GIZ Sector Project Sustainable Agriculture (SV NAREN)

Modules on Sustainable Agriculture (MOSA) – Reader

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LIST OF ABBREVIATIONS

ABD	Agrobiodiversity
BMZ	Federal Ministry for Economic Cooperation and Development, Germany
CA	Conservation Agriculture
CH_4	Methane
CO_2	Carbon Dioxide
COSA	Committee on Sustainable Agriculture
CSA	Climate smart agriculture
CSO	Civil society organizations
EV	Economic Viability
FAO	Food and Agriculture Organisation of the United Nations
FSC	**Food supply chain**
GDP	Gross domestic product
GHG	**Green House Gases**
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), GmbH
GQoL	Good Quality of Life
GT	**Giga ton**
Ha	Hectare
IAASTD	International Assessment of Agricultural Knowledge, Science and Technolog for Development
ICT	Information and Communication Technology
ILO	International Labour Organisation
ILM	Integrated Landscape Management
IPM	Integrated Pest Management
JKI	Julius Kühn-Institut
KSNL	Criteria System of Sustainable Agriculture
MOSA	Modules on Sustainable Agriculture
NGO	Non-Governmental Organization
N_2O	Nitrous Oxide
OECD	Organisation for Economic Co-operation and Development
PAEGC	**Powering agriculture: An Energy Grand Challenge for Development**
RISE	Response inducing sustainability evaluation
SAFA	Sustainable assessment of food and agricultural systems
SHARP	Self-evaluation and Holistic Assessment of Climate Resilience of Farmers and Pastoralists
SLM	Sustainable Land Management
SWC	Soil and water conservation
UN	United Nations
VC	Value Chain
WAC	World Agroforestry Centre (ICRAF)
WCED	World Commission on Environment and Development

Module Introduction

The GIZ sector project 'Sustainable Agriculture' supports its partners on behalf of the Federal Ministry for Economic Cooperation and Development (BMZ) in the field of the sustainable management of natural resources.

The general awareness of sustainable agricultural practices and their crucial role for maintaining the conditions for agricultural production in a permanent way is still very weak. This holds true for farmers, but also for extension workers, and others, who work in the agriculture sector.

The sector project 'Sustainable Agriculture' therefore developed a modular training-tool on sustainable agriculture (MOSA – Modules of Sustainable Agriculture), which targets all those who work in the agriculture sector and helps them to obtain a sound understanding of the concept of sustainable agriculture. The vision should go in the direction that conventional agriculture should become more sustainable.

Since 2012, GIZ has been using the RISE[1] Tool (Response-Inducing Sustainability Evaluation) in close cooperation with HAFL (*Hochschule für Agrar-, Forst- und Lebensmittelwissenschaften* Switzerland) in different countries to examine and assess the sustainability of agricultural production at farm level. RISE considers ten themes and fifty indicators in three sustainability dimensions (social, environmental, economic) and serves as a basis for agricultural advice to farmers. Since RISE provides a holistic view on sustainability at farm level, it was used as a starting point for the development of the training modules within MOSA.

FAO is developing since three years a tool called SHARP[2] (Self-Evaluation and Holistic Assessment of Climate Resilience of Farmers and Pastoralist). SHARP assesses the climate resilience of farmers and pastoralists. The definitions of vulnerability, general resilience, climate resilience and adaptability capacity -based on the SHARP vision- were also considered in MOSA

Objectives

MOSA aims to provide and create a holistic view about sustainable agriculture and its present and future challenges. It should further serve as a platform of changing ideas and experiences. As part of the training, concepts on organic agriculture, agroforestry, conservation agriculture, climate smart agriculture will also be presented and discussed. At the end of the 6-day course participants will be aware of sustainable agricultural practices as a way to increase productivity without compromising the quality and availability of natural resources and moving towards a more resilient agriculture. They will get to know good practices and will be

[1] www.hafl.bfh.ch/en/research-consulting-services/agricultural-science/sustainability-and-ecosystems/sustainability-assessment/rise.html

[2] http://www.fao.org/in-action/sharp/en/

enabled to self assess the sustainability of agricultural practices. Each module of MOSA is designed in a way that it can be used independently. The modules should be regarded as introductory modules to the different themes influencing sustainable agriculture. Therefore, a flexible combination of modules is possible. However, MOSA is ideally provided as a full 6-day training containing all modules in order to achieve the learning objectives as proposed.

Content of the MOSA training

The training covers **13 core issues** which are relevant to agriculture with regard to sustainability and are summarized in the Reader:

1) Soils	8) Plant protection
2) Livestock	9) Labour and labour conditions
3) Nutrient cycles	10) Good quality of life
4) Water and water use	11) Sustainable value chains
5) Climate	12) Economic viability and Farm Management
6) Energy	13) Post-Harvest Management
7) Agrobiodiversity	

General issues related to sustainability

The following **4 additional issues** are also considered in the Reader

» Sustainability

» Elements of sustainable agriculture

» Integrated landscape management and the SDGs

» Measuring sustainability at Farm Level

SETTING THE SCENE

Agriculture is the most important land use activity covering 37 % of the world's surface and providing jobs for about 1.3 billion people, which constitutes 40 % of the global workforce[3] .

Since the late 1960s agriculture was able to increase productivity through the development of high-yielding varieties of cereal grains, expansion of irrigation infrastructure, modernization of management techniques, distribution of hybridized seeds, synthetic fertilizers, and pesticides. Nevertheless, this productivity gain was not least to the expense of the environment. (WRI, 2013[4] and FAO 2014[5]).

- The world's population is projected to grow from about 7 billion in 2012 to 9.6 billion people in 2050.
- The population increase, together with the climate change, the loss of biodiversity and the (over)exploitation and contamination of natural resources demand for new ways of farming.
- In addition to population growth, world's per capita meat and milk consumption is also growing—especially in China and India—and is projected to remain high in the European Union, North America, Brazil, and Russia. These foods are more resource-intensive to produce than plant-based diets.
- Food production on land and in aquatic systems already dominates much of the global terrestrial surface, and has major negative impacts on the Earth's ecosystems. For example, inefficient use of water for crop production depletes aquifers, reduces river flows, degrades wildlife habitats, and has caused salinization on 20 per cent of the global irrigated land area.
- Inappropriate use of fertilizers and pesticides has translated into water pollution, affecting rivers, lakes and coastal areas.

The current food system does not seem to be suitable to meet future demands for food while maintaining resources and the environment. Therefore, political commitment is demanded to make sure that community environmental and social goods are protected and to promote decent lives for all people. Nowadays on the international scale sustainability and sustainable agriculture have become major issues on the agenda. Not least the newly ratified Sustaina-

3 FAO Stat, 2011 at : http://faostat3.fao.org/home/E
4 WRI (2013): Global food challenges explained in 18 graphics. Available online: http://www.wri.org/blog/2013/12/global-food-challenge-explained-18-graphics
5 FAO Building a common vision for sustainable food and agriculture, principles and approaches at: http://www.fao.org/3/919235b7-4553-4a4a-bf38-a76797dc5b23/i3940e.pdf

ble Development Goals (SDGs)[6] identified food and farming as one of their core development issues.

The 21th century is posing great challenges on agriculture. There is the need to inherently rethink the food system. The fundamental idea for the development of solutions is **“sustainability**”.

6 http://www.un.org/sustainabledevelopment/sustainable-development-goals/

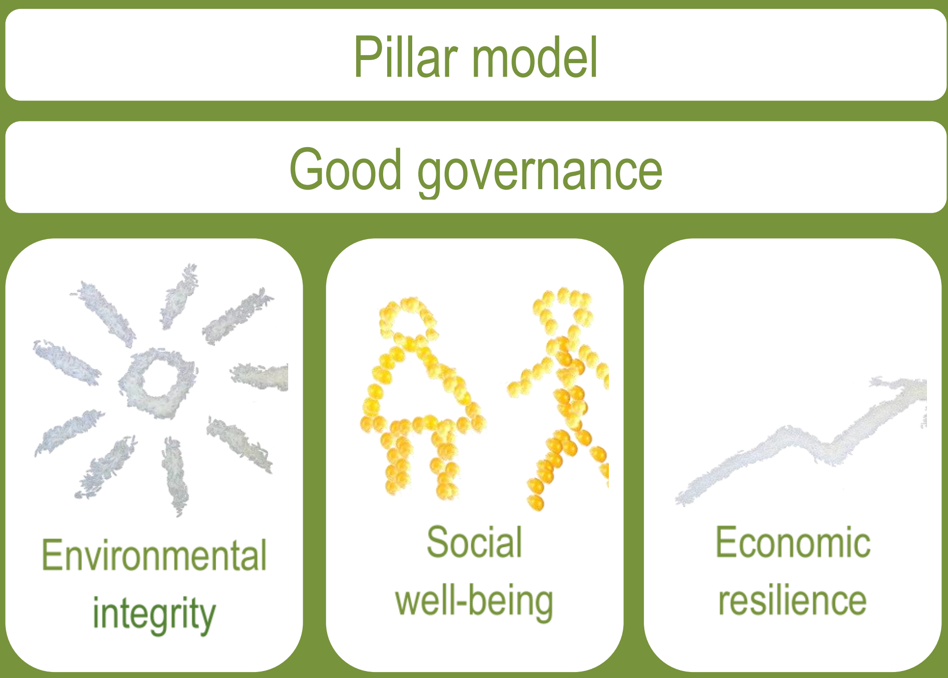
General issues related to sustainability

Sustainability

Integrated landscape management and the SDGs

Elements of sustainable agriculture

Measuring sustainability at farm level



Source: Adapted fromFAO-NRDD (2013): Sustainability Assessment of Food and Agriculture Systems (SAFA). Rome.

SUSTAINABILITY

1 Introduction

The terms 'sustainability' and 'sustainable' are used often and by countless different stakeholders, in both the public and the private sectors, and around the globe. To those using them, the two words seem to have become placeholders for anything considered good and desirable. Therefore, whenever a programme or project for 'sustainability' is to be launched, it is necessary to clarify what is meant by 'sustainable' in this particular context.

The term 'sustained yield forestry' was coined by Hanns-Carl von Carlowitz, who was responsible for the mining sector in the Kingdom of Saxony (Germany), in 1713. He suggested forestry principles that should ensure that wood stocks would not decline, in order to prevent the economy from running out of its most important energy carrier. Carlowitz' central paradigm was that wood extraction from an area must not exceed regrowth on that area in any given period of time. Corresponding rules for the use of e.g. alpine meadows and irrigation water had existed in many areas of the world well before the 18^{th} century, and many are still in place today.

The term sustainability did not make its way into politics until the 1970s, when environmental pollution and resource scarcity were recognised as global threats to the wellbeing of humanity. In the 1980s, the link with another global challenge, poverty reduction through economic development, was established, most notably in the 1987 report 'Our common future' of the World Commission on Environment and Development (WCED). Sustainable development became an almost universally acclaimed paradigm at the 1992 'Earth Summit' in Rio de Janeiro, through the Rio Declaration on Environment and Development and Agenda 21, the 'Action Program for the 21^{st} century'.

Key properties of sustainable development are multi-dimensionality, or comprehensiveness and the long-term perspective. While some have argued that maintaining a healthy environment is the only thing that counts (as we could not survive in a destroyed environment anyway), multi-pillar sustainability concepts are much more widespread. Most commonly, three pillars or dimensions are recognized: Environmental sustainability, economic sustainability and social sustainability. Governance is increasingly being added as a fourth dimension to sustainable development. In fact, while this is about how things are done, while the others are about what is done, governance can be considered to form the roof over the three pillars.

2 Challenges and need for action

Principle 1 of the Rio declaration states that '**Human beings are at the centre of concern** for sustainable development. They are entitled to a healthy and productive life **in harmony with nature**.' These two sentences outline the central challenge of sustainable development: (1) At least the basic needs of every human being on Earth must be met, and no one must live in poverty. (2) This must and can only be achieved while protecting the natural environment and safeguarding the natural resources that form the basis of human economy. In the words of the WCED report sustainable development is 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. This definition turns sustainability, once a rather technical principle of forest managers, into a normative paradigm for global development.

