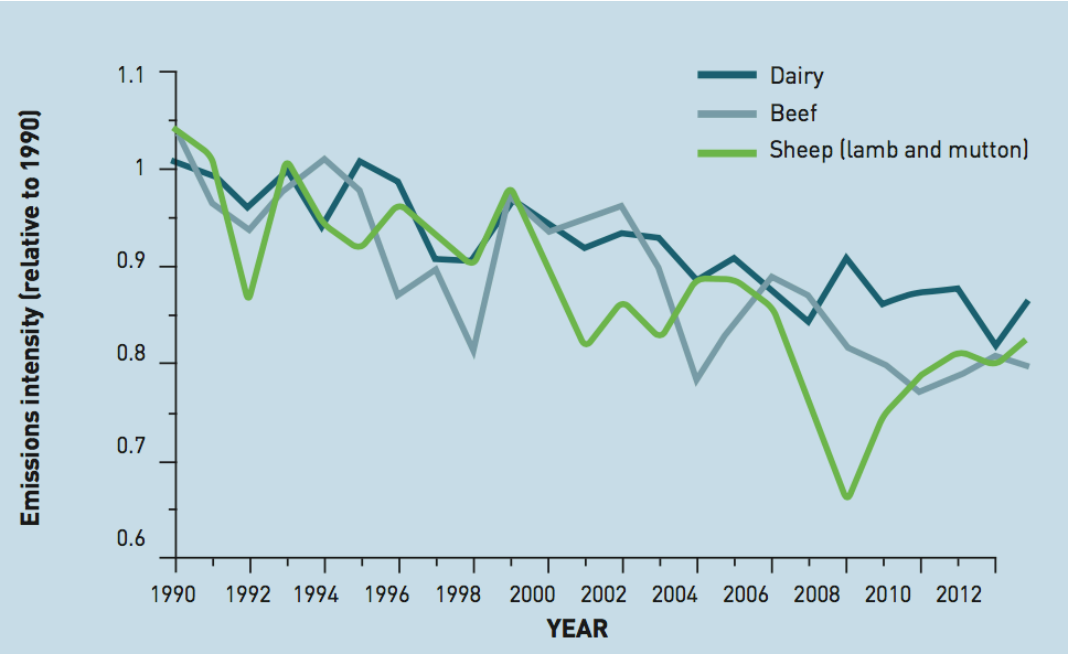
Method of computation

Without specific reference to climate-oriented traits, calculate for each species the percentage of purely indigenous, cross-bred, and adaptation-selected breeds in overall livestock at all scales of production.

Data resources

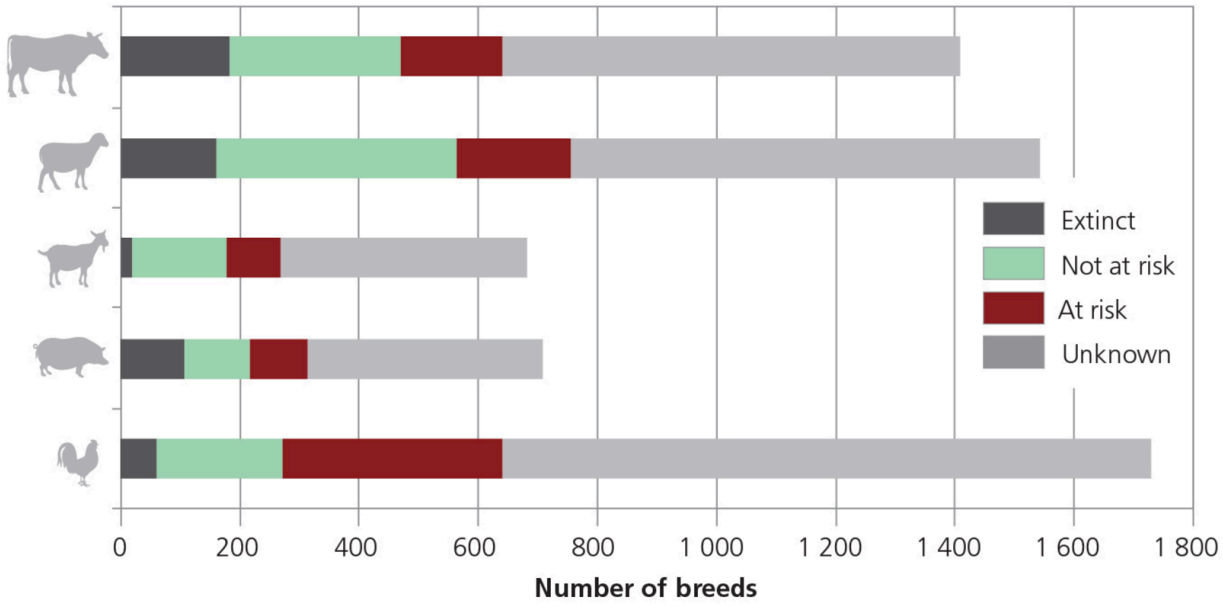
Data are needed for the complete population of livestock population, with detailed spatial information on individual species.

Example 13.1: Lifecycle Emissions Intensity of New Zealand Livestock Production (indexed to 1990=1)



Source: Reisinger, 2016

Example 13.2: Status of the World's Livestock Breeds



Source: FAO, 2013

Conserve and sustainably use the oceans, seas and marine resources for sustainable development

14.1 Livestock and Marine Resources

Over three billion people depend on marine and coastal biodiversity for their livelihoods. SDG 14 calls for the sustainable management of this critical resource with an emphasis on significantly reducing marine pollution, protecting coastal ecosystems, and regulating harvesting and destructive fishing practices.

The world's ocean fish face serious threats to their biodiversity. The principle source of pressure is overexploitation by fisheries, which have affected the size and viability of fish populations, the genetics of target species, and the food chains and ecosystems of which they are part. In 2011, about 60% of marine stocks were fully fished and 30% overfished, and this has increased in the last decades (FAO, 2014). A significant, but declining, proportion of world fisheries production is processed into fishmeal (mainly for high-protein feed) and fish oil (as a feed additive in aquaculture and also for human consumption). They can be produced from whole fish, fish remains or other fish by-products. About 35 percent of world fishmeal production was obtained from fish residues in 2012 (FAO, 2014), but this still represent about two thirds of fishmeal production directly responsible for the depletion of marine life. Pigs and chicken currently use about 27% of global fishmeal production (IFFO, 2010), a share that is decreasing due to the rapid growth of aquaculture.

Nutrient runoff and leaching from livestock waste have serious environmental consequences if not properly managed, and can be detrimental to coastal marine fisheries (Nixon, 1996; Vitousek et al., 1997; IAASTD, 2009). Leaching rates vary depending on climatic and soil conditions, which can differ significantly between countries or regions within a country (Schils et al., 2007; Vries and Boer, 2010). Best management practices to reduce coastal eutrophication must, therefore, be context specific, taking land and land use data into consideration. In regions with high livestock density, improving waste management practices can be a cost-

effective way to reduce river-based nitrogen loads, which often end up in marine systems and contribute to coastal eutrophication (Arheimer et al., 2004).[44]

14.2 LSDG 14: Promote sustainable fishery habitat, production, processing, and marketing systems, with special reference to the global majority of low income fishery-dependent households.

Objective

Promote vocational and general education for livestock producers and livestock-dependent communities.

Indicators

LSDI 14.1: Per capita extent and productivity of smallholder accessible local fishery resources

LSDI 14.2: Proportion of domestic fishery sector output from aquaculture

LSDI 14.3: Proportion of household per capita protein from fishery products

LSDI 14.1: Per capita extent and productivity of smallholder accessible local fishery resources

Definition

This indicator measures, on a smallholder per capita basis, the extent (area) and productivity (average yield) of accessible local (freshwater and marine) fishery resources.

Method of computation

For a given local community, estimate the extent and productivity of fishery resources that are accessible to smallholder fisher-people at no cost or very low cost. Per capita should be calculated both per fisher (supply capacity) and per population member (demand capacity). Both freshwater and marine fisheries are eligible, but aquaculture is not included.

[44] A Life Cycle Assessment study measuring the macro-scale environmental impacts of the US broiler supply chain finds feed provision accounts for 97% of eutrophying emissions, emphasizing the importance considering the full supply-chain in order to ensure environmentally sound management practices (Pelletier, 2008).

Data resources

Local, provincial, and national fishery data, combined with census and household survey data.