In the past, human societies managed to flourish while sustainably managing their natural resources at the local and regional levels. Land use systems from the Ifugao terraces in the Philippines via the agro-forestry home gardens of Java and Mexico to the alpine pastures of central Europe testify to our ability to create sustainable socio-ecological systems by creating and respecting rules for resource use. However, establishing and enforcing such rules at the global scale is a new challenge. The Montreal Protocol, signed in 1987 with the aim of protecting the Earth's stratospheric ozone layer, is a global success story. Scientists expect the ozone layer to recover over the next decades. One critical question is to what extent sustainable development can be achieved through top-down approaches, e.g. through legislation, and to what extent bottom-up approaches should be pursued.

3 Recent development

The **planetary boundaries framework** arises from the scientific evidence that Earth is a single, complex, integrated system – that is, the boundaries operate as an **interdependent set**. The framework identifies nine global priorities relating to human-induced changes to the environment. The science shows that these nine processes and systems regulate the stability and resilience of the Earth System – the interactions of land, ocean, atmosphere and life that together provide conditions upon which our societies depend. This has profound implications for global sustainability; because it emphasizes the need **to address multiple interacting environmental processes simultaneously** (e.g. stabilizing the climate system requires sustainable forest management and stable ocean ecosystems). Four of nine planetary boundaries have now (2015) been crossed as a result of human activity. The four are: climate change, loss of biosphere integrity, land-system change, altered biogeochemical cycles (phosphorus and nitrogen). Two of these, climate change and biosphere integrity, are what the scientists call ‘core boundaries’. Significantly altering either of these ‘core boundaries’ would ‘drive the Earth System into a new state’.

A further recent development is **Cradle to Cradle Design**. It models human industry on nature's processes viewing materials as nutrients circulating in healthy, safe metabolisms. It suggests that industry must protect and enrich ecosystems and nature's biological metabolism while also maintaining a safe, productive technical metabolism for the high-quality use and circulation of organic and technical nutrients (namely **waste free production**)[7].

Achieving sustainable development is arguably an even bigger challenge than fighting the ozone hole. In the last 200 years, humanity has made unprecedented economic and social progress. An average human being now enjoys a longer, richer and healthier life than ever before in human history. Our average life expectancy is 71 years (in 2014), up from 32 years in 1800, 33 years in 1900 and 67 years in 2000. Global average per capita Gross Domestic Product (GDP), a measure of economic productivity, has risen from 2,863 US$ per year in 1960 to 7,603 US$ per year in 2011[8].

But there are still important sustainability deficits:

- The World Bank states that despite a substantial decline of poverty, particularly in East Asia and Latin America, 1.2 billion people have to live on less than 1.25 US$ a day and thus are considered extremely poor.
- In the period 2011 to 2013, 842 million people in the world suffered from chronic hunger according to the 2014 FAO report ‘State of Food Insecurity’. This hunger is due to a lack of access to food rather than a lack of agricultural production, as worldwide 2,868 kcal were produced per day and per capita by 2011[9].
- The consumption of fossil energy carriers as well as the emissions of greenhouse gases have reached record highs and keep increasing[10].
- Hazardous waste and waste generation is continuously increasing[11]

4 Approaches

The central question concerning sustainable development is: How can we meet the needs of those who now are still poor and hungry without further damaging the environment, and without running out of non-renewable resources?

[7] Rethinking production, 2008 at http://www.worldwatch.org/files/pdf/SOW08_chapter_3.pdf
[8] All figures on GDP and life expectancy were retrieved from www.gapminder.org. Global means are unweight means of those countries and territories for which figures were reported for the concerned year.
[9] http://faostat.fao.org/site/368/DesktopDefault.aspx?PageID=368#ancor. The minimum daily per person energy requirement assumed by FAO is 1,680 kcal: www.fao.org/fileadmin/templates/ess/documents/food_security_statistics/metadata/undernourishment_methodology.pdf).
[10] www.ipcc.ch/report/ar5
[11] http://ec.europa.eu/eurostat/web/waste/key-waste-streams/hazardous-waste

Two popular approaches of politics and industry to answer the above question are ‘decoupling’ and the ‘green economy’, the first being a pillar of the latter. Decoupling aims at breaking the link between economic growth and resource use. Further growth is to be achieved with ever smaller energy consumption and at ever smaller environmental cost per unit produced. Consequently, the two pillars of a sustainable energy system are (1) increasing energy efficiency and (2) replacing fossil energy carriers by renewable energies (**decarbonisation**). In addition, the green economy approach puts emphasis on job creation and growth through innovative resource-efficient technologies. For example, the renewable energies industry and the recycling industry are expected to act as job engines.

Some scientists and politicians are sceptical about the potential of decoupling and efficiency gains. They argue that the per capita resource consumption and waste production levels of countries in North America and Western Europe are just too high. Would all of humankind consume like that, resources would quickly be depleted. As long as consumption keeps growing faster than efficiency gains, total resource use will keep growing as well and, one day, the boundaries of global resource use will inevitably be reached. The proponents of this view call for sufficiency. We should not consume more than we need, and economic growth should be replaced by development in a qualitative sense. A consequent transition to a policy of sufficiency may ultimately result in a ‘stationary state’ of the economy, without further economic growth. This in turn appears unlikely to be possible in our monetary and economic system which functions based on the expectation of profits.

How people can participate in an according process, is yet another central challenge of sustainability. As sustainable development is first and foremost about meeting people’s needs, finding out about their needs is of crucial importance.

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Interesting websites:

- FAO Sustainability Pathways: www.fao.org/nr/sustainability/home/en
- Gapminder: www.gapminder.org
- Stockholm Resilience Centre: www.stockholmresilience.org
- UN Millennium Development Goals: www.un.org/millenniumgoals
- UN Division for Sustainable Development: sustainabledevelopment.un.org
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Source: Heinz Beckedahl and http://www.un.org/sustainabledevelopment/sustainable-development-goals/

INTEGRATED LANDSCAPE MANAGEMENT AND THE SDGS

Many practitioners use the terms, **landscape approach, jurisdictional approach** and **ecosystem approach**, interchangeably to loosely describe any spatially explicit attempt to simultaneously address conservation and development objectives.

“Landscape approaches” seek to provide tools and concepts for allocating and managing land to achieve social, economic, and environmental objectives in areas where agriculture, mining, and other productive land uses compete with environmental and biodiversity goals.

Integrated landscape management is a way of managing the landscape that involves collaboration among multiple stakeholders, with the purpose of achieving **sustainable landscapes.**

Interested stakeholders in the landscape come together for cooperative dialogue and action in a **multi-stakeholder platform**. They undertake a systematic process to exchange information and discuss perspectives **to achieve a shared understanding** of the landscape conditions, challenges and opportunities. This enables **collaborative planning** to develop an agreed action plan. Stakeholders then **implement the plan**, with attention to maintaining collaborative commitments. **Stakeholders also undertake monitoring for adaptive management and accountability**, which feeds into subsequent rounds of dialogue, knowledge exchange and the design of new collaborative action.

The Sustainable Development Goals (SDGs), otherwise known as the **Global Goals**, build on the Millennium Development Goals (MDGs), eight anti-poverty targets that the world committed to achieving by 2015.

The SDGs, and the broader sustainability agenda, go much further than the MDGs, addressing the root causes of poverty and the universal need for development that works for all people. On September 25th 2015, countries adopted a set of goals to **end poverty**, **protect the**

planet, and **ensure prosperity for all** as part of a new sustainable development agenda. (**2030 Agenda for sustainable development**). Each goal has specific targets to be achieved over the next 14 years.

For the goals to be reached, everyone needs to do their part: governments, the private sector, civil society and common people.

The sustainable development goals are linked and inter-dependent, such as those related to poverty eradication; sustainable agriculture; food security and nutrition; water and sanitation; health; sustainable cities and human settlements; terrestrial and marine ecosystems and biodiversity; climate adaptation and mitigation; clean power generation; social stability and security; and sustainable production and consumption.

Because of these SDGs' **inter linkages** and the complexity and interrelated nature of current global challenges, **integrated landscape management** can significantly contribute to implementing the SDGs.

The governance structure of landscapes, size and scope, and number and type of stakeholders involved (e.g. private sector, civil society, government) of a landscape can vary. The level of cooperation also varies, from information sharing and consultation, to more formal models with shared decision-making and joint implementation.

Implementing sustainable agriculture supports also the further development of sustainable landscapes. **A sustainable landscape helps to meet the principles of sustainable development as defined in the UN Sustainable Development Goals**. These are landscapes that can meet the needs of the present, without compromising the ability of future generations to meet their own needs.

SDGs can also be seen as a wedding cake and food being the linkage element between them. See more details at: http://www.stockholmresilience.org/research/research-news/2016-06-14-how-food-connects-all-the-sdgs.html

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- The Sustainable Development Goals (SDGs) at: http://www.un.org/sustainabledevelopment/sustainable-development-goals/

Elements of Sustainable Agriculture

1 Introduction

Global agricultural production has contributed to significant growth in total global wealth. The intensive use of fossil energy, both as a source of power and as energy source for the production of mineral fertiliser, has significantly contributed to the growth of agricultural production. The development of highly productive plant and livestock breeds has contributed as well to the process of wealth creation through agricultural production.

The way forward for agriculture is a topic of global discussion. On the one hand, for a long time the conventional approaches to agricultural production did not recognise the linkages of agriculture to the ecosystem. Many of these conventional approaches have a mono-focal approach to agriculture in aiming at production only. On the other hand, the challenges for agriculture to feed a growing world population are substantial. This challenge is even greater if one considers that in many countries the availability of agricultural land is starting to reach its limits, for example in India.

A variety of approaches to agriculture are tested. Some of these are old approaches and have been practiced for centuries. Some of the approaches are new or are a combination of elements of known approaches. But there is no single solution; it must always be adapted to the individual context.

2 Challenges and need for action

Meeting the challenges means that one has to perceive agricultural production in a rapidly changing world of urbanisation, growing inequities, human migration, globalisation, changing dietary preferences, climate change, environmental degradation, a trend towards using biofuels in transport and an increasing population. These conditions are affecting local and global food security and putting pressure on productive capacities and ecosystems.

A range of natural resources (e.g., land, water, air, biological diversity including forests and fish) provide the indispensable base for agricultural production. During the last 50 years, the physical and functional availability of natural resources shrunk faster than at any other time in history due to increased demand and/or the degradation of ecosystems at the global level. This is compounded by a range of factors including human population growth. These processes have resulted in unprecedented loss of biodiversity, deforestation, loss of soil health, water quality, air quality and impacts from climate change. In many cases such negative impacts can be mitigated; and in some cases, they actually are mitigated.

Given the multifunctional nature of agriculture, it is critical to consider links and effects between agricultural production and ecosystems, as these have important implications for the resilience and/or the vulnerability of such systems. The Millennium Ecosystem Assessment (2005) projects an increase in sudden non-linear changes to many ecosystems. Such changes will be sudden and hard to predict.

3 Recent development

Research in the field of agriculture has intensified for some years. Common to most of the research efforts is the focus on 'sustainability'. **Therefore, research considers the interconnections of agriculture, the natural environment in general and natural resource management in particular to a much greater extent than before**. Two reports summarise the present state of research, promote the process of changing research approaches in agriculture and indicate the further research direction:

» The IAASTD (2010) report puts forward the 'multi-functionality' of agriculture and thereby indicates that future agricultural research ought to include the natural environment in which agriculture is practiced. The report highlights that agriculture is embedded into international trading mechanisms like never before and hence, requires regulation and institutional support.

» The Millennium Ecosystems Assessment (2005) is not an agricultural publication but it rather focusses on the global natural environment. Accepting the close links of agriculture to the natural environment, the assessment puts forward conclusions which are as well important for research in agriculture.

Agro-ecology is the basic science to explain the functionality of agro-ecosystems considering sustainability. Agro-ecology as a science is first and foremost based on the rediscovery and study of traditional small-scale farming. It is an answer that tries to relink agricultural production to the various natural systems from which conventional agriculture has been de-linked a long time ago. It includes a trans disciplinary approach and can be defined as a transition process aiming to make agriculture more sustainable. It is also understood as a social movement that seeks to increase small scale farmers' autonomy and control over their agricultural and food systems for realizing food sovereignty.

It has identified five core principles that form the basis for ecological sustainability:

- Assuring favourable soil conditions, e.g. by keeping soil covered with mulch or a cover crop, guaranteeing a high level of organic matter and an active soil life (bacteria, actinomycetes, fungi, algae, protozoa, worms, etc.) for a healthy soil
- Increasing the recycling of biomass and achieving a balance in nutrient flows
- Minimizing nutrient losses from the system by closing the cycles (organic fertilizers, crop rotation, integration of crop and animal production)
- Promoting biodiversity of the agricultural ecosystem above and below ground and at landscape level
- Enhancing the resilience of the agricultural ecosystem by promoting the increase of biological interactions and synergies between the system components

4 Approaches and best practices

Given the central position of 'sustainability' in current future agricultural research and practice most of the good practices focus on maintaining the functionality of ecosystems services.

For example, **sustainable land management** (Schwilch et. al. 2012) is targeted towards improving or stabilising agricultural productivity, improving people's livelihoods and improving ecosystems. See also the previous chapter about **integrated landscape management**.

Conservation agriculture (Goddard et. al. 2010) aims at keeping the soil functional as the basis for production by minimising the disturbance of the soil life.

Various other approaches and methods combine methodological elements. For example, 'integrated agriculture' is an approach that seeks to minimise external inputs and aims at establishing a system of mutually supportive cycles in agriculture or even at the farm level. 'Integrated production' in agriculture is a trademark in many industrialised countries. '**Organic agriculture**' goes a step further by refraining from using synthetic fertiliser or chemical pesticides and hence, decreasing the amounts of external inputs even more.

The promotion of stakeholder involvement commonly referred to as **participation**; in developing practices and approaches has been a central element. **Using traditional knowledge systems had long been neglected**. It is essential for many agricultural development efforts as well as in agricultural research.

Climate-smart agriculture (CSA) is an approach for transforming and reorienting agricultural systems to support food security under the new realities of climate change. Widespread changes in rainfall and temperature patterns threaten agricultural production and increase the vulnerability of people dependent on agriculture for their livelihoods[12]

Moving from farm to landscape scale implies moving from individual to collective decision-making, which requires innovative approaches to foster co-design. **Integrated landscape management** is such an option.[13]

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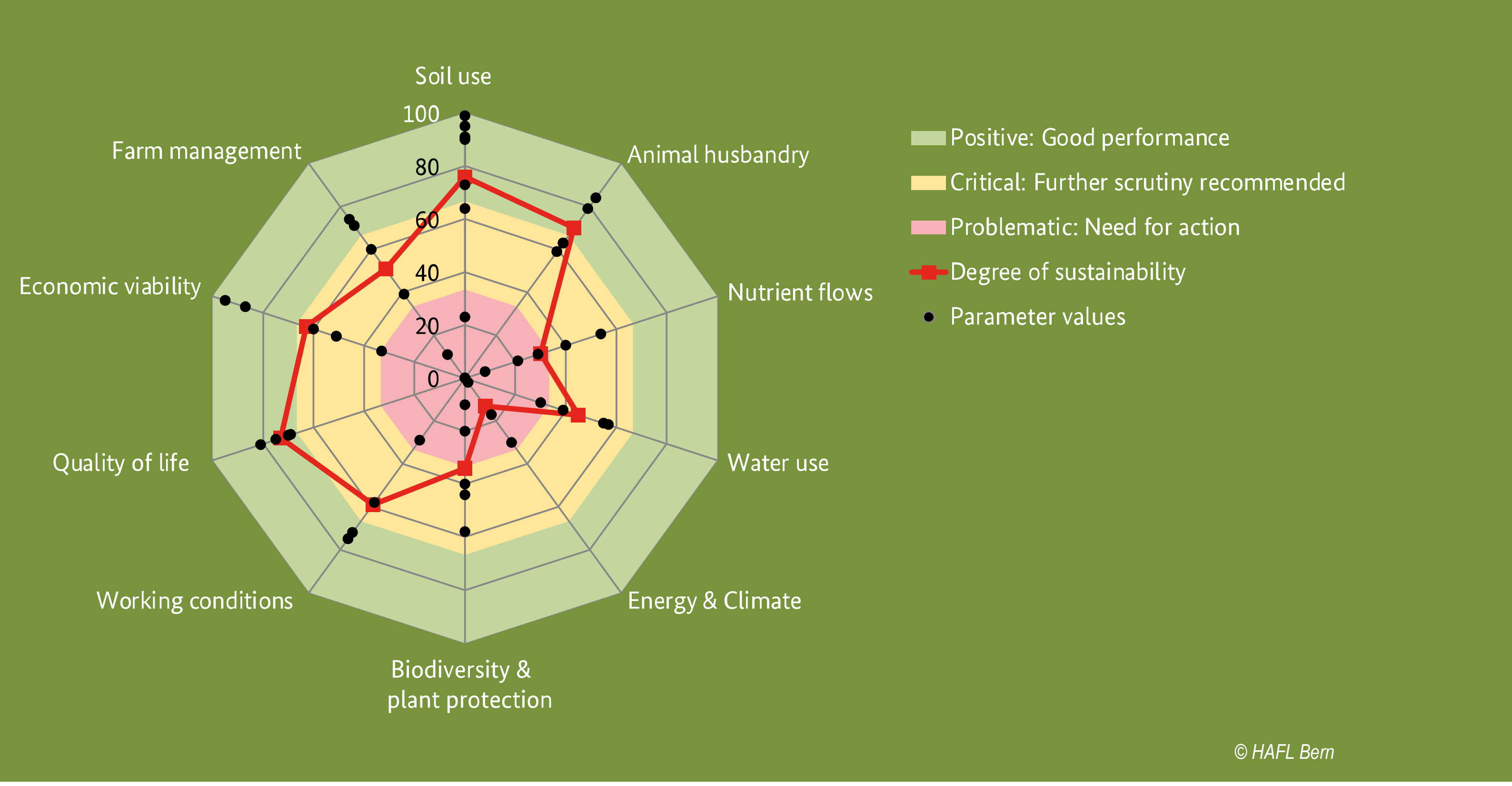

MEASURING SUSTAINABILITY AT FARM LEVEL

1 Introduction

Since the 1992 Earth Summit in Rio de Janeiro, sustainability has become an accepted paradigm of development in almost all countries of the world and in all sectors of the economy. In recent years, an increasing number of private companies expressed their commitment to a sustainable development. A widely popular principle in public and private management postulates that 'what cannot be measured cannot be managed'. As a consequence, entities of all sizes and types are being managed with the help of monitoring and quality management schemes, virtually all of which employ indicators (including the 'key performance indicators') as a means of tracking progress towards defined goals. An indicator is a means that represents the state or level of something. An index is a composite measure, e.g. an aggregate of several indicators. It is widely believed that the establishment and use of sustainability indicators will support a more targeted progress towards sustainability.

Indeed, a growing number of countries, companies and civil society organizations (CSO) have established and are tracking their own sets of sustainability indicators. Sustainability is a multi-dimensional phenomenon. Hence, it cannot be directly measured – unlike economic growth, soil organic matter content or life expectancy, all of which are measurable. Sustainability indicators and indices are therefore inherently compromised by two characteristics. (1) They are composite measures, and therefore their scores are influenced by aggregation and weighting procedures decided by their developers. (2) They have to rely on proxies where a direct measurement of an aspect of sustainability is not possible. For example, life expectancy is used as a proxy for health and wellbeing. A third issue stems from the trade-off between communicability and complexity: (3) Sustainability indicators are usually expected to carry a clear message, in the sense of ‘this is a good score and that is a bad score’. Such messages are generated through valuation, rating or normalization procedures, which inevitably reflect the values and norms in which the developers (but maybe not the audience) believe.

2 Challenges and need for action

Challenges for developers and users of sustainability indicators and indices stem from the quality criteria which a good metric should fulfil, namely relevance, methodological coherence, reproducibility, sensitivity to change, transparency and a reasonable cost: benefit ratio.

Relevance, or ‘What exactly is sustainability and what phenomena are most closely related with it?’. Sustainability is a normative and interpretable term. Its most widely accepted definition is notoriously vague: ‘Development that meets the needs of the present without compromising the ability of future generations to meet their own needs’[14]. What exactly are the needs that should be met? And how is ‘the ability of future generations’ defined? There are no universally accepted answers to these and to other relevant questions. As a consequence, the sustainability goals defined by national governments, companies or CSO are diverse. For example, the ‘sustainability indicators’ of some entities only include environmental indicators and in extreme cases only indicators related to greenhouse gas emissions, while others focus on socio-economic indicators, such as the GDP growth rate. National sustainability monitoring schemes will usually include indicators in all dimensions of sustainable development.

Methodological coherence, or ‘Is there a reliable, accepted data collection protocol?’. The coherence between indicator systems tends to be high concerning the environmental aspects of sustainability, in particular those that are measurable: water quality, soil fertility status, air quality. Coherence is lower in the economic and social dimensions and lowest for aspects of governance. Different procedures for data collection and valuation lead to widely variable scores for these aspects.

Reproducibility, or ‘How reliable are our indicator scores?’. Many relevant aspects of sustainability such as quality of life and ecosystem functioning, cannot be directly measured and therefore have to be approached indirectly through proxies. This will inevitably cause imprecision, as does the use of qualitative survey questions on the social dimension of sustainability. Furthermore, budgets for sustainability monitoring schemes tend to be restricted, which

[14] World Commission on Environment and Development (1987): Our common future. www.un-documents.net/our-common-future.pdf

limits the number of possible observations and thus, also the precision and accuracy of measurements.

Sensitivity to change, or ‘How big does a change have to be to be reflected in the indicator score?’. As for reproducibility, any optimization of this property is hampered by restrictions to budget and time. In addition, the inaccuracy of measurements and surveys limits an indicator’s sensitivity to change.

Transparency, or ‘How easily can indicator scores be understood and disentangled?’. Both, the development and the use of a metric should be transparent. Stakeholders should be involved in its development, and all assumptions, data sources, shortcomings etc. should be made transparent. However, involving too many people in indicator development can result in inflated indicator sets, as every expert wants her/his field of interest to be adequately represented. Publishing all relevant information on an indicator may be inacceptable to the media, which usually want short, easy-to read texts. One result is the often inadequate broadcasting on e.g. comparisons of the environmental impacts of different products or production systems.

3 Recent developments

Here, we cannot give a comprehensive overview of all sustainability indicator systems that are currently in use, as there are hundreds of them. The following is a selection of different sustainability indicator systems.

- National sustainability monitoring system of Switzerland: MONET[15]: The system breaks down the Swiss sustainable development strategy into 45 postulates. The achievement is measured through 80 indicators, 16 of which are considered key indicators.
- The Unilever Sustainable Living Plan[16]: This is the decoupling plan – launched in 2010 – of one of the world’s largest food companies. They have defined 3 goals, underpinned by 9 commitments, for each of which a number of indicators are tracked.
- The Human Development Index[17] of the UN Development Programme: This is a socio-economic index that aggregates data on life expectancy, per capita GDP and schooling years.
- The Happy Planet Index[18] of the New Economics Foundation, a UK-based think tank: This socio-ecological index is calculated at the national level and combines data on life expectancy, experienced well-being and the Ecological Footprint.
- The Response-Inducing Sustainability Evaluation (RISE)[19]: a system for evaluating and communicating the sustainability of agricultural operations at farm level. It is composed of 50 indicators condensed into ten thematic scores, but no single index.

15 www.are.admin.ch/themen/nachhaltig/00268/00551/index.html?lang=en
16 www.unilever.com/sustainable-living-2014/our-approach-to-sustainability/unilever-sustainable-living-plan-summary
17 http://hdr.undp.org/en/content/human-development-index-hdi
18 www.happyplanetindex.org

4 Approaches

The existing approaches to indicator development are too manifold to be listed here.