LSDI 14.2: Proportion of domestic fishery sector output from aquaculture

Definition

This indicator measures the significance of aquaculture to fishery production, locally and at the provincial and national levels.

Method of computation

Estimate the share of fishery production from aquaculture at the community, local district, provincial, and national levels. Species can be disaggregated, and smallholder and large enterprise aquaculture should be disaggregated where possible.

Data resources

National fishery sector data, as well as enterprise and household surveys.

LSDI 14.3: Proportion of household per capita protein from fishery products

Definition

This indicator measures household's relative nutritional dependence on fishery products.

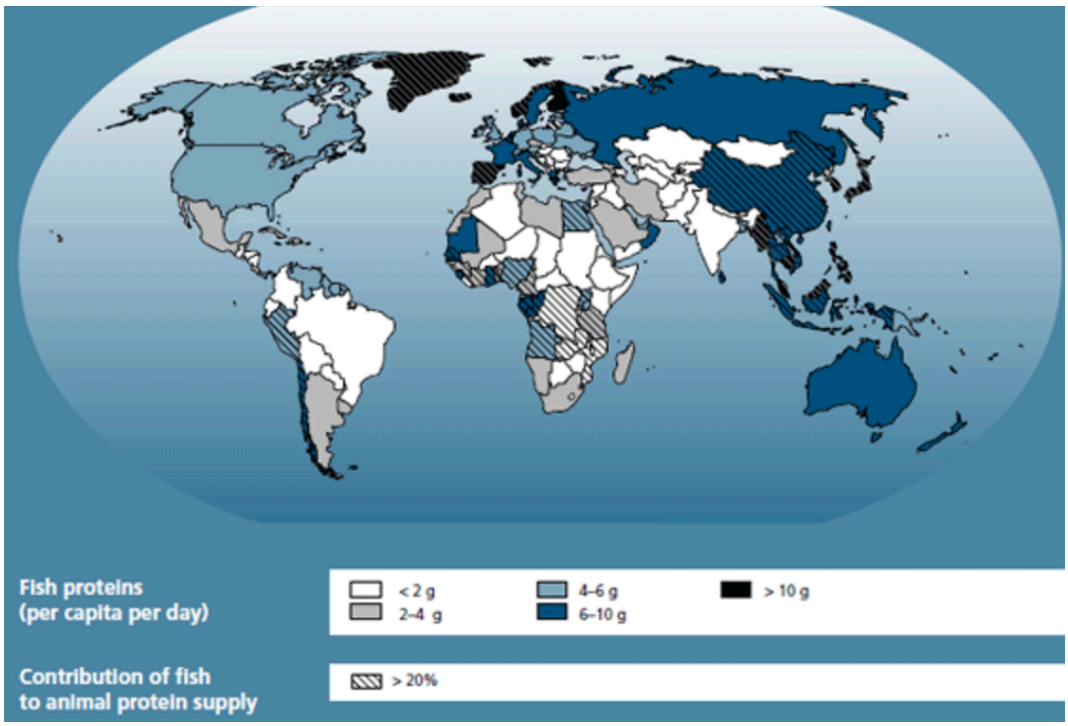
Method of computation

Estimate per capital household protein intake of fishery products as a percent of all protein intake, by household type.

Data resources

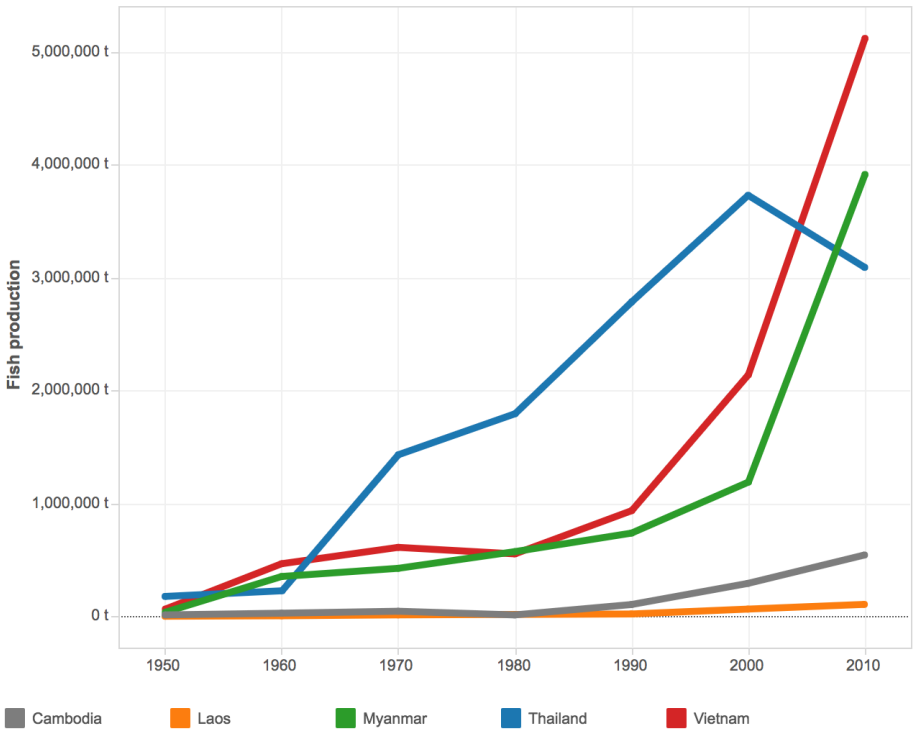
National nutrition and household surveys.

Example 14.1: Fish as Food: Per Capita Supply (average 2007–2009)



Source: FAO (2012).

Example 14.1: Fish Production in the Lower Mekong Basin



Source: FAO, 2013

Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

15.1 Livestock and Land Resources

SDG 15 is committed to protecting land resources through sustainable forest and land management with an emphasis on halting desertification, land degradation, and biodiversity loss. Livestock production is globally ubiquitous, with up to 26% of terrestrial areas dedicated to rangelands and 33% of croplands dedicated to fodder production.

Whether livestock yields a positive or negative impact on biodiversity depends on the intensity of production, the nature of specific practices, the livestock species used and the local ecological conditions. At one extreme, undisturbed habitats can be destroyed, such as in conversions of primary forest to pastures or feed crops (e.g. soybean) in the Brazilian Amazon, although livestock is not the only driver and overall deforestation was significantly reduced since 2004 (Steinfeld et al., 2006). At the other extreme, in some places with a long history of livestock grazing, a unique biodiversity has specifically adapted to habitats associated with the presence of livestock. This relationship may be related to herbivory being a factor that shapes biodiversity in many ecosystems (Frank, 2005), where livestock has taken over the role of wild herbivores when under adequate management (Bond & Parr, 2010). Livestock pressures on biodiversity are not only manifested through conversion/conservation of natural habitats and land use change, but also from impacts on water quality and quantity as well as contributions to climate change.[45]

Better management of rangelands can reverse desertification, and potentially sequester 12 to 20 billion metrics tons of carbon over a 50-year period (assuming two-thirds of the historic loss can be re-sequestered) (Lal, 2003). Land use and

[45] Alkemade et al studies the harmful impacts of livestock production on rangeland ecosystems, which includes reduction in biodiversity due to removal of biomass, destruction of root systems, and displacement of wild grazers (Alkemade et al., 2010)

management strategies to sequester soil organic carbon include: afforestation with suitable tree species, soil management on cropland for fodder production (such as applying manure or vegetative mulches), and pasture management on grazing land. Pasture management practices vary by location and region, but may include controlled grazing at an ecologically sustainable stocking rate, sowing legumes and other improved grazing species, prescribed burning, agroforestry, and erosion management..[46] In addition to promoting carbon sequestration, these various pasture management strategies contribute to grassland restoration, improve nutrient cycling, and, to varying degrees, facilitate water infiltration as well as greater resiliency to extreme weather conditions.

15.2 LSDG 15: Support more a sustainable livestock sector with policies securing property rights, sustainable natural resources, and technology access.

Objective

Promote vocational and general education for livestock producers and livestock-dependent communities.