However, best practices for sustainability indicator development and use have been defined, e.g. by ISEAL (a meta-organization of voluntary standard developers), by the Global Reporting Initiative and by scientists. For example, the Bellaggio STAMP (Sustainability Assessment and Measurement Principles) calls for the following in indicator development: (1) Guiding vision, (2) Essential considerations, (3) Adequate scope, (4) Practical focus, (5) Transparency, (6) Effective communication, (7) Broad participation and (8) Continuity and capacity.

Beyond these principles, it can be generally stated that each indicator score should be carefully interpreted, keeping in mind who are its developers and how measurements are done. Measuring and rating can be valuable elements of sustainable development strategies.

Different tools have been developed to assess sustainability/resilience at the farm e.g. RISE, SAFA, SHARP for citing a few tool examples.

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- Gapminder: www.gapminder.org

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CORE ISSUES
SUSTAINABLE AGRICULTURE

Soils

Livestock

Nutrient cycles

Water

Climate

Energy

Agro biodiversity

Plant protection

Labour and labour conditions

Good Quality of Life

Sustainable value chains

Economic viability and farm management

Post-harvest management

Photo: © Friederike Kraemer.
Compost making

Module 1: Soils

1 Introduction

Soils are habitats for human, animal and plant life. They are a vital foundation for biodiversity. Soils perform buffer and storage functions and have the capacity to transform organic material into nutrients, thereby, helping to regulate the cycle of matter and to conserve and regenerate groundwater. They do not only act as carbon sinks but also release carbon into the atmosphere and thus, have a significant impact on the climate. After the oceans, soils are the world's greatest reservoirs of carbon, storing 1,500 giga tonnes.

Soils are highly significant for humans: They are essential for growing food crops as well as non-food renewable resources. They are the foundation of global food security; at the same time, they are an important source of income, especially in the agrarian economies of many developing countries.

2 Challenges and need for action

Soils are a non-renewable and non-multipliable resource – it can take centuries or even millennia for new soil to form. Soil resources get under ever-increasing pressure from global population growth and the ensuing demand for additional food and raw materials. Overuse and misuse lead to nutrient depletion, erosion and other forms of degradation. In dryland areas in particular, the end result can be desertification: when so little soil remains that virtually no crops will grow. Worldwide, a land area equivalent to twice the size of Belgium (6 million ha) becomes degraded each year. Agricultural yields inevitably decline and in some cases the resulting destruction of ecosystems is irreversible. This is detrimental to both, food security and economic development; hunger and poverty are the consequences.

Furthermore, climate change will have an increasing impact on soil fertility and erosion in the future. The increasing occurrence of drought and heavy rainfall will further exacerbate soil degradation and erosion. Changes in temperature and water balance will intensify the pressure on soils. But even the soil itself can contribute to climate change. Land-use changes and improper fertiliser use result in the release of greenhouse gases. The human beings are thus faced with the challenge of increasing soil productivity despite the deteriorating climatic conditions. The long-term aim must be to increase soil productivity and to conserve the area of land usable for agriculture by adopting sustainable land-use methods.

3 Recent developments

There is international consensus that we must respond to the anticipated changes by intensifying agriculture and land use in a sustainable manner. At the same time, we must protect the soil from degradation. However, opinions differ as to how soil productivity can be increased in the best way. For example, many non-governmental organizations advocate the promotion of organic smallholder farming systems or other forms of agriculture which largely manage without external inputs. In contrast, other organizations support the increased use of inorganic fertilizers, plant protection products and improved seeds to make more efficient use of soils. And another group is committed to conservation agriculture: a farming system that helps to reduce erosion while increasing soil fertility and the carbon content of the soil.

4 Approaches and best practices

Soil conservation is a basic requirement for the maintenance of soil fertility. It is a priority that needs to be addressed before rather than after serious damage has been done. Protecting the soil demands good agricultural practices which improve the soil structure, balance nutrients and improve its water and nutrient-use efficiency. An integrated nutrient management system is necessary to maintain closed nutrient cycles as far as possible.

Soil conservation/soil fertility cannot be treated as a separated topic. As the soil is part of a wider production system, other related resources like water and nutrients (e. g. from livestock keeping) have to be considered in best practices as well. In order to successfully implement best practices for sustainable soil use, an integrated approach is needed. Measures should be planned at the scale of watersheds as soils are part of a landscape or catena. Planning and implementation should be done with active participation from the population concerned. Within a watershed, different measures are needed for different sites and uses.

Important elements to maintain or improve soil fertility on individual farmers' fields are:

» Protection of the soil from strong sunlight and heavy rain: e. g. through soil and water conservation measures, mulching with plant residues, green manure crops or cover crops. In order to prevent soil erosion and to preserve soil moisture a balanced crop rotation and mixed cropping is advisable.

- An appropriate tillage method: suitable for getting a good soil structure without causing erosion and compaction.
- A good nutrient management: application of manures and fertilizers according to the demands of the crops in their respective growth stages.
- Balanced feeding with organic material and protection of soil organisms.

5 Land degradation and soil health

Land degradation is defined as 'any form of deterioration of the natural potential of land that affects ecosystem integrity either in terms of reducing its sustainable ecological productivity or in terms of its native biological richness and maintenance of resilience' (UN GEF). This is mainly caused by human activities. Main drivers are unsustainable agricultural practices, deforestation and ceiling of landscapes. Land degradation and desertification threaten fertile land and the benefits human society derives from it throughout the world.

The most important resource in the context of land degradation is soil. At this stage, the livelihoods of 1.5 billion people are at threat, as soils are not able to perform their ecosystem functions anymore. In order to maintain soil functions its health is of key importance. Soil health has been defined as 'the capacity of soil to function as a living system. Healthy soils maintain a diverse community of soil organisms that help to control plant disease, insect and weed pests, form beneficial symbiotic associations with plant roots, recycle essential plant nutrients, improve soil structure with positive repercussions for soil water and nutrient holding capacity, and ultimately improve crop production' (FAO). Hence, nutrients and micro-organisms available in the soils need to be well managed to maintain its fertility in a sustainable manner.

Another general thread to agricultural land and food security is caused by non-reversible land consumption. Cities and transport infrastructure are expanding all over the world, particularly in developing countries and emerging economies. If arable land has been built on, it can no longer be used to grow food. Therefore, the dedication of land for various purposes should be planned and implemented in a wise, sensitive and sustainable manner while minimizing the consumption of arable land. On the other hand, the forests should not be considered as reserve for gaining new arable land since the forests are ecosystems in their own right and importance.

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» WOCAT (best practices on sustainable land management): www.wocat.net

» UN GEF Land degradation. at: www.thegef.org/gef/land_degradation

Interesting links

» FAO 2015 Healthy soils are the basis for healthy food Production, online: www.fao.org/3/a-i4405e.pdf

» www.saveoursoils.com
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Photo: © GIZ/Friederike Kraemer.
Pig production

Module 2: Livestock

1 Introduction

Global livestock production is organised in specific systems which are ideally tuned to the specific environmental conditions in a region. For example, the East African plains are well suited for the grazing systems which have ideally developed there over centuries. On the other hand, in a densely populated urban situation in South East Asia intensive pig production relying on external feed input (landless) has been established. Such systems have evolved over time. This does however not mean than these systems are rigid. They are in fact, modifying themselves to a degree and over a certain timescale constantly.

Mixed systems of livestock keeping are in fact the most prominent systems globally. Mixed systems aim at integrating livestock operations and agricultural operations and by-products so that synergistic effects are utilized of to a great extent.

The globally increasing demand for livestock products can offer opportunities for income for small scale livestock producers. However, it may also work to their disadvantage in the sense that the business opportunities which emerge as results of the increasing demand for livestock products are realized by larger industrial type of production units as these are quicker and financially stronger in realising opportunities.

Livestock production systems contribute considerable amounts of greenhouse gasses. There exist methods to reduce the emissions from the livestock sector. Changing ruminant production systems to more intensive systems seems to be required as the ruminant sector is the largest contributor to greenhouse gas emissions from the livestock sector.

2 Challenges and need for action

Livestock production has been intimately linked to human development from time immemorial. For example, it helps societies to define themselves culturally and it renders religious meaning to other societies. Livestock has helped building nations and it has been the first forms of power intensification in agriculture.

Since some time, livestock production is supporting the growing human population (WISP, 2008). Consumption of livestock products is closely linked to wealth. The growing urban middle class in many non-industrialised countries demands more livestock products. As a result, industrialised forms of livestock production are quickly taking shape. The growth of the chicken ‘industry’ in India is one such example.

Challenges emerge in the form of pollution both, as greenhouse gases and as nutrients. Pollution and nutrient overload is one result of this development. There exists need for action in the area of emission reduction from large livestock units, especially of methane resulting from poor manure management. The question of nutrient inputs into the livestock sector and, as a consequence of nutrient outputs into the environment is another challenge which needs solutions.

In the large plain and mountainous grazing areas of the world, livestock production has been the only opportunity to transfer plant fibre into high quality products for human consumption. The justification has long been that these lands were of ‘marginal’ value to any other land use. Since some time, the interest on these lands increases (large scale land acquisition, AfDB, 2012). This leads to competition for land on which there has been no competitor to grazing earlier.

3 Recent developments

As it is the case with crop production, established production systems are reaching their production limit. These systems rely on an ever decreasing genetic spectrum. In order to keep such production systems functional, ever larger inputs, especially highly valuable protein is used. The direction of development and research has been too focussed on exclusive production traits.

Producers in developing countries cannot compete with these production systems. Yet, traditional breeders have developed productive breeds as well.

However, while the industrialised production systems of the past cannot be a solution for the future, the extensive systems in many developing countries can similarly not be an approach for meeting the future challenges for livestock production.

Research is beginning to realise the danger of the narrowing genetic base, especially in terms of the challenges from emerging diseases and from a changing climate.

Delgado et al. (1999) argued in a publication that livestock production is a good avenue for international development efforts as the increasing demand for livestock products offers profitable markets. However, Steinfeld et al. (2006) argue that the global livestock production produces considerable externalities which need to be tackled. Better systemic integration of livestock into natural systems, better manure management and some form of sustainable intensification are promising approaches.

4 Approaches and best practices

New challenges for existing livestock production systems are emerging like the climate challenge and the challenge of the globally increasing demand for livestock products.

Good technical practices range from breed diversification, to manure management, to the application of environmental standards in order to fight the externalities from livestock production.

Other practices focus on the systems as such. In general, the practices focus on an 'as-best-as-possible' integration of livestock production into the natural systems, like it is for example the case with the pastoral systems. However, here we have the situation that well integrated systems are challenged to change because of emerging desires for the grazing land.

Practices are continuing to develop and there is probably nothing such as best practice. However, some approaches to developing practices can be identified:

- Understand the reason for a certain livestock production system
- Understand its economic and environmental linkages and conditions
- Understand the policies that govern the livestock sector
- Halt a further narrowing of the genetic base of livestock

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N- fixation with trees: Acacia albida

Module 3: Nutrient Cycles

1 Introduction

Chemical elements, called nutrients are essential for biological growth. Plants require 16 nutrients, some in larger amounts (Nitrogen, Phosphorus and Potassium) and others in micro quantities. All nutrients, except for nitrogen derive from minerals in soils and bed-rock. Nitrogen derives from the atmosphere and can be fixed through microorganisms, or by chemical synthesis.

Balanced nutrient ratios in soils are important to maintain soil fertility and to provide good yields, with nitrogen and phosphorus being of specific importance. Organic manures and mineral fertilizers can contribute to this.

2 Challenges and need for action

Nutrient deficiency is a widespread problem in smallholder agriculture. This is due to an overuse of soils, to a lack of appropriate fertilization, to soil erosion etc. Nutrients are often neither applied sufficiently nor in a balanced way. Practices of using mineral fertilizer often display an overuse of nitrogen. This is detrimental to soil fertility; nitrogen enhances soil acidity and decomposition of soil humus. In addition, nutrient flows are to a great extent not functioning in cycles; a high proportion of nutrients applied to soils are lost through leaching or into the atmosphere. This causes severe environmental and atmospheric problems. The economic side is no less important: Due to rising costs for fossil fuels (needed in large quantities for chemical nitrogen synthesis) and increasing scarcity of mineral deposits (e.g. phosphorus) nutrients are getting increasingly expensive, and are used with low efficiency. This makes agriculture a costly exercise, and for many smallholders the use of mineral fertilizer non-economical.

Therefore, the challenge for sustainable nutrient management is to improve nutrient use efficiency. In other words, nutrient cycles will have to be closed as far as possible and adverse environmental impacts to be avoided. Secondly, the turn-over of nutrients – from the soil to the plant and back – has to be accelerated. In doing so, with a fixed amount of nutrients more biomass can be produced.

3 Recent developments

There is increasing evidence that improved nutrient cycles require sufficiently high humus content in soils. Humus acts as an important means to store nutrients and prevent them from leaching. Secondly, it requires a soil with high biological activity. This again depends on humus content, humus quality and soil acidity. In the past, it was assumed that mineral fertilizers could not only stimulate yields, but also contribute to build-up of soil humus. Numerous long-term trials have shown that routine fertilization with nitrogen, phosphorus and potassium deplete the humus content despite of significant amounts of crop residues. Instead, organic manures and related methods are required to maintain soil humus.

4 Approaches and best practice

On the path towards ‘sustainable intensification’ precedence should be given to measures that raise or maintain the soil humus content and enhance nutrient and energy cycles. Practices of sustainable land management (SLM) are in focus. They range from the use of animal manure and compost to green manures, intensive fallows and agroforestry. No less important are measures of soil and water conservation (SWC) which prevent soil erosion, allow water harvesting and water storage in soils.

Mineral fertilizers are complementary. This concerns an increased use of phosphate fertilizers and a change in the provision of nitrogen. For many farms, phosphorus is a very limiting nutrient. As phosphorus fertilizers are scarce and costly, additional ways of obtaining fertilizers have to be accessed and partially soluble rock phosphate to be used much more than today. Recycling of organic waste and human faeces in urban areas represents another valuable source of phosphorus fertilizers.

Nitrogen fertilizers are extremely important for agricultural growth and crop yields. But synthetic nitrogen bears risings costs and increasing adverse effects on soils, environment and atmosphere. Therefore, a change from synthetic to biological nitrogen is required. There is scientific evidence that biological nitrogen fixation by leguminous plants as well as other techniques could produce more nitrogen to allow for sufficiently high yields – today and in the future. The transition should start as soon as possible. It requires sound technology development and time for extension.

Last but not least, it is important to take action against soil acidification. Many farms have very acidic soils and systematic liming is indispensable. In-house calcium resources such as wood ash or the earth from termite mounds are valuable local resources but can usually only make a very small contribution. A more important step would be to inspect local rocks for limestone, check its quality and calculate the costs of making and transporting ground lime.

Finally, soil analysis is important to know the nutrient status in soils and soil acidity (pH-value).

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Sustainable Land Management (SLM) for improved water availability

Module 4: Water and water use

1 Introduction

There is an intrinsic link between the challenge we face in ensuring water security and other global issues, most notably climate change and the need to sustainably manage the world's rapidly growing demand for energy and food. Humanity needs to feed more people with less water, in a context of climate change and growing energy demand while maintaining healthy ecosystems. Competing demands for water, energy and food will require making intelligent – and sometimes tough - choices and radically moving away from business as usual solutions.

Water, energy, land use and climate change are all connected. The challenge is to provide more food, fiber and fuel in a growing and more affluent world and at the same time to be more efficient in the use of resources, not only water and energy but also other resources such as land and scarce minerals, whilst mitigating and adapting to climate change.

2 Challenges and need for action

Water for production continues to be a key constraint to agriculture, due to highly variable rainfall, long dry seasons, and recurrent droughts, as well as floods. If rainfall is less than crop water requirements, then clearly actual yields will be less than the potential. Moreover, the impact of variable rainfall is strongly affected by the nature of the soil and the stage of the growing period.

In addition, climate change will affect these regions where livelihoods are largely rainfed, and cereal or livestock farming system based.

Beside the challenges of coping with water scarcity and stress due to climatic variability, land degradation resulting from soil erosion by wind and water, and poor management of soil fertility contribute to low rainwater use efficiency.

To unlock the potential of small-scale rainfed agriculture investments in better water management need to be emphasised. In drier areas, water harvesting coupled with in situ water management as well as improved soil, nutrient and crop management have great potential. In humid areas, in situ water management technologies such as conservation agriculture (based on no-till, mulching and crop rotation) can be suitable and appropriate.

3 Recent developments

If there is some rainfall but not enough to cover the water needs of the crops, irrigation water has to supplement the rainwater in such a way that the rainwater and the irrigation water together cover the water needs of the crop. This is often called supplemental irrigation: The irrigation water supplements or ads to the rainwater.

Irrigation water requirement depends on the crop water requirement and the water naturally available to the crops (effective precipitation, soil moisture, etc.). While part can be estimated based on climatic conditions, part results from physiological processes at plant level for which actual figures are not available.

The water quality used for irrigation is essential for the yield and quantity of crops, maintenance of soil productivity, and protection of the environment. For example, the physical and mechanical properties of the soil, soil structure (stability of aggregates) and permeability are very sensitive to the type of exchangeable ions present in irrigation waters.

Agriculture is both cause and victim of water pollution. It is a cause through its discharge of pollutants and sediment to surface and/or groundwater, through net loss of soil by poor agricultural practices, and through salinization and waterlogging of irrigated land. It is a victim through use of wastewater and polluted surface and groundwater, which contaminate crops and transmit diseases to consumers and farm workers.

4 Approaches and best practices

There are multiple benefits if water is used efficiently e.g. by

» appropriate forms of water harvesting,
» supplemental irrigation,
» demand adjusted irrigation,
» soil conservation methods (mulching, etc...) or/and
» drip irrigation and other methods of water saving irrigation.

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Adaption to climate change via drip irrigation.

Module 5: Climate

1 Greenhouse gas emissions and options for emission reductions

Numbers and facts

Greenhouse gas emissions from agriculture

» Agriculture: responsible for approximately **10% of global greenhouse gas emissions**

» Land-use changes due to agriculture: another **14% of global greenhouse gas emissions**

» **Total: 24%** (IPPC, 2014)

» Emissions are composed of the following GHG emissions, although the composition varies on regional scale (EC, 2015):

- **Carbon dioxide (CO_2)** (emitted due to e.g. deforestation, fuel consumption of agricultural machinery, pump irrigation systems, during processing, storage or cooling of agricultural products)
- **Methane (CH_4)** (emitted due to e.g. animal husbandry, inappropriate fertilization management, paddy rice cultivation)
- **Nitrous oxide (N_2O)** (emitted during the use of nitrogenous fertilizers)

Options to reduce GHG emissions from agriculture

» Emission reductions of 1.2 up to 4.3 Gt CO_2 are possible through:

- Increased soil or biomass **CO_2 storage capacity**

- **Emission reductions** during agricultural production processes (increasing agricultural productivity while decreasing GHG emissions per unit of output)
- **Sustainable intensification** of agricultural production on land recently used for agriculture, to decrease GHG emissions from the transformation of wetlands or pastures into agricultural land and from deforestation

» Technical emission reductions through agricultural practices which allow for maximum biomass production per hectare (sufficient soil coverage, efficient nutrient management, reduced usage of synthetic nitrogen fertilizer, ideal growth conditions, increased soil and biomass CO_2 storage capacity (UNEP, 2013:3; GIZ, 2014a)

- **No-till farming:** Planting is done right through the residues of previous plantings, which leads to a reduction of emissions from soil cultivation and from the usage of agricultural machinery
- **Better nutrient and water management in rice cultivation:** Emission reductions through less flooding and precise fertilizer application
- **Agro-Forestry:** Increased CO_2 uptake and storage from the atmosphere into biomass and soil, additionally **legume cultivation** can reduce the need for synthetic nitrogen fertilizer
- **Animal husbandry:** Reduced herd size, pasture management to reduce overgrazing, herd management, fodder management

» **Reductions of losses along the whole value chain have** a high potential to reduce emissions: the carbon food print of produced but not consumed food is about 4.3 Gt CO_2-equivalents (FAO, 2013:6).

» Worldwide about 4 million hectare of agricultural and grass land could be set free for different usage if consumers would eat less meat and would throwaway less food. Thereby, about 67 million t CO_2-equivalents of GHG could be saved. In Germany approximately 800 kg CO_2-equivalents per capita or 7% of the GHG emissions produced by one person could be saved through a behavioural change towards less meat consumption and food waste (WWF 2012).

Deforestation and its effect on climate

» Yearly about **14 million hectare of forest are destroyed** (FAO 2010: 15; GSW Film, 2014) (comparable to the area of Greece), every two seconds an area comparable to a football pitch gets destroyed[20].

» **Deforestation and degradation** of forests contribute with **12%** to anthropogenic global GHG emissions (IPCC, 2014; WRI, 2015).

» Deforestation of **1 hectare of rainforest equates to 1833.5 tons of CO_2**[21].

» From 1980 to 2000 83% of the expansion of agricultural land resulted from deforestation or land-use change (UNEP, 2012:18).

[20] Own calculation (SV IWP).
[21] Own calculation, assuming 500 tons of bound carbon per acre (SV IWP).

- If the goal of the New York Declaration on forests (UN climate summit 2014) to end deforestation by 2030 would be reached **4.5 – 8.8 billion tons of CO_2 could be saved**. This is more than the total GHG emissions of the European Union in the year 2012 (3.6 billion tons) (Dahl-Jorgensen, 2015: 2; EEA 2014).

2 Approaches and best practices

Numerous new approaches, so called climate smart approaches in the field of agriculture and natural resources management, have been developed.

Climate Smart Agriculture (CSA) and conservation agriculture (CA) are prominent general approaches seeking to better adjust agricultural practices to changing climate patterns and thus, reducing the vulnerability of those who depend on primary natural resources. There has been a rapid uptake of the term Climate Smart Agriculture by the international community, national entities and local institutions in the past years. However, implementing this approach is challenging, partly due to a lack of tools and experience. Climate-smart interventions are highly location-specific and knowledge-intensive. Considerable efforts are required to develop the knowledge and capacities to make CSA a reality.

Conservation agriculture (CA) is another approach to agricultural production. The approach aims at achieving sustainable and profitable agriculture and subsequently, aims at improved livelihoods of farmers through the application of the three CA principles: minimal soil disturbance, permanent soil cover and crop rotation.

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Solar power panels

Module 6: Energy

1 Introduction

Energy is involved in all life cycles and is essential in agriculture as much as in all other productive activities. An elementary food chain shows the need for energy: Crops need energy from solar radiation to grow, harvesting needs energy from the human body in work, and cooking needs energy from biomass in a wood fire. The food provides the human body with energy. Agriculture provides foodstuffs and drinks, produces animal feed and products, and delivers a wide range of non-food goods and services, including fibres for clothing and fuel. All these production and transformation steps require energy, which is thus, considered a key factor in agriculture in achieving sustainable development and poverty reduction.

Energy is a scarce resource, at least for some groups of people in some places and, maybe, for the world as a whole. A rational use of energy is then necessary for economic, environmental and social reasons. This applies to agriculture as much as to any other sector of the economy. Studying agricultural systems with a systemic point of view is prerequisite to understand the respective system's components and their relation to each other. Between these components humans can intervene in the system, take advantage of it (e.g. by increasing crop yields) and so become part of the system.

2 Challenges and need for action

In recent years, the 'nexus approach' is widely discussed and promoted, recognizing the interconnections between energy and food, along with other natural resources such as land, water and climate. Humanity needs to feed more people with less water, in a context of climate change and growing energy demand, while maintaining healthy ecosystems.