Indicators

LSDI 15.1: Proportion of smallholders with access to secure land tenure

LSDI 15.2: Proportion of feed-based livestock development

LSDI 15.1: Proportion of households with access to secure land tenure

Definition

This indicator measures the proportion of rural households who have land rights secured by legal documentation of individual or community (village-level) ownership. Generally speaking, secure land rights are a necessary condition for

[46] Lal (2003) presents a geographically diverse selection of studies exhibiting these different soil, pasture, and rangeland management strategies. Additional studies conducted in Botswana and Zimbabwe show the impact of a low stocking rate and controlled grazing on improved biomass productivity and vegetative biodiversity (Abel and Blaikie, 1989), and in the US improved grazing management increased carbon storage in rangeland soils (Schuman et al., 2002).

sustainable practices of agriculture and local resource use. This is particularly true for livestock rearing, where common property resources (rangeland, water, forested areas) can be vulnerable to competitive depletion.

Method of computation

Data resources

Data come mainly from household and farm surveys. In countries without such data from surveys, data can be derived from population and housing censuses, which usually include questions about land tenure.

LSDI 15.2: Proportion of feed-based livestock development

Definition

This indicator measures the share of livestock production that is sustained by marketable feed and fodder, as opposed to free range and foraged sources of livestock nutrition. This measure is thought to indicate the degree to which livestock production is profitable independently of local natural resource constraints. Depending on feed crop yields, there may also be opportunities to reduce the global extent of rangeland, offering opportunities for afforestation and other uses.

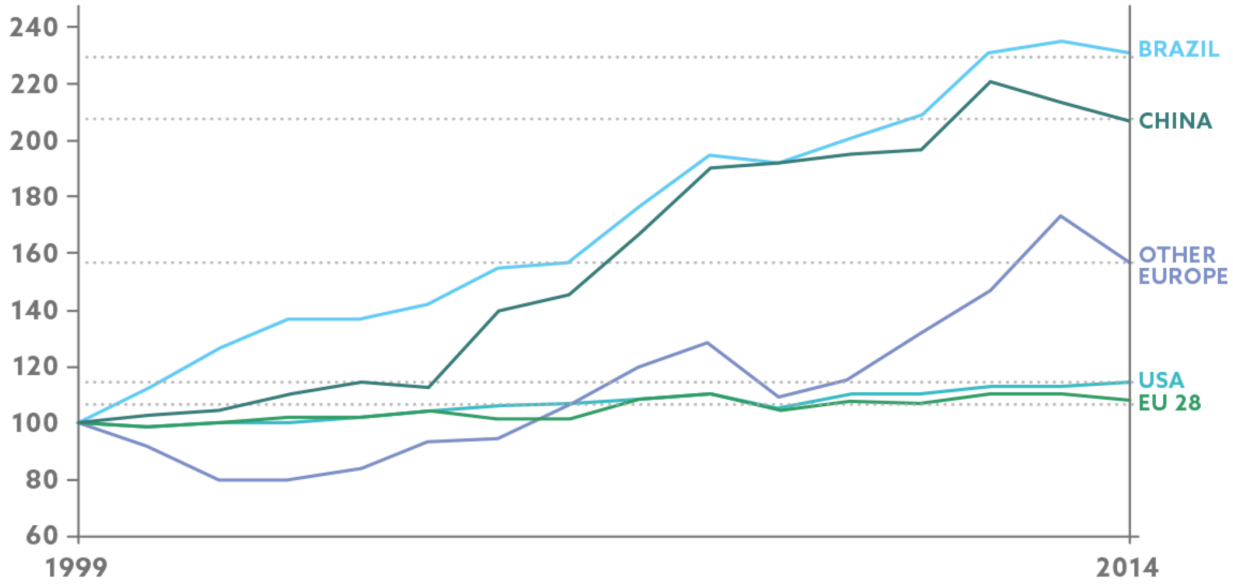
Method of computation

Estimate the share of household, local, provincial, and national livestock production sustained by commodity feed products. Estimates by species, and even with respect to different feedstocks, can be useful to inform sustainability strategies.

Data resources

Data can be obtained from extension services, market surveys, and household/farm survey data.

Example 15.1: Feed Production Growth Rates (indexed to 1999=100)



Source: IFIF, 2015

Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

16.1 Livestock, Peace, and Justice

SDG 16 is dedicated to promoting just, peaceful and inclusive societies. Improving property rights, food security, and reducing inequality all improve economic and environmental justice outcomes, thereby mitigating systemic risks of social rivalry and conflict. Resource scarcity, tenure insecurity, and chronic inequality have all been identified as endogenous determinants of rural conflicts (Pica-Ciamarra et al., 2007), and numerous conflicts have emerged in areas where access to land creates social tension (e.g. pastoralists vs agronomists). Because of zoonoses risks to animals, humans, and food security, livestock can also be a threat to biosecurity and public safety.

Insecure land rights can jeopardized the livelihood of marginalized communities pastoralists whos' livelihoods depend on rangeland resources and grazing areas. Achieving SDG 16 in ensuring inclusive participatory decision-making at all levels and equal access to justice is linked to securing land rights for livestock owners. Participatory land-use planning that reflects the views of herders and establishing joint land-use agreement are tools being used by the International Livestock Research Institute (ILRI) to recognize and protect group land rights and prevent conflict over land and resources.

16.2 LSDG 16: Support a more inclusive livestock sector development with policies promoting equitable access to markets, financial and information services.

Objective

Promote vocational and general education for livestock producers and livestock-dependent communities.

Indicators

LSDI 16.1: Proportion of smallholders with access to internet-based agrifood technical and market information

LSDI 16.2: Smallholder capital adequacy for livestock enterprise development

LSDI 16.1: Proportion of smallholders with access to internet-based agrifood technical and market information

Definition

The internet has become the most cost-effective distributed information source for modern agriculture, yet its availability in rural areas of developing countries remains limited. This indicator measures the proportion of rural farm households how have effective access to these information resources.

Method of computation

Estimates effective access to internet-based agricultural information, meaning services are available and accessible. Accessibility requires means relevant language implementation and locally relevant technical and market data, implemented for existing communication technologies, or mobile phones with appropriate interfaces. Subject to these criteria, estimate household percentage with access by information category (weather, agronomic, marketing, etc.).

Data resources

Data should be available from more recent household, enterprise, and communications surveys.

LSDI 16.2: Smallholder capital adequacy for livestock enterprise development

Definition

This indicator measures the net financial resources available to smallholders for investment in livestock enterprise development. These resources are essential to expand capacity, improve productivity, product quality, and meet higher downstream market standards.

Method of computation

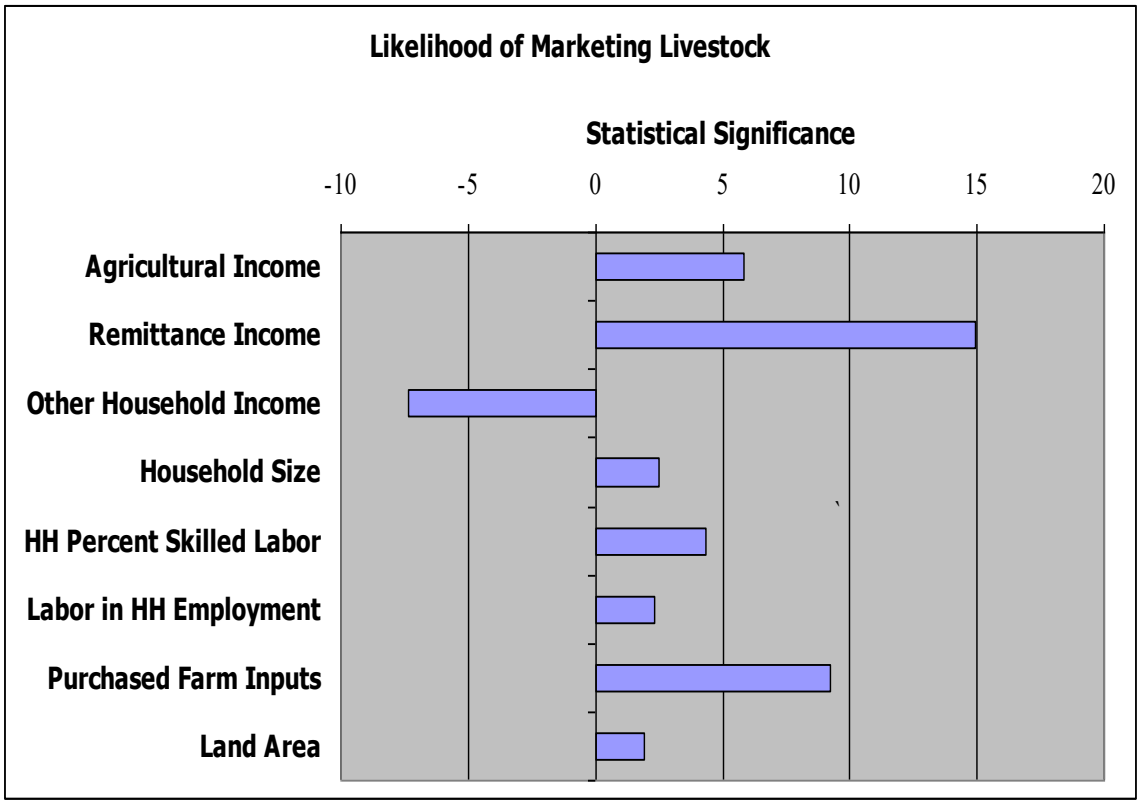
Using household budget information, supplemented by estimates of local credit conditions, estimate net financial assets in hand and available, discounted for costs of capital including interest, search, qualification, etc. Both formal and informal financial sources should be included, including remittances and

lending capacity from banks, credit cooperatives, government programs, and informal lenders.

Data resources

Household surveys, LSMS, financial sector surveys, public lending programs.

Example 16.1: Financial Resources for Smallholder Livestock Development, Logit Regression Results from Upland Vietnam



Source: Otte and Roland-Holst: 2008.

Strengthen the means of implementation and revitalize the global partnership for sustainable development

17.1 Livestock and Global Partnerships

SDG 17 focuses on revitalizing global partnerships and bringing together governments, the private sector, and civil society for achieving universal stainable development. The establishment of multi-stakeholder partnerships that foster the sharing of knowledge, expertise, technology and financial resources is a fundamental condition to the achievement of the SDGs, and can be crucial in leveraging inter-linkages between separate goals to maximize their effectiveness and impact.

The livestock sector exhibits a number of multi-stakeholder partnerships at global and regional levels, which are key engines for ensuring sustainable growth in livestock production that keeps up with rising global demand, while simultaneously addressing key environmental, social and economic challenges.

The Global Agenda for Sustainable Livestock (GASL) unites a wide range of stakeholders including the public and private sector, academic institutions, and community-based organizations to facilitate the sharing of knowledge, expertise, and experience to enhance policy coherence in addressing the sector's most pressing issues. The agenda's three main areas of focus include: (1) improving production efficiency; (2) restoring value to grasslands; and (3) managing manure.

Improving efficiency through investments in livestock health and nutrition leads to increased production using fewer resources, contributing to food security while mitigating environmental impact. Restoring value to grasslands through better grassland management improves the quantity and quality of forage species, and simultaneously increases livestock production, carbon storage, water efficiency and biodiversity. Finally, appropriate manure management through biogas generation and fertilizer production can help reduce pollution to

surrounding air and waterways, while recovering energy and nutrients to offset fuel use and synthetic fertilizer applications.[47]

In addition to GASL, a number of existing partnerships at global, regional and nationals levels are being strengthened, and new ones being fostered in the field of animal health and at the interface of animal, human and ecosystems health. This is in recognition of the fact that livestock plays a crucial role in contributing positively to human health, but can also be a major source of debilitating and deadly infectious diseases. Between 60% to 75% of the existing and emerging human pathogens are of animal origin, respectively. Thus improving efficiency through investments in livestock health and nutrition leads to increased production using fewer resources, contributing to food as well as global health security while mitigating environmental impact.

At a global level, FAO, OIE and WHO have forged a tripartite alliance ensuring that the three international agencies continue to work together, and consolidate existing partnerships to prevent, detect, control and eliminate disease risks to humans originating directly or indirectly from animals. Through this formal partnership the three organizations work together under a common strategy, applying One Health principles, to synergize their respective expertise in tackling diseases of animals and humans at the human-animal-environment interface.

FAO also continues to build stronger multi-sectoral partnerships within countries by supporting development of country level One Health strategies and platforms, and providing training in multi-sectoral approaches to increase efficiency in the prevention and control of diseases originating from animals.

Multi-factorial drivers of diseases necessitate broader partnerships with a range of sectors such as forestry, agro-forestry, fisheries, wildlife, natural resource management and environment. Such partnerships are being increasingly forged through investment by a number of donors to better understand the drivers of disease emergence and spillover and apply risk mitigation measure at the source.

FAO is continuing to enhance public and private partnerships to include livestock producers, traders, feed manufacturers, and pharmaceutical companies, and ministries of animal and human health in order to ensure that the 'farm to fork' food chain is safe and biosecure.

[47] The GASL focus areas are presented in greater detail on the GASL website http://www.livestockdialogue.org/en/

Similar partnerships are also being forged, with the emergence of 'super bugs' due to anti-microbial resistance, to enhance compliance with standards that require responsible use of antibiotics in the livestock and fisheries sectors. Such partnerships are expected to contribute significantly to food safety.

The Global Health Security Agenda, launched in 2014, is a partnership of over 50 countries, international organizations, non-governmental organizations, and non-governmental stakeholders, that aims to promote a multilateral and multi-sectoral approach to strengthen both the global and national capacities in human and animal health systems to prevent, detect, and respond to infectious diseases threats. Through this partnership the global health security has become a shared responsibility, the success of which depends upon partnerships and collaboration among the health, security, environment, and agriculture sectors. FAO, is providing technical advice to the GHSA through its scientific expertise in the areas of animal health, emergency management, agriculture/livestock and aquaculture production and marketing systems, and through its links with the food safety (Codex), forestry and wildlife management, agriculture and animal health legislation, and aspects of economic and social development, including vast efforts in capacity development and governance.

17.2 LSDG 17: Develop a global partnership for pro-poor livestock production, technology transfer, and supply chain development

Objective

Establish institutions and agreements to facilitate dissemination and sharing of intellectual property, genetic material, technologies, while supporting public and private supply chain partnerships related to livestock production, processing and marketing.

Indicators

LSDI 17.1: Net ODA directed to smallholder agriculture or rural poverty, as a percentage of OECD/DAC donors' gross national income.

LSDI 17.2: Proportion of bilateral, sector-allocable ODA of OECD/DAC donors for livestock and livestock related development.

LSDI 17.3: Proportion of livestock product trade covered by administrative measures.

LSDI 17.4: Proportion of total developed country imports (by value and excluding arms) of livestock products from developing countries and from least developed countries, admitted free of duty.

LSDI 171.: Net ODA directed to smallholder agriculture or rural poverty, as a percentage of OECD/DAC donors' gross national income

Definition

Official development assistance (ODA) comprises grants or loans to developing countries and territories on the Organisation for Economic Co-operation and Development/Development Assistance Committee (OECD/DAC) list of aid recipients that are undertaken by the official sector with promotion of economic development and welfare as the main objective and at concessional financial terms (if a loan, having a grant element of at least 25 percent). Technical cooperation is included. Grants, loans and credits for military purposes are excluded. Also excluded are aid to more advanced developing and transition countries as determined by the DAC.

Donors' gross national income (GNI) at market prices is the sum of gross primary incomes receivable by resident institutional units and sectors. GNI at market prices was called gross national product (GNP) in the 1953 System of National Accounts. In contrast to gross domestic product (GDP), GNI is a concept of income (primary income) rather than value added.

Method of computation

GNI is equal to GDP (GDP at market prices represents the final result of the production activity of resident producer units) less primary incomes payable to non-resident units plus primary incomes receivable from non-resident units. In other words, GNI is equal to GDP less taxes (less subsidies) on production and imports, compensation of employees and property income payable to the rest of the world plus the corresponding items receivable from the rest of the world.

Data resources

Data are compiled by OECD/DAC.

LSDI 17.2: Proportion of bilateral, sector-allocable ODA of OECD/DAC donors for livestock and livestock related development

Definition

Official development assistance (ODA) comprises grants or loans to developing countries and territories on the Organisation for Economic Co-operation and Development/Development Assistance Committee (OECD/DAC) list of aid recipients that are undertaken by the official sector with promotion of economic development and welfare as the main objective and at concessional financial terms (if a loan, having a grant element of at least 25 percent). Technical cooperation is included. Grants, loans and credits for military purposes are excluded. Also excluded are aid to more advanced developing and transition countries as determined by the DAC. Bilateral official development assistance is from one country to another.

Data resources

Compiled by OECD/DAC.