Modern agriculture demands tremendous amounts of energy, especially the production of nitrogen fertilizer accounts for nearly one third of all the energy used in agricultural production. This energy cost is high because nitrogen fertilizer is used so intensively and because large amounts of energy are required to produce it. Modern agriculture threatens a sustainable balance between energy input and output. Today, non-sustainable agriculture is using more energy to produce, process, transport, and market food than the food itself contains. Modern energy sources are mainly related to fossil fuel which is not available in abundant supply and is affected by unpredictable price fluctuations.

There is a need for action to expand the use of energy from more renewable and more sustainable sources of energy in agricultural production, e.g. through using energy from human and animal sources which are renewable, locally available and environmentally benign and further, reducing energy inputs by using biological nitrogen fixation, manures and recycling.

The following important actions towards the development of more energy efficient agricultural systems are recommended:

- Use energy more efficiently while retaining productivity and quality
- Reduce the use of fossil fuels and increase the role of renewable and low-carbon energy
- Reduce energy inputs by using biological nitrogen fixation, manures and recycling
- Achieve more efficient management of natural resources (land, water and soil) and external inputs (fertilisers and machinery) through a holistic ecosystems approach

3 Recent developments

Industrial agriculture often uses more energy to produce, process, transport, and market food than the food as a final product contains. Most sources of the invested energy come from finite sources. If the dependency on these energy sources will be continued, the consequences will further undermine the ecological foundation of agriculture, increase economic risks and cause social problems – an assault on all three dimensions of sustainability. Dependence on fossil-fuel use means greater vulnerability to changes in the price and supply of petroleum. As was seen in the oil crisis of 1973, and periodically since then, petroleum prices can suddenly rise, increasing the costs of agricultural production.

The present state of research indicates that the energy agriculture nexus is of growing importance, since modern agriculture is depending on fossil fuels and thus, has an impact on climate change. Since the 41st G7 summit in Elmau, Germany, the G7 committed a stepwise shifting from fossil fuels to renewable energies in the next 85 years, challenges of connectivity, price fluctuations and availability in the rural areas can be addressed through promoting renewable energies.

The multi-donor initiative ‘Powering Agriculture: An Energy Grand Challenge for Development’ (PAEGC) seeks to identify and support new and sustainable approaches to accelerate the development and deployment of clean energy solutions for increasing agriculture productivity and/or value in developing countries. For this purpose, USAID has partnered with the

Swedish International Development Cooperation Agency, the German Federal Ministry for Economic Cooperation and Development(BMZ), Duke Energy and the Overseas Private Investment Corporation. Very real and practical alternatives exist and more can be developed if research is directed towards whole-systems analysis of agro ecosystems.

4 Approaches and best practices

Energy inputs in agricultural value chains occur in production processes (land preparation, irrigation, fertilising, crop protection, harvesting), processing, post-harvest and storage (drying, milling, pressing, packing, storing) as well as in distribution and retail (infrastructure and transport, information and communication technology (ICT), training, selling). Energy supply options in agricultural systems include electricity, mechanical power and thermal energy.

Energy inputs in the following value chain operations are of large importance for agricultural value creation and the development of the rural economy:

» Irrigation: Irrigated land productivity is significantly higher compared to rain-fed land.

» Fertilisation: Proper fertiliser use can improve land productivity.

» Cold and dry storage: Improper storage can cause significant food losses.

» Processing: Processing allows products to be conveniently stored, preserved, transported and marketed.

» Market access: Transport services and functioning infrastructures enable farmers to attain revenues from products.

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Agrobiodiversity

Module 7: Agrobiodiversity

1 Introduction

Agricultural Biodiversity (ABD) is a vital subset of the global biodiversity. While the global biodiversity refers to the variability within and among **all** living organisms and the ecosystems they are part of, ABD includes the variability within and among those species that are used directly or indirectly for food, agriculture and other human needs, e.g. fibre, fuel and pharmaceuticals — and the agro-ecosystems they are part of. ABD is thus, the part of the global biodiversity that is intimately linked to humans and their needs.

ABD is important for sustainable agriculture in several ways: It provides humans with food and satisfies other important needs, it helps to make farming systems more sustainable and resilient, and it can contribute to income generation and livelihoods, as well as to cultural identity and human well-being (Padulosi et al., 2013).

2 Challenges and need for action

In spite of its importance, ABD is presently under-utilized. Out of the 7000 edible plant species that are known to be used by humans in history, only four species account for 60 per cent of energy supply in human diets today. Thus, nearly all other species are presently under-utilized.

It is estimated that three quarters of the genetic diversity in major food crops is already lost. Genetic erosion continues at a rate of 1 to 2 per cent per year – with huge variation between regions and crops. Case studies show that ABD loss is ongoing at fast pace and also in regions where traditional crop varieties are still grown by many farmers (Chaudhary et al., 2004).

Livestock revolution led to changes in livestock keeping that affect livestock genetic resources. High yielding but fragile exotic breeds are dominating in big farms while multipurpose, local breeds adapted to local conditions are vanishing. Major reasons for the decline in agricultural diversity are variety replacement, agricultural intensification, environmental degradation, land use changes, inconsistent policies or economic pressure.

3 Recent developments

Many initiatives have been initiated to stop the present loss of genetic diversity. While ex situ conservation technologies are well developed, there is much needed to safeguard the diversity in situ and on farm. Effective targeting towards the needs of farmers is the key to success. Participatory approaches should be applied involving the rural population, focusing on farmer-led activities, local institution building and empowerment, location-specific, considering the vital role of women as well as the existing traditional knowledge. In one way or the other, farmers need to benefit from their conservation activities – either through marketing of produce (value chain development) or by external compensation.

Agrobiodiversity also tackles aspects of the environment, nutrition, education, health, water and sanitation, infrastructure and markets as well as social sciences. Depending on the objective of the project, multi-disciplinary skills and a multi-sectoral approach might be needed.

4 Approaches and best practices

Approaches to ABD conservation and use include *in situ* conservation, market development, breeding programs and knowledge sharing activities.

Best practices for each of these approaches are presented in the module. Examples are priority areas for *in situ* conservation, value chain development, participatory plant breeding, and seed or diversity fairs. In some cases, these practices can be effectively combined, for example *in situ* conservation or breeding programs with value chain development.

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Plant protection product.

Module 8: Plant protection

1 Introduction

Yield losses due to agricultural pests in world rice production are estimated to range from 20-50 per cent despite the presently adopted cultural, biological and chemical plant protection strategies and to 60-80 per cent if no plant protection measures would be applied (Oerke, 2006). Similar ranges for yield losses are estimated for other important crops like wheat, maize and cotton. Considering the estimated loss potential of pests worldwide, there is no doubt that plant protection is essential, not only to increase agricultural production income on the individual farm level but also on global level, if we want to ensure food supply for an increasing world population.

Table 1 Yield losses in global rice production (after Oerke, 2006)

Attainable production	933.1 M t
Potential yield loss **without** plant protection	60 – 80%
Actual yield loss **with present** plant protection	20 – 50%

The intensive use of pesticides, as exercised in today's agricultural production, however, has also implications on the environment including biodiversity and water bodies, user and consumer protection and food safety, as well as on pesticide externalities. These implications together with concerns about overused or polluted water resources, long-term deteriorated soils and social concerns like unequal access to pesticides have raised increasing awareness for the need for a more sustainable agricultural production and plant protection.

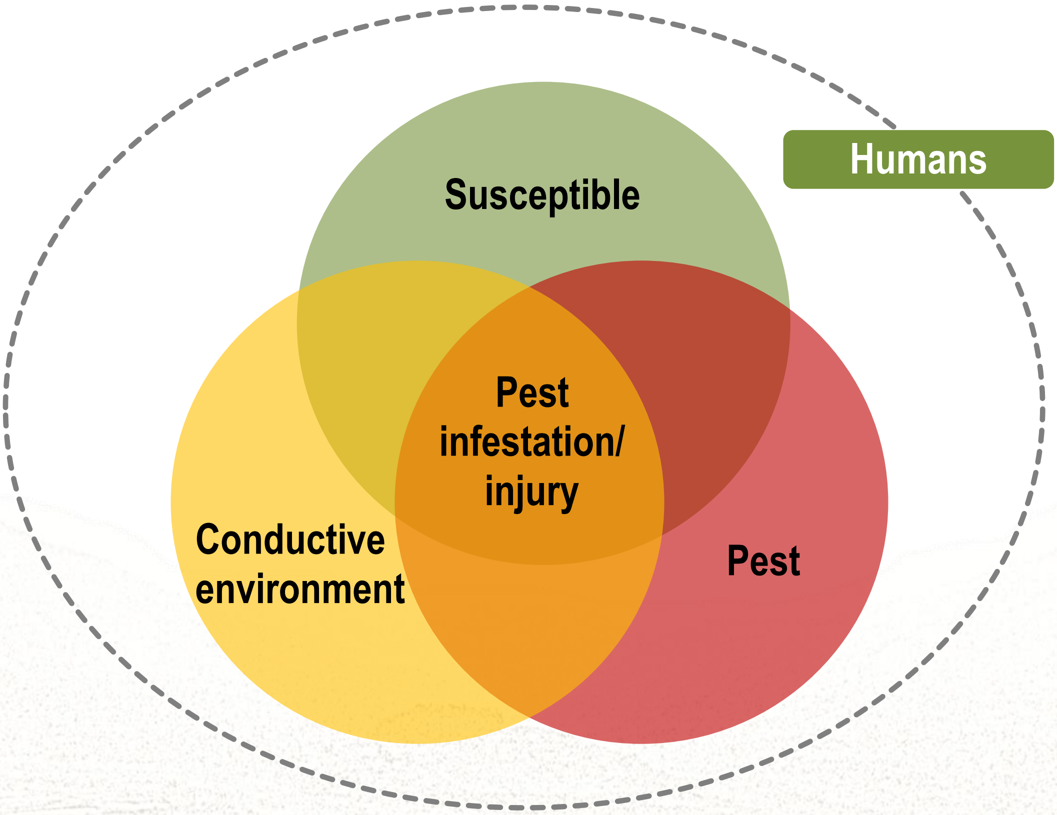
2 Recent developments

Legally binding international laws related to pesticides are the Chemicals and Waste Conventions (Basel Convention, Rotterdam Convention and Stockholm Convention). Several other classifications and management systems in the field should be considered. The European Union adopted a directive that all EU countries should convert to the use of Integrated Pest Management (IPM) in agricultural production by 2014. The GIZ has adopted a holistic and sound pesticide management system. It includes a list of pesticides which will be excluded from procurement through GIZ, safety standards, safety recommendations and training for best practices.

3 Approaches and best practices

In order to understand the fundament of sustainable plant production and protection we have to understand the interaction between environment, crops, pests and humans. Human beings have direct influence on most environment-crop-pest systems and thus can influence - or manage - the occurrence of pest infestation and plant injury.

Figure 1 Interaction between environment – crops – pests – humans



Source: Vanderblank, 1963, Zadoks and Schein,1979

Good Agricultural Practice is the best fundament for the prevention of pest problems and includes among others availability and use of good quality seeds, proper field cultivation, adequate fertilization and crop rotation. IPM is a systematic approach to sustainable crop protection building on Good Agricultural Practice.

The following main elements can be considered typical for an IPM approach:

- Prevention and/or suppression of pests through cultural practices and Good Agricultural Practice.
- Use of pest resistant/tolerant cultivars.
- Protection and enhancement of beneficial organisms.
- Pest management measures based on monitoring and thresholds.
- Sustainable pesticide use as last resort.

The IPM approach emphasizes improvement of agricultural productivity while minimizing harmful effects on the environment and human health and aims to minimize the use of pesticides and to preserve natural resources for coming generations.

4 Challenges and need for action

Preconditions for sustainable plant protection are seen on individual and governmental level. Education and training of farmers are the most important preconditions to empower farmers to take knowledge-based decisions and there is a need for independent, decentralized plant protection advice.