LSDI 17.3: Proportion of agricultural trade covered by administrative measures that distort trade

Definition

The percent of total agricultural imports and exports that are covered by export taxes, import tariffs and quantity restrictions, as well as other measures that distort trade flows. Of particular relevance in the present context are livestock products and animal feeds.

Method of computation

Data resources

LSDI 17.4: Proportion of total developed country imports (by value and excluding arms) of livestock products from developing countries and from least developed countries, admitted free of duty

Definition

Imports and imported value of goods (merchandise) are goods that add to the stock of material resources of a country by entering its economic territory. Goods simply being transported through a country (goods in transit) or temporarily admitted (except for goods for inward processing) do not add to the stock of material resources of a country and are not included in the international merchandise trade statistics. In many cases, a country's economic territory

largely coincides with its customs territory, which is the territory in which the customs laws of a country apply in full. Goods admitted free of duties are exports of goods (excluding arms) received from developing countries and admitted without tariffs to developed countries.

There is no established convention for the designation of developed and developing countries or areas in the United Nations system. In common practice, Japan in Asia, Canada and the United States in North America, Australia and New Zealand in Oceania and Europe are considered 'developed' regions or areas. In international trade statistics, the Southern African Customs Union is also treated as a developed region and Israel as a developed country; countries emerging from the former Yugoslavia are treated as developing countries; and countries of Eastern Europe and European countries of the former Soviet Union are not included under either developed or developing regions.

The indicator monitors the international effort made to remove barriers to trade for developing countries, to encourage the achievement of the Sustainable Development Goals. Poor people in developing countries work primarily in agriculture and labor-intensive manufactures, sectors that confront the greatest trade barriers. Removing barriers to merchandise trade, therefore, could increase growth in these countries by a significant amount.

Method of computation

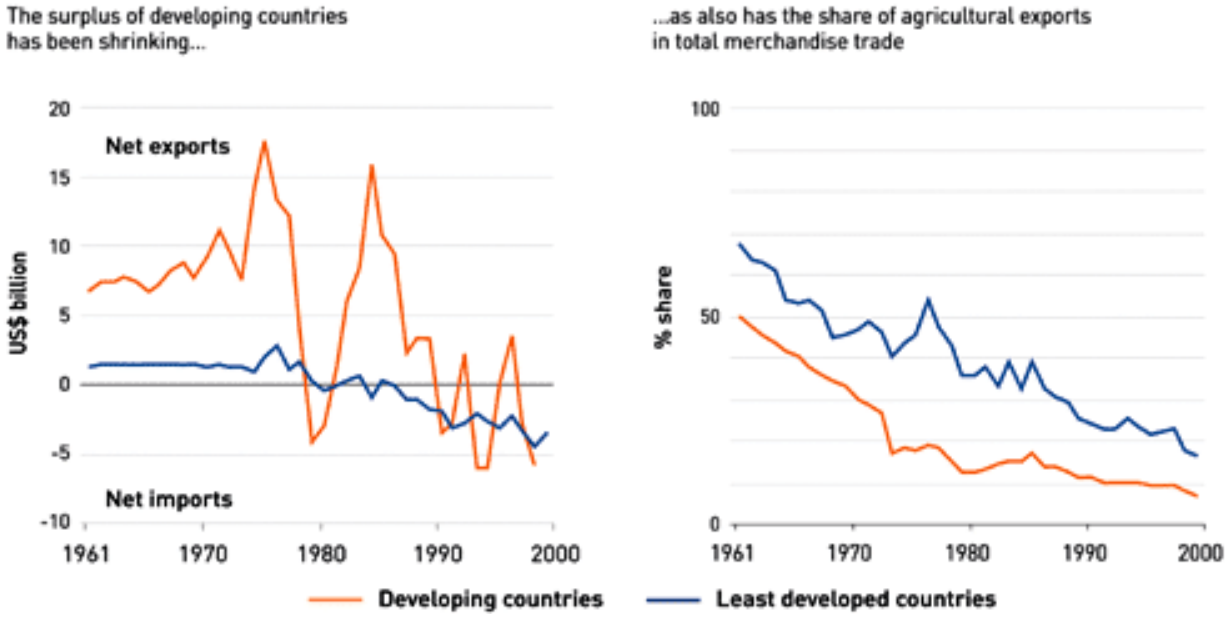
To value their exports, countries can choose free-on-board (f.o.b.) values, which include only the transaction value of the goods and the value of services performed to deliver goods to the border of the exporting country, or cost, insurance and freight (c.i.f.) values, which add to this the value of the services performed to deliver the goods from the border of the exporting country to the border of the importing country. It is recommended that imported goods be valued at c.i.f. prices for statistical purposes. Specific duties "not expressed as a proportion of the declared value" may or may not be included in calculations of goods admitted free of duties.

Data resource

This indicator is calculated by the United Nations Conference on Trade and Development in collaboration with the World Bank and the World Trade

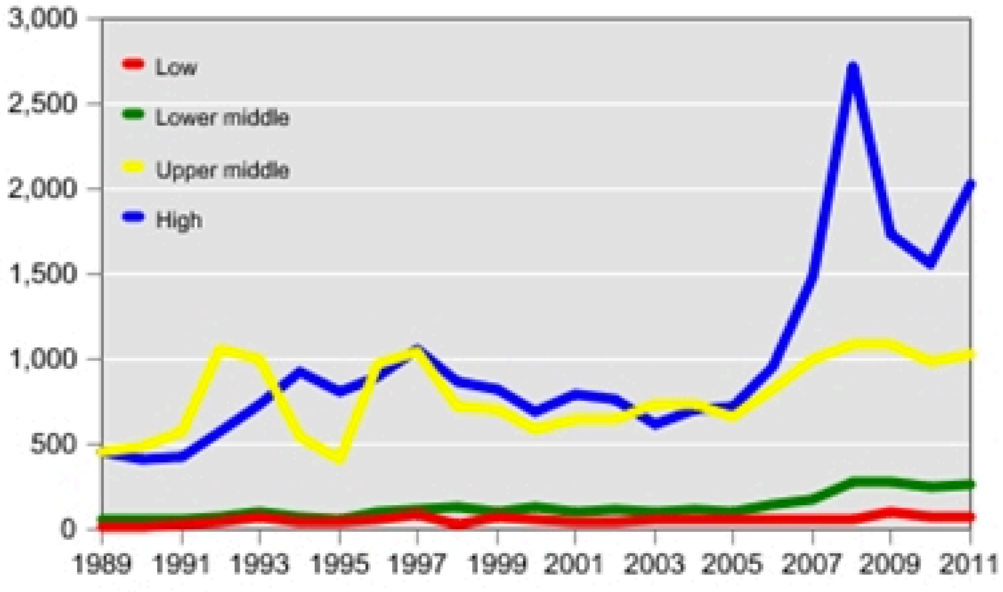
Organization, from the Trade Analysis and Information System (TRAINS) CD-ROM, version 12 (2012).

Example 17.1: Declining Agricultural Export Competiveness for Developing Countries



Source: FAO, 2005

Example 17.2: The Majority of US Agriculture Imports are Supplied by High and Middle Income Countries (imports by source in USD millions)



Source: USDA/ERS, 2014

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Annex A – Concordance between UN SDGs and LSDGs

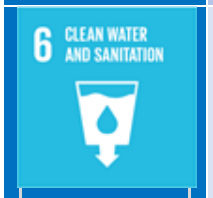
	SDG	LSDG
1	End poverty in all its forms everywhere	By 2030, raise the minimum incomes of all livestock-dependent people above the global poverty line.
2	End hunger, achieve food security and improved nutrition and promote sustainable agriculture	Increase livestock's sustainable contribution to global nutrition and food security.
3	Ensure healthy lives and promote well-being for all at all ages	Promote global human health through higher standards for animal health and husbandry, including hygienic and humane production and processing practices
4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	Promote extension services, agribusiness education, and technology transfer across smallholder livestock supply chains.
5	Achieve gender equality and empower all women and girls	Promote gender balanced livestock production, processing, and management practices and increase investment in female-centered livestock related activities
6	Ensure availability and sustainable management of water and sanitation for all	Promote sustainable water use and water quality management in livestock production and processing systems.
7	Ensure access to affordable, reliable, sustainable and modern energy for all	Promote energy efficiency and lower carbon technologies (including gas and biomass recycling) in livestock production and processing.
8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	Double public investments for enhancing smallholder access to extension services and markets by 2030, with emphasis on public actions that increase smallholder value and employment.

9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	Promote inclusive investment and market participation at all stages of livestock production, processing, and marketing systems.
10	Reduce inequality within and among countries	Advance sustainable smallholder livestock production, market access, and value creation.
11	Make cities and human settlements inclusive, safe, resilient and sustainable	Improve urban food and health security with investments in expanded and modernized local livestock production, processing, and marketing systems.
12	Ensure sustainable consumption and production patterns	Ensure sustainable livestock production at all enterprise scale, while promoting more resource-efficient products and consumption practices.
13	Take urgent action to combat climate change and its impacts*	Promote livestock production, processing, and marketing practices that explicitly address climate mitigation and adaptation needs.
14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development	Promote sustainable fishery habitat, production, processing, and marketing systems, with special reference to the global majority of low income fishery-dependent households.
15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	Support more a sustainable livestock sector with policies securing property rights, sustainable natural resources, and technology access.
16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	Support a more inclusive livestock sector development with policies promoting equitable access to markets, financial and information services.
17	Strengthen the means of implementation and revitalize the global partnership for sustainable development	Develop a global partnership for pro-poor livestock production, technology transfer and supply chain development

Annex B – Sustainable Development Goals, Livestock Development Goals, and Livestock Development Indicators

	**End poverty in all its forms everywhere**	**LSDG 1:**	**End poverty in livestock-dependent communities**
		LSDI 1.1:	Proportion of LD population below $1.90 (PPP) a day
		LSDI 1.2:	Poverty headcount ratio (percent of LD population below national poverty line)
		LSDI 1.3:	Poverty gap ratio (incidence x depth of poverty)
		LSDI 1.4:	Share of poorest quintile in national consumption
	**End hunger, achieve food security and improved nutrition and promote sustainable agriculture**	**LSDG 2:**	**Increase livestock's sustainable contribution to global nutrition and food security**
		LSDI 2.1:	Proportion of LD population below minimum level of dietary energy consumption
		LSDI 2.2:	Prevalence of underweight in LD children (under five years of age)

	**Ensure healthy lives and promote well-being for all at all ages**	**LSDG 3:**	**Promote global human health through higher standards for animal health and husbandry, including hygienic and humane production and processing practices**
		LSDI 3.1:	Livestock health indicator
		LSDI 3.2:	Smallholder livestock health indicator
		LSDI 3.3:	Smallholder animal health adversity
		LSDI 3.4:	Smallholder animal health gap
		LSDI 3.5:	Smallholder animal health severity
		LSDI 3.6:	Epidemic and zoonotic animal disease prevalence indicator
		LSDI 3.7:	Animal disease outbreak indicator
		LSDI 3.8:	Veterinary extension indicator
			Vaccination Coverage
	**Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all**	**LSDG 4:**	**Promote extension services, agribusiness education, and technology transfer across smallholder livestock supply chains.**
		LSDI 4.1:	Livestock extension services indicator
		LSDI 4.2:	Livestock-dependent community education spending

	**Achieve gender equality and empower all women and girls**	**LSDG 5:**	**Promote gender balanced livestock production, processing, and management practices and increase investment in female-centered livestock related activities**
		LSDI 5.1:	Headcount of women and girls in livestock extension service enrollment.
		LSDI 5.2:	Headcount female employment in formal sector livestock production, processing, and marketing enterprises.
		LSDI 5.3:	Average per capita income of females working in formal sector livestock enterprises, as a percentage of male per capital income.
		LSDI 5.4:	Share of extension service spending on female-centered livestock related activities, e.g. small animal husbandry/processing/marketing, eggs, dairy, furs, etc.
		LSDI 5.5:	Share of formal, informal, and public livestock related enterprise credit extended to females.
	**Ensure availability and sustainable management of water and sanitation for all**	**LSDG 6:**	**Promote sustainable water use and water quality management in livestock production and processing systems.**
		LSDI 6.1:	Direct water us in livestock Production, Processing, and Marketing
		LSDI 6.2:	Proportion of animal production and processing waste subject to containment and biosecure processing.

	**Ensure access to affordable, reliable, sustainable and modern energy for all**	**LSDG 7:**	**Promote energy efficiency and lower carbon technologies (including gas and biomass recycling) in livestock production and processing**
		LSDI 7.1:	Proportion of smallholder energy from renewable sources
		LSDI 7.2:	Recycling Index for Livestock Related Biomass and Biogas
	**Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all**	**LSDG 8:**	**Double public investments for enhancing smallholder access to extension services and markets by 2030, with emphasis on public actions that increase smallholder value and employment.**
		LSDI 8.1:	Total public outlays on smallholder and LD community extension services, as a percent of smallholder income.
		LSDI 8.2:	Smallholder and LD community value added as a percent of sector value added
		LSDI 8.3:	Increase spending on research to improve smallholder and LD community agricultural profitability
	**Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation**	**LSDG 9:**	**Promote inclusive investment and market participation at all stages of livestock production, processing, and marketing systems.**
		LSDI 9.1:	Total factor productivity growth in smallholder and LD community livestock production

		LSDI 9.2:	Investment in livestock processing and market infrastructure serving smallholder rural and LD communities
		LSDI 9.3:	Marketing extension services and commercial microcredit for smallholder rural and LD communities
	**Reduce inequality within and among countries**	**LSDG 10:**	**Advance sustainable smallholder livestock production, market access, and value creation**
		LSDI 10.1:	Livestock Income Gini Coefficient.
		LSDI 10.2:	Livestock and LD Community Terms of Trade.
	**Make cities and human settlements inclusive, safe, resilient and sustainable**	**LSDG 11:**	**Improve urban food and health security with investments in expanded and modernized local livestock production, processing, and marketing systems.**
		LSDI 11.1:	Share of urban livestock production, processing, and marketing that is subject to consistent and credible food safety standards.
		LSDI 11.2:	Proportion of Urban Livestock Products Provided by Urban and Peri-urban Agriculture
		LSDI 11.3:	Incoming Food Safety Risks for Urban Markets

	**Ensure sustainable consumption and production patterns**	**LSDG 12:**	**Ensure sustainable livestock production at all enterprise scale, while promoting more resource-efficient products and consumption practices.**
		LSDI 12.1:	Land Use Intensity of Livestock Production
		LSDI 12.1:	Proportion of Food Wasted from Livestock Sources
	**Take urgent action to combat climate change and its impacts***	**LSDG 13:**	**Promote livestock production, processing, and marketing practices that explicitly address climate mitigation and adaptation needs.**
		LSDI 13.1:	Emissions Intensity of Livestock Production
		LSDI 13.2:	Percentage of Indigenous, Crossbred, and Adapted Species in Livestock Production
	**Conserve and sustainably use the oceans, seas and marine resources for sustainable development**	**LSDG 14:**	**Promote sustainable fishery habitat, production, processing, and marketing systems, with special reference to the global majority of low income fishery-dependent households.**
		LSDI 14.1:	Per capita extent and productivity of smallholder accessible local fishery resources
		LSDI 14.2:	Proportion of domestic fishery sector output from aquaculture
		LSDI 14.3:	Proportion of household per capita protein from fishery products

	**Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss**	**LSDG 15:**	**Support more a sustainable livestock sector with policies securing property rights, sustainable natural resources, and technology access.**
		LSDI 15.1:	Proportion of smallholders with access to secure land tenure
		LSDI 15.2:	Proportion of feed-based livestock development
	**Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels**	**LSDG 16:**	**Support a more inclusive livestock sector development with policies promoting equitable access to markets, financial and information services.**
		LSDI 16.1:	Proportion of smallholders with access to internet-based agrifood technical and market information
		LSDI 16.2:	Smallholder capital adequacy for livestock enterprise development
	**Strengthen the means of implementation and revitalize the global partnership for sustainable development**	**LSDG 17:**	**Develop a global partnership for pro-poor livestock production, technology transfer, and supply chain development**
		LSDI 17.1:	Net ODA directed to smallholder agriculture or rural poverty, as a percentage of OECD/DAC donors' gross national income.

		LSGI 17.2:	Proportion of bilateral, sector-allocable ODA of OECD/DAC donors for livestock and livestock related development.
		LSDI 17.3:	Proportion of livestock product trade covered by administrative measures.
		LSDI 17.4:	Proportion of total developed country imports (by value and excluding arms) of livestock products from developing countries and from least developed countries, admitted free of duty.