On the governmental and institutional level of many development countries there is a need for a range of initiatives supporting sustainable plant protection such as providing regionally adapted Good Agricultural Practices for all cropping systems, promoting alternatives to pesticides (e. g. favourable policies for biological control), defining rules for pesticide registration and quality and application equipment inspection, establishing capable institutions to design policies and enforce rules (e. g. quality control of pesticides and seeds), strengthening regional/national research to provide locally adapted solutions, strengthening a seed sector that provides locally adapted high quality seeds and facilitating crop insurances and credit systems.

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Working in a watershed.

Module 9: Labour and Labour Conditions

1 Introduction

There are two major links between labour and sustainable agricultural practices.

Sustainable agricultural practices can have a significant impact on labour markets in terms of demand and seasons of labour. Sustainable agricultural practices should be used to redress imbalances in labour supply and demand and raise labour productivity. The second link is the quality of labour conditions for people engaged in sustainable agriculture, both, hired workers or non-hired workers. According to the type of production methods and engagement in agricultural labour conditions can vary greatly. Most vulnerable groups are found in family subsistence agriculture, in plantations as daily paid labourers, seasonal or migrant workers without land, women and child labourers. Sustainability contains not only ecological aspects but among others '*the concept of 'needs', in particular the essential needs of the world's poor, to which priority should be given*' (WCED, 1987). Therefore, social and economic aspects of work in agriculture, considering the labourers' health and safety, Work Organization, Respect of Human Rights, Community, Remuneration and Working Hours and Non-Discrimination are an integral part of sustainable practices.

2 Challenges and need for action

Agriculture is one of the three most hazardous sectors of activity; at least 170,000 agricultural workers are killed each year (ILO). Workers in agriculture run twice the risk of dying on the job compared to workers in other sectors. Millions more are seriously injured in workplace accidents involving agricultural machinery or poisoned by pesticides and other agrochemicals. Housing and living conditions on many farms and plantations are often inadequate. Less than 20 per cent of agricultural workers have access to social security. Income of smallholder farmers and wages of agricultural labour are often beneath subsistence level. When claiming their rights, agricultural labourers are criminalised in some countries. Women, who account for 30 per cent of waged workers in agriculture, are often additionally burdened with reproductive tasks and have specific needs for protection. Almost 70 per cent of child labourers are unpaid family workers. About 59 per cent (or 70 million) of all children in hazardous work aged 5–17 are in agriculture (FAO-ILO).

3 Recent developments

International Regulations of Labour conditions: The UN Declaration of Human Rights declares every person's right to work in just and favourable conditions. The International Convention of Economic, Social and Cultural rights stipulates the rights to work and good working conditions. The International Labour Organisation promotes rights at work, encourages decent employment opportunities, enhances social protection and strengthens dialogue on work-related issues. Following ILO conventions are valid for 'employees and workers' in agriculture, comprising 'self-employees' like small-holder farmers: Freedom of Association and Protection of the Right to Organize (No. 87); Right to Organize and Collective Bargaining (No. 98); Discrimination (Employment and Occupation) (No. 111); Equal Remuneration (No. 100); Abolition of Forced Labour (No. 29/No. 105); Minimum Age (No. 138); Worst Forms of Child Labour (No. 182); Labour Inspection (Agriculture) (No. 129); Safety and Health in Agriculture (No. 184).

Transfer to National Law: Implementation of these regulations is a challenge. National labour law often protects agricultural workers insufficiently.

Controversy on Child labour: ILO Conventions declare a minimum working age of 14. Light work can be carried out between 12 to 14 years as long as it does not threaten the children's health or hinder education. A new law on child labour in Bolivia leaves the limit of 14 in place but allows exceptions from age of 10 under the conditions that employers have to insure the physical and mental health of employed children, and prevent child exploitation. Criteria include a voluntary decision from the child to work, consent from the parent or guardian and permission from the public ombudsman. However, the ILO warns of potential loopholes in implementation, especially in view of many children working in agriculture on their family's farm.

4 Approaches and best practices

Human-Rights-Based-Approach in International Cooperation: The HRBA is a framework based on international human rights standards, integrating international human rights law into the processes of development. Target groups turn from 'beneficiaries' into 'right-holders'. Human Rights Principles: Participation, Accountability, Non-discrimination, Transparency, Human dignity, Empowerment and Rule of law (PANTHER) orient the implementation of processes.

Sustainability standards systems in agricultural production: Sustainability standards define and review good social and environmental practices. They comprise all three dimensions of sustainability, but different standard systems have different foci. Rainforest Alliance, for example has a strong focus on ecological aspects, while Fairtrade has a stronger focus on the living and working conditions of peasants and agricultural labourers. Often, a certification programme assures compliance.

Fair trade debate: The concept of fair trade certification is subject to frequent debates regarding its overall impact. A recurrent criticism claims that extra margins applied to fair trade goods and fair trade premiums (additional amounts paid by buyers of Fairtrade goods to use on community projects) do not actually reach producers. Others argue there is no transparency regarding profit margins for the different actors involved in a value chain, from producer to retailer. Therefore, the claim of fairness is unjustified. While fair trade producers do receive higher prices or incomes than non-fair trade producers they may still be living in poverty. In order for producers to receive real living wages large-scale structural changes in international trade networks are required.

Good practice incentives on farm level: The above are different possibilities for reference of what good labour conditions may look like. Good social practices have inherent benefits on the farm level and should not be understood as a burden, imposed top-down. Economic incentives include: higher productivity *(e.g. when workers work where they are most productive and children can develop their human capital; participation favours modern management methods and helps to avoid mistakes),* fewer losses *(good training increases capacities and quality of products)*, improved risk management *(control of dangerous substances and tools and supply of protective clothing)*, fewer absences *(improved working conditions reduce health detriments, fewer production days lost)* and less fluctuation *(improved working conditions increases satisfaction at work and training increases satisfaction and motivation).* Another incentive are the positive effects on relationships: With workers *(more reliable and consistent), w*ith clients *(compliance with customer needs can ease access to new markets, improvement of social standards can be a first step towards good reputation and certification, on the national scale it can be a competitive advantage in a globalised world)* or with neighbours *(control of pesticides and chemicals will not affect neighbours).* Of course, legal adherence to international, national and local laws and regulation on labour and the avoidance of punitive fees can also be an incentive for good social practices.

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Module 10: Good Quality of Life

1 Introduction

Quality of Life (GQoL) is defined as '*the individuals' perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns*.' (WHO, 1997). It stems from the fulfilment of individual goals within current objectives and can be rated by the importance of various aspects of life and the level of people's satisfaction with these aspects. The development of the concept has its roots in the criticism of rating human development in economic measures.

2 Challenges and need for action

Good Quality of Life can include diverse aspects for individuals and communities depending on their situation in life and their specific context and value-systems. When putting sustainable agriculture into practice, the consideration of a Good Quality of Life means ensuring the satisfaction of those people engaged regarding their: Financial situation, Social relations, Personal freedom and values, Occupation and education, Health and safety and other aspects they individually find relevant.

Sustainable agricultural practices bear the potential to specifically address shortcomings in sustainable livelihoods and of GQoL: Worldwide, women face discrimination e.g. in access to land and to services as well as in terms of wage levels. They are more likely than men to be in seasonal and/or low-paying jobs when engaged in rural wage employment. Often, women are underrepresented in rural organizations and poorly informed about their rights. Therefore, it is important to consider different impacts and reduced/increased workloads, to promote equal participation in decision-making processes and collective activities and to ensure access to knowledge and resources for all genders.

While the world's youth cohort is expected to grow, employment and entrepreneurial opportunities for young people – particularly those living in economically stagnant rural areas – remain limited, poorly remunerated and of poor quality. Including youths in the development of sustainable agricultural practices and supporting their access to rights, participation and resources will ensure the future of sustainable agriculture.

3 Recent developments

In recent history, economic growth has been the major benchmark for human progress. The sustainability debate draws attention to the fact that economic growth is not the key to sustain well-being or environmental integrity. There are many approaches to amend the evaluation of human development by aspects of Good Quality of Life, e.g. the Gross National Happiness Index in Bhutan and its inspiration of the UN World Happiness Report, the OECD Better Life Index and many others. They aim at including context specific evaluation of Good Quality of Life e.g. placing the community first, rather than the individual or rating the importance of basic needs like housing, jobs, health, and education etc. for subjective Good Quality of Life.

4 Approaches and best practices

An approach to integrate the concept of Good Quality of Life in economic (i.e. agricultural) activities is the concept of the Economy of the Common Good. It is a concept from an Austrian initiative that places human beings and all living entities at the centre of economic activity, translates standards for human relationships and constitutional values into an economic context and rewards economic stakeholders for behaving and organizing themselves in a human, cooperative, ecological and democratic way. Various local approaches include the diversification and strengthening of different assets of small-holder farmers to ensure sustainability of livelihoods or the promotion of gender related aspects and involve youths when introducing sustainable agricultural production methods.

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MODULE 11: SUSTAINABLE VALUE CHAINS

1 Introduction

The term value chain means 'all aspects from the availability of rural credit and the purchasing of seed and other inputs to land preparation, agronomic management, quality control to meet market standards, post-harvest technology, packing and transport, food processing and interactions with output markets' (CGIAR, 2012). It has been also defined as 'an institutional arrangement linking and coordinating producers, processors, traders and distributors of a particular product.' (GIZ, value links).

A supply chain is understood as the existing relationship between individual actors normally found in the market. When this relationship becomes a strategic collaboration between various participating organisations in order to achieve certain objectives in the market over the long term and for the mutual benefit of the participants, it is known as a value chain. A value chain approach is demand driven, not dictated by supply, meets the needs of consumers and requires a high level of trust among participants. All participants of the chain recognise their interdependence, are willing to work together, share risks and make the relationship work between them to maintain consistent quality levels according to market demands.

Designing a value chain development project has two dimensions: The first concerns what the VC actors must do to become more competitive and to generate greater added value. This is known as the *value chain upgrading strategy.* The second dimension concerns the role of facilitators, e.g. governments and development agencies running chain development projects and providing assistance. This is referred to as the *facilitation of VC upgrading* or *'value chain promotion'.*

2 Recent developments

Over the past decade, the value chain development approach has been increasingly adopted by governments, donors and NGOs to generate income and reduce rural poverty. However, income is not the only determinant of livelihood welfare and single-chain approaches do not do justice to diversified livelihoods since there are trade-offs between market orientation and food security. Market-based interventions work best for those farmers who meet minimum asset thresholds and hence, are value chain ready. Those who are not require specific, non-market-based interventions to create the necessary preconditions for their participation in value chain development (Stoian et al., 2012). Poor small farmers tend to optimize their complex livelihood systems (mix of subsistence and market oriented crops, off farm income, remittances etc.) as part of their risk management strategy. Generally, they are not able to successfully participate in traditional single value chains which require specialization that may lead to increased risk and vulnerability. Small farmers often did not reach the required critical threshold of assets (natural, human, social, physical, financial capitals).

Diversified livelihood strategies for small farmers are necessary to manage risk and increase resilience against external shocks. Value chain development projects should contribute to meaningful asset building at household level for those farmers balancing opportunities and risk. What interventions are needed to increase the critical threshold of assets at household level? There is both, a need for and an opportunity to combine value chain development with other approaches to rural development such as sustainable rural livelihoods, territorial development, and investments in rural infrastructure and services (Stoian et al., 2012).

3 Challenges and need for action

From 2 billion smallholder farmers worldwide approx. 70 per cent live in marginalised areas under harsh conditions. The soils in these regions are usually poor meaning that high yielding hybrid varieties of commodity crops (high requirement of inputs such as pesticides and fertilisers) are not a suitable option. Current methods and tools for value chain development (VC prioritisation-analysis of bottlenecks-upgrading) only promote and measure the creation of economic value (and reduction of transaction costs) and not the potential of VC for contributing to multiple purposes such as better nutrition, health, climate resilience and food security.

Much needs to be learned about the best possible design and implementation of value chain programmes and pertinent combinations with other approaches. Existing value chain research and development tools need to be reviewed and adapted in order to capture the multiple value dimensions which will then influence the selection and prioritisation of crops to be funded through public and private investments in value chain development projects. Without the adoption of an asset-based approach to value chain development, poor households and smallholder enterprises in the upstream segments of the chain will continue to be exposed to high uncertainty and risk and, in particular, to potentially harmful trade-offs between value chain optimisation and resilience at the household and business level (Stoian et al., 2012).