Annex C - Tabulation of Linkages between the Livestock Sector and the Agenda for Sustainable Development

SDG	Key Targets	Proposition	Livestock linkage	Potential indicator
Goal 1. End poverty in all its forms everywhere.	By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day	1.5 billion People live on less than %1.25 a day that means around 12% of the world population. The proportion of the poor population is higher in rural, 70% of the world's poor live in rural areas.	Livestock constitute a major financial assets category for the majority of rural households in developing countries.	Proportion of the population below the international poverty line, disaggregated by sex, age group, employment status and geographical location (urban/rural)
	By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions	Households headed by woman are poorer than those headed by men; Poverty is higher among unemployed (old) people; Poverty is higher among people with low	Livestock play an important role for women labor in the household both in the management of the asset and the financial return, reducing the household income dependency ratio; Livestock is an important source of employment for people both labor and self-employment. Livestock assets can increase	Proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions.

		level of education.	the marginal productivity of unskilled rural labor.	
	By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance	Improved livelihoods of the rural poor rely on secure and equitable access to and control over land and other natural resources. Entitlement to these resources is subject to competition with alternative agrifood production systems, unsustainable agricultural practices, and urbanization,.	One third of the planet's arable land is occupied by livestock feed crop cultivation. Feed crop cultivation may increase the economic scarcity of food crops for the poor, deplete water resources, and undermine long term land fertility.	

	By 2030, build resilience among the poor and vulnerable and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters	Poverty is higher among people living highly vulnerable areas and exposed to extreme climate events.	Livestock plays an important role in building resilience of poor people, particularly pastoralists, living in vulnerable areas and exposed to economic, social, and environmental shocks.	
Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture	By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round	Prevalence of malnutrition is higher among children (particularly important in early life as it has long-lasting effects).	Animal source products (ASPs) provide a broad spectrum of essential nutrients and are readily available to the poor through subsistence animal production and distribution across networks of small and household enterprises.	Smallholder livestock production and marketing as a percent of national agrifood production and value added.

	By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons.	In 2015, about 5.9 million children under the age of 5 died, and 45% of these child deaths were attributable to malnutrition.	Meat, milk, eggs, and other ASPs offer digestible protein to local communities without the need for advanced food distribution and preservation technologies. Livestock products contribute 17 per cent to caloric intake and 33 per cent to protein intake to the global human diet globally (Rosegrant et al. 2009). However the production of livestock commodities may leads to soil degradation, water resource depletion and deforestation.	Prevalence of malnutrition and protein deficiency among children under 5, disaggregated by type.
	By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to	Agricultural productivity has grown at an annual rate of less than 1.5 percent in developing regions. The efficient functioning of agricultural markets is fundamental condition to	Demand for ASPs has grown much faster than demand for agricultural staples. Thus livestock promotion enhances growth leverage for the rural sector and provides enhanced value opportunities for agrifood market participation.	Livestock subsectors: total factor productivity revenue per capita headcount growth rate revenue growth rate

	land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment.	increase agricultural productivity.		
	By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality	Climate stresses will intensify in the most populous regions of the developing world, dominated by smallholder agrifood producers, threatening local, national, and global food security.	There is a high potential to increase the sustainability of livestock production systems by promoting the development of systems that promote employment creating, reduce pollution, and	

	By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed.	Smallholder producers remain the most adapted to local agro-ecological conditions, are keepers of the majority of agrifood biodiversity, and retain most of the extant traditional knowledge regarding localized agronomic and ecological conditions, history, and systemic risks.	Native livestock in traditional agriculture are highly adapted to local ecological conditions and resilient against established environmental cycles. As such, they pose smaller livelihood risk than other categories of agrifood products and non-farm employment opportunities. Genetic diversity in livestock species is important to agriculture and food production because it enables livestock to be raised in a wide range of production environments and to provide a wide range of products and services (food, fibres, manure, draught power, etc.). It also provides the basis for adapting livestock populations to future changes in environmental conditions or in demand for products and services. Livestock genetic diversity is threatened by various factors including the trend towards greater homogeneity in the world's livestock production systems and a lack of appropriate management	Number of plant and animal GRFA secured in either medium or long term conservation facilities Percentage of local breeds, classified as being at-risk, not at-risk or unknown level of risk of extinction

			strategies and policies. Planning measures to promote the sustainable use, development and conservation of animal genetic resources requires information on the diversity of these resources nationally and internationally. In the absence of direct measures at genetic level, the main method used to monitor trends in the diversity of terrestrial domesticated animals is to monitor aggregate changes in breed risk status, i.e. changes in the proportion of breeds categorized as being at risk of extinction. This is done using data from the Domestic Animal Diversity Information System (DAD-IS at http://www.fao.org/dad-is/), maintained by the Food and Agriculture Organization of the United Nations (FAO).	
Goal 3. Ensure healthy lives and promote well-being for all at all ages	By 2030 end preventable deaths of new-borns and children under 5 years old, with all countries aiming to reduce	Agriculture presents a broad spectrum of health and safety risks, including high rates of occupational and accidental injury,	Livestock ownership increases child exposure to zoonotic diseases, and livestock keeping presents a variety of health and safety challenges to vulnerable populations, including children and the elderly.	DHS data could be used to monitor health status in countries. These datasets include both child growth and livestock ownership information. This

	neonatal mortality to at least as low as 12 per 1000 live births and under-5 mortality to at least as low as 25 per 1000 live births.	exposure to disease and infection, and in some cases chronic exposure to toxic chemicals and environmental contaminants..		measure could be routinely evaluated in association with child stunting.
Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.	By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes.	Over 65 million primary school-age children attend classes hungry across the developing world, with 23 million in Africa alone.	School milk programs and other ASP-rich supplementary meal schemes can increase school enrollment, improving both attendance and students performance.	
	By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university.	The majority of the world's extreme poor (nearly one billion) are employed in household enterprises, where the most productive form of education	Livestock rearing is an important source of household employment, especially women, who can increase their productivity substantially with cost-effective extension services and technology transfer.	Participation rate of youth and adults in formal and non-formal education and training related to sustainable livestock in the last 12 months.

		consists material production skills.		
Goal 5. Achieve gender equality and empower all women and girls.	End all forms of discrimination against all women and girls everywhere.	As the atomistic unit of social organization, household production systems are the first line of defence against gender discrimination. In agriculture, this means extension and education services must target gender balance and equitable compensation in all agrifood production practices.	An estimated two thirds of poor livestock keepers, totalling approximately 400 million people, are women. They share responsibility with men and children for the care of animals, and particular species and types of activity are more associated with women than men.	

	Recognize and value unpaid care and domestic work through the provision of public services, infrastructure and social protection policies and the promotion of shared responsibility within the household and the family as nationally appropriate.	Women comprise 43 percent of the agricultural labour force in developing countries; this figure ranges from around 20 percent in Latin America to 50 percent in parts of Africa and Asia, and exceeds 60 percent in a few countries. Their total compensation is far below these participation shares, however, and their property rights may be severely limited.	Labour-force statistics may actually underestimate the amount of work that women do in livestock: women are less likely than men to define their activities as work, they are less likely to report themselves as being engaged in livestock and they work, on average, longer hours than men.	Share of women engaged in livestock sector related labour activities.

	Undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property, financial services, inheritance and natural resources, in accordance with national laws.	Women landholders are significantly fewer than male landholders in all regions of the world. Moreover, evidence also reveals that, women who hold land generally have smaller plots, of an inferior quality and with less secure rights.	Women are heavily involved in ASP production and marketing, but they have less access than men to productive resources and opportunities across all regions.	Share of women among owners or right-bearers of agricultural land, by type of tenure. Share of women engaged in agricultural labour, land tenure, total number of holders, female holders, GINI land concentration index. FAO-Gender and land database.
Goal 6. Ensure availability and sustainable management of water and sanitation for all.	By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of	Less than one per cent of the world's renewable fresh water is directly available for human use.	Agriculture uses approximately 70% of the available freshwater supply, and 29% of the total agriculture's water footprint is linked to livestock production, one third of which supports beef cattle. Global livestock sector expansion is intensifying agricultural water use while the latter increasing competition with other human water needs and environmental services.	Percentage change in water use efficiency of livestock production systems over time.

	people suffering from water scarcity.			
Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all.	By 2030 double the global rate of improvement in energy efficiency	Today, 2.5 billion people rely on traditional biomass fuels as their principal source of energy for cooking and heating. About 85 per cent of the global population using biomass for cooking lives in rural areas.	Within this scenario, waste manure and other organic materials from livestock farms could be an important source of renewable energy, improving soil fertility, and reducing livestock production post-harvest losses.	Energy intensity measured in terms of primary energy gross domestic product
Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment	Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least	Agrifood productivity in developing countries is far lower than in formal and urban sectors, as are skill and technology levels.	Livestock is one of the fastest growing economic subsectors in developing countries. Its share of agricultural GDP is already 33 per cent and is quickly increasing. (Delgado 2005). Livestock production and merchandizing in industrialized countries account for 53 per	Annual growth rate of real GDP per capita

and decent work for all.	developed countries		cent of agricultural GDP (World Bank 2009) Capturing the economic benefits of global and national livestock market growth trends domestically may contribute to sustain per capita economic growth.	
	Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors.	Agriculture in developing countries is generally caught in a low level investment trap. Institutional reforms to overcome capital market failures, improved the smallholder investment and risk management environment can sharply increase long term agrifood productivity growth.	Livestock is the agricultural subsector where value added opportunities are substantial and largely unrealized. Increasing the marginal productivity of labour in the livestock sector through training, technological upgrading and innovation may lead to substantial and sustained value creation across developing country ADP value chains.	Annual growth rate of real GDP per employed person

	Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead.	Largely because of cheap resource policies (water, energy, etc.) agriculture in many developing countries is characterized by excessive resource intensity, inappropriate technology and product choice, and unsustainable land use practices.	Adjusting the value of livestock commodities to its true economic cost (including social and environmental) may lead to a more efficient use of resources.	Resource productivity
	By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and	Agriculture adsorbs a significant proportion of labor in developing countries. The livestock sector employ at least 1.3 billion people globally and directly support the	Because of livestock's superior growth potential and the labor intensity of higher value ASPs, employment returns to investment in this sector are higher than average, with more diverse recruitment including women and older adults. This is true in both rural (production)	Average hourly earnings of female and male employees, by occupation, age group and persons with disabilities

	equal pay for work of equal value	livelihoods of 600 million poor smallholder farmers in the developing world (Thornton et al. 2006).	and urban (processing/marketing) areas.	
	Take immediate and effective measures to eradicate forced labour, end modern slavery and human trafficking and secure the prohibition and elimination of the worst forms of child labour, including recruitment and use of child soldiers, and by 2025 end child labour in all its forms.	In many countries child labor is mainly an agricultural issue. Worldwide 60 percent of all child laborers in the age group 5-17 years' work in agriculture, including livestock. This amounts to over 98 million girls and boys. The majority (67.5%) of child laborers globally are unpaid family members.	Livestock represent one of the most widespread and culturally accepted forms of children's work in many regions. Some tasks often categorized as domestic chores contribute to livestock production such as milking, collecting grass for cattle, cleaning out cowsheds and looking after small livestock for domestic consumption. These forms of labor may not be directly onerous, but can have a high opportunity cost in terms of forgone or intermittent education.	

Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	Promote inclusive and sustainable industrialization and, by 2030, significantly raise industry's share of employment and gross domestic product, in line with national circumstances, and double its share in least developed countries	Livestock production is becoming a large industrial businesses in many developing countries.	The livestock sector is becoming rapidly concentrated increasing the size of operations and reducing the number of producers. Developing livestock marketing infrastructure in developing countries, can foster manufacturing of livestock products while promoting inclusive and sustainable livestock industrialization processes.	9.2.1 Livestock manufacturing value added as a percentage of GDP and per capita
Goal 10. Reduce inequality within and among countries	By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average.	In many developing countries livestock plays an important role in economic development contributing to reduce inequality through different channels such as provision of income, food and employment.	In many developing countries the livestock sector is becoming rapidly concentrated increasing the size of operations and reducing the number of producers threatening the potential of small producers in to benefit from livestock economic growth.	Level of market concentration

Goal 11. Make cities inclusive, safe, resilient and sustainable	By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums	In many developing countries livestock keeping is common in urban and peri-urban areas in particular backyard poultry and pigs, often in close confinement in densely populated slum areas.	Despite the benefits of urban livestock keeping. The risks in urban livestock are also large: unsanitary conditions and weak infrastructure mean that livestock can be a source of pollution and disease.	
Goal 12: Ensure sustainable consumption and production patterns	Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries.	Fundamental changes in the way societies produce and consume are indispensable for achieving global sustainable development.	Something on total protein need and consumed in developing and develop countries http://www.who.int/nutrition/topics/3 _foodconsumption/en/index4.html	Number of countries with sustainable consumption and production (SCP) national action plans or SCP mainstreamed as a priority or target into national policies

	By 2030, achieve the sustainable management and efficient use of natural resources	Should the global population reach 8.5 billion by 2030, the equivalent of almost two planets could be required to provide the natural resources needed to sustain current lifestyles	The world's livestock sector is growing at an unprecedented rate. The demand for livestock products will increase in more than 70% between 2005 and 2030 (FAO, 2009). There are productivity potentials for the livestock sector to produce more output using less resources.	Material footprint and material footprint per capita
	By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses	Each year, an estimated one third of all food produced – equivalent to 1.3 billion tonnes worth around $1 trillion – ends up rotting in the bins of consumers and retailers, or spoiling due to poor transportation and harvesting practices	Roughly one fifth on each kilogram of meat and meat products, gets lost of wasted globally. Meat losses and waste in industrialized regions are most severe at the end of the FSC, explained by a high per capita meat consumption combined with large waste proportions by retailers and consumers, especially in Europe and the U.S. Waste at the consumption level makes up approximately half of total meat losses and waste (FAO, 2011b).	Livestock global food loss index

Goal 13: Take urgent action to combat climate change and its impacts	Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries			
	Integrate climate change measures into national policies, strategies and planning			
	Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning			
	Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on			

	Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible			
	Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on			

	women, youth and local and marginalized communities			
Goal 14: Conserve and sustainably use the oceans, seas and marine resources	By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution.	Nitrogen is one of the main causes of nutrient pollution and therefore eutrophication in coastal marine environments.	Reduce water contamination from livestock intensive systems runoff may contribute to reduce the level of costal eutrophication in costal marine environments.	Index of coastal eutrophication
	By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as	Around 2 million tons of fish meal are consume every year (FAOSTAT, 2016).	An important proportion of fish meal is used for livestock feed as source of protein, particularly in pigs and poultry feed rations. Increments in the demand for livestock may lead to increments in the used of fish meal and therefore fish overharvesting.	

	determined by their biological characteristics			
Goal 15: Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss	By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally	Thirteen million hectares of forests are being lost every year while the persistent degradation of drylands has led to the desertification of 3.6 billion hectares.	In some countries, particularly in Latin America, the land that was cleared and burned was converted to grazing livestock. Supporting research, extension and training for more sustainable grazing systems, including silvopastoriles techniques may lead to simultaneous increments in livestock production, reduce deforestation and protect the soil against nutrient depletion, compaction and erosion.	Forest area as a proportion of total land area
Goal 16: Promote just, peaceful and inclusive societies.				
Goal 17:	Enhance the global partnership for sustainable development, complemented by multi-stakeholder	The establishment of government lead multi-stakeholders partnerships is a fundamental conditions to the achievement of the SDGs.	The Global Agenda for Sustainable Livestock (GASL) is multi-stakeholders partnerships that mobilizes and share knowledge, provides robust evidence, develop cutting-edge tools and promotes an integrated approach to enhance policy coherence for sustainable livestock, supporting countries, particularly	Registration of GASL as a UN official partnership

	partnerships that mobilize and share knowledge, expertise, technology and financial resources, to support the achievement of the sustainable development goals in all countries, in particular developing countries		developing countries, in achieving the Sustainable Development Goals related to livestock.	
			Similarly, there is a burgeoning literature on mitigation in agriculture. There are several options related to livestock, including grazing management and manure management. Global agriculture could offset 5–14% (with a potential maximum of 20%) of total annual CO_2 emissions for prices ranging from $20 to 100 per t CO_2 eq (**Smith *et al.* 2008**). Of this total, the mitigation potential of various strategies for the land-based livestock systems in the tropics amounts to about 4 per cent of the global agricultural mitigation potential to 2030 (**Thornton & Herrero submitted**),	