4 References and further reading

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Interesting websites

- GIZ valuelinks methodology and other knowledge products: www.valuelinks.org
- Value chain knowledge clearinghouse under CGIAR Policy, Institutions & Markets (PIM) Value Chain Research: www.tools4valuechains.org
- CGIAR Agriculture for Nutrition and Health (A4NH) Value Chain Research: www.a4nh.cgiar.org/our-research/value-chains-for-enhanced-nutrition

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Farmer business school

Module 12: Economic Viability and Farm Management

1 Introduction

In view of the multifaceted problems farms and agricultural enterprises, especially in developing countries and emerging countries, and agriculture in general are facing a large variety of concepts has been developed to assess economic viability (EV) differently than through a few classical business indicators. These broader approaches have developed different sets of criteria for defining, assessing and measuring economic viability with a view to sustainable agriculture. Some of them also respond to specific conditions in developing countries, e.g. emphasising the household, sustainable livelihoods and/or resilience perspective.

2 Recent developments

In line with the dissemination of the concept of sustainable development the approaches to assess the EV of farms and agricultural enterprises tend to move beyond accounting and monetary profit and loss statements as well as basic business indicators centred on financial profit. They choose a broader scope for EV drawing on different sets of additional sustainability-related parameters and indicators. The selected approaches, e.g. KSNL, RISE, COSA, SAFA interpret the term 'economic viability' differently depending on the chosen view on the economy and their scope of EV (narrow, broader, short, long-term) as well as on the main focus (more economy-centred, people-centred, nature-centred etc.). Thus, in addition to the economic bottom line they consider as well other aspects of sustainable development when assessing EV of farms.

Each of these approaches has different advantages and shortcomings: There is especially a trade-off between comprehensiveness and applicability in practice. In addition, there is still the challenge to broadly apply the approaches to assess EV in a broader perspective more widely, especially in developing countries and emerging economies.

3 Approaches and best practices

In one way or the other, all conceptual approaches to assess economic viability/sustainability do take into consideration the following basic aspects of farming:

1. The natural frame conditions (land, soil, climate, rainfall/sunshine, extreme weather events, access to energy/electricity, markets)
2. Inputs: soil, seeds, animals, fertilizer, pest management, water/energy for irrigation
3. Processing (costs): irrigation, energy, labour, poss. processing of products
4. Marketing: access to markets, market structure: regular/seasonal, type of customers: individuals, wholesale, monopolies
5. Sales, revenues, saving, investment
6. Use of profit: investment, consumption
7. Management decisions which affect all the other aspects

4 Challenges and need for action

As there is no shortage of concepts and tools, the main challenge is to disseminate the broader concepts of economic viability and sustainable agriculture which integrate 4 bottom lines; resilience, and livelihoods concerns.

As means in developing countries are scarce, especially at the local and farm levels (limited time and capacities), the revision of the approaches in view of higher practicality and cost-effectiveness is also of interest for a broader application and dissemination.

5 References

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- DLG-Sustainability Standard (Nachhaltigkeitsstandard): www.nachhaltige-landwirtschaft.info www.nachhaltige-landwirtschaft.info/21.html
- DLG, Sustainable Agriculture, DLG Certificate, www.Nachhaltige-Landwirtschaft.info , p. 9.
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6 Annex

Summary of economic indicators according to selected approaches:

KSNL-CSSA 'Criteria System of Sustainable Agriculture'

The KSNL-CSSA system was developed by the Thüringer Landesanstalt für Agriculture (TLL) and comes from mainstream agronomics but takes into account the three pillars of sustainability.

KSNL Economic indicators	**Profitability** ➔ Income (Operating income + labour costs); Profit-ability rate; Return on assets; Return on Equity; Relative factor remuneration (operative income to factor costs of all production factors) **Solvency** ➔ Financial capacity; CASH FLOW III **Resilience** ➔ Equity ratio; Changes in equity; Net investment **Value added** ➔ Revenue

RISE Response-Inducing Sustainability Evaluation

RISE was developed by members of HAFL- School of Agricultural, Forest and Food Sciences in Bern, Switzerland. RISE 2.0 is an instrument not of control or enforcement but to holistically determine a farm's position in the context of a voluntary record of achievement respect the sustainability of agricultural production at farm level.

RISE Economic indicators	➔ **Economic viability** • Liquidity reserve • Indebtedness • Economic vulnerability • Livelihood insurance • Financial scope ➔ **Farm management** • Farm strategy & planning • Supply & yield stability • Planning instruments & documentation • Quality management • Cooperation

COSA - Committee on Sustainable Agriculture

COSA claims to be a participatory process of many different stakeholders and experts from science, producer groups, private firms, NGOs, and development agencies. It aims at developing transparent global measurement tools to understand, manage and accelerate sustainability.

COSA Economic indicators	➔ **Producer Livelihood** • **Revenue** ➔ Farm revenue; Target crop revenue (Yield, Price); Household labour revenue • **Costs** ➔ Total production costs for target crop (Labour costs; Fertilizer costs; Biocide costs; Equipment costs; Energy costs); Certification costs (direct); Compliance costs (indirect) to meet standards (Specific training & infrastructure, Record keeping e.g. traceability) • **Income** ➔ Producer net income from target crop ➔ **Risk** • **Diversification** ➔ Portion of total production revenue from target crop; Portion of cultivated farm area used for other crops • **Information** ➔ Access to market information; Price formation – Producers understanding the factors that affect the price • **Credit** ➔ Access to credit (how much and from what sources) • **Volatility** ➔ Price; Yield • **Vulnerability** ➔ Access to medical services; Relationship to National Poverty Line; Days without sufficient food; Discrimination - compare pay (gender or diverse ethnicity or affiliation) for same role ➔ **Competiveness** • **Business Development** ➔ Access to market information; Ratio of farm price to global reference price; Training attended (Type, amount of time); Price formation • **Differentiation** ➔ Quality practices in cultivation and processing; Producers knowing quality levels; Ownership or control of certification or standard; Number of current standards or certifications; Amount of price premium for complying to a standard or certification; Portion of crop sold as compliant or certified • **Efficiency** ➔ Labour efficiency; Wealth change over time; Productivity - efficiencies of output/inputs (Labour use, agrochemical use, energy use) ➔ **Producer Organization** • **Governance** ➔ Producer participation levels in groups; Democratic process in organization; Women's participation with local producer groups • **Services** ➔ Number of basic services provided by association; Community relations - farms participating in projects ➔ **Perception** • **Producer Perception** ➔ Producer perceptions of change in overall economic circumstances

FAO-SAFA – Sustainability Assessment of Food and Agriculture Systems

It builds mainly on existing sustainability schemes, creating opportunities for enterprises to use existing data and combining efforts with other tools and sustainability initiatives.

SAFA encourages continuous improvement and builds capacity for sustainability.

It strives to establish an easy-to-use standardized system, which does not require external experts.

FAO SAFA **Economic resilience indicators**	**➔ Investment** • Internal Investment • Community Investment • **Long-ranging Investment** ➔ Long-term profitability; Long-term business plan • **Profitability** ➔ Net income; Cost of Production; Price determination **➔ Vulnerability** • **Stability of Supply** ➔ Procurement channels; Stability of supplier relationships; Dependence on the leading supplier • Stability of Market • **Liquidity** ➔ Net cash flow; Safety nets • Risk Management • **Stability of Production** ➔ Guarantee of production levels; Product diversification **➔ Product Quality and Information** • **Food Safety** ➔ Control measures; Hazardous pesticides; Food contamination incidents • **Food Quality** ➔ Quality standards • **Product Information** ➔ Product labelling; Traceability system; Certified production **➔ Local Economy** • **Value Creation**➔ Regional workforce; Fiscal commitment • Local Procurement

Integrated Stored Product Protection in organic production

Pest prevention	Early pest detection	Pest control
• Structural design • Store quality • Inspection • Sampling • Drying • Cooling • Sanitation • Packaging	Visual inspection Check: • Temperature • Moisture • Movements • Structural design • Product density • Bioacoustics • traps	• Physical • Biological • Biotechnical • CO_2 / N_2 / Diatomaceous earths (DE)

Integrated storage protection based on three pillars

Module 13: Post-harvest Management

1 Introduction

After plant production and the harvest of agricultural products, the post-harvest phase starts which can be short and simple or long and highly complex, either traditional or industrialized.

Along the entire food supply chain (FSC) or value chain ‘from the field to the plate’, including production, storage, processing and distribution, food losses can occur. However, harvest and post-harvest activities are very sensitive with regard to food losses which are unacceptable from both economic and environmental points of view since they vitiate investment that has already been made in agricultural inputs, labour force and natural resources such as soil and water.

Building on the concept of integrated protection of stored produce and storage management on the one hand and socio-economic conditions on the other, the system approach to post-harvest activities was developed by the FAO, GTZ and partners in the mid-1990s. This was a multi-disciplinary and participative approach that involved all stakeholders at all stages of the ‘post-harvest chain’.

2 Advantages of integrated post-harvest management

Today the perspective has widened to include the causes of food losses and to consider losses not only at producer level but also along the entire value chain, whether during storage, the largest losses occur and the most effective measures can be put in place. The desired result will not be achieved if storage facilities are built without an adequate transport infrastructure, without market information or without further processing opportunities. Technical innovation without prior cost/benefit analysis, without capacity building and without a sound gender approach is unsustainable. The integrated approach and the implementation of 'Good Agricultural Practice' can lead to increased yields, higher productivities per hectare and finally to a higher level of food security and nutrition as well as income.

3 Challenges

Each crop and harvested product demands special knowledge, experience, construction, working tools and organisation of activities. At first hand, pests and diseases are threatening the conservation of the harvested produce and have to be detected, identified, controlled and prevented from re-infestation. Often products are no more marketable or consumable, e.g. spoiled, rotten, damaged, not fully mature (green potatoes). In combination with these physical losses, financial losses may occur: Lower prices paid due to insufficient quality or loss of value due to bad storage facilities or due to contamination with mycotoxins.

4 Need for action

The following main recommendations for action can be given:

» Good Agricultural Practices (GAP) have a key role to play in efforts to improve production and to prevent loss during production, harvest and post-harvest stages.

» The harvested produce should be cleaned and dried before it is stored or processed to reduce the prevalence of aflatoxin contamination.

» The first step towards reducing the post-harvest losses is to carry out an analysis with the aim of identifying problem areas and hot spots of losses.

» Preventive measures are the most effective way of avoiding loss. Further pillars of integrated storage protection are the early pest and disease detection and pest control.

» Preventive measures can be taken at various levels: dealing carefully with the produce, appropriate construction of warehouses, package material which fits the needs, infrastructure and roads, market organisation etc.

» Sanitary and phytosanitary inspection and control systems should be provided.

» Investments in the post-harvest sector should not only reduce losses but help to maintain or improve the quality of produce.

» Integrated harvest and post-harvest management combines all elements of planning, steering, communication and cooperation as well as practical activities to save the produced agricultural goods in full quantity and quality during harvest and post-harvest activities.

» Many authorities, organisations and private enterprises can contribute to the improvement of the frame conditions like infrastructure, transfer of research results, investments for mechanisation and construction, social welfare, gender equity in post-harvest activities etc.

» Efforts to connect farmers with processors and sales markets and the dialogue amongst the stakeholders should be promoted. Contract farming can be a good option for a more productive value chain with a high quality product at the end.

» Preventing food loss means at the same time to reduce greenhouse gas emissions of the produce which finally – despite all the inputs and efforts – is not used for human consumption.

5 References and further reading

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» Relevant publications on storage protection and post-harvest management of GIZ and other organisations can be found in the library of postharvest losses and food waste of the global donor platform. Experiences from former development projects (1980-1995): More than 200 studies, publications and „grey literature' are still available and listed: www.donorplatform.org/postharvest-losses-and-food-waste/on-common-ground

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Further literature and portals

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