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# Linking good agricultural practices and climate smart agriculture

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# Table of contents

# Preface

This is the summary report of the BO-10-020-003 project 'Aligning good agricultural practices and climate smart agriculture' commissioned by the Dutch Ministry of Economic Affairs and executed by the DLO-foundation.

# Executive summary

Recently, the concept of Climate Smart Agriculture (CSA) was introduced to position agriculture and food security in relation to climate change adaptation and mitigation. Good Agricultural Practices (GAP) with the aim to create cleaner and safer production systems and products has been around for a while. Because the goals of CSA and GAP ultimately need to be achieved by farmers it is logical to link and integrate CSA goals with Good Agricultural Practices (GAP). This report provides some insight in how this can be done and uses cases to illustrate some of the issues.

Although the general scope of GAP is clear, i.e. sustainable agriculture, there is little common ground in what 'good' means in practice. Most schemes seem to focus on environmental issues and consumer concerns only a few focus on what is good for producers. The ‘good’ is mainly determined by those creating the schemes. Specific contexts, circumstances and capacities of countries determine how GAP is implemented. Linking to farmers and addressing practical implementation is only just emerging.

Climate Smart Agriculture starts from development goals and aims at sustainably increasing agricultural productivity and farmers’ incomes while at the same time addressing climate change via adaptation and mitigation. Adaptation to climate change seem to be a natural ally for food security goals whereas opportunities to reduce and remove GHGs are in low input systems not per se inline with productivity goals.

In this report a context specific framework to integrate CSA and GAP is presented, followed by a section on how GAP is embraced in a range of certification schemes and standards adopted by the agri-food sector. The framework consists of different steps including a description and assessment of current production systems, identification and evaluation of CSA options and GAP requirements, identification of institutional and financial barriers to the development of coherent strategies for implementation of promising CSA-GAP options. This integrated framework is used in three case studies with different commodities, economic conditions, physical conditions and expected impacts of climate change. The cases illustrate the location-specific differences in current and future strategies and potential barriers.

# 1. General introduction

The Food and Agriculture Organization (FAO) estimates that 70% more food needs to be produced by 2050 to meet the growing global demand, which is mainly driven by a larger population and change in diets towards the consumption of more animal products (FAO, 2009). Climate change has the potential to undermine economic, environmental and energy related activities including those aiming to improve food security. It can also hamper development by its impact on the natural resource base upon which agriculture depends (Halsnæs & Verhagen, 2007; IPCC, 2007a). Besides being directly impacted by climate change, agriculture is also a contributing factor to climate change as it contributes to the emission of greenhouse gases (GHGs). Agricultural land accounts for approximately 15% of global anthropogenic gases, mainly methane and nitrous oxide. The role in the global carbon budget is linked to the use of electricity, fossil fuel. Moreover agriculture is also an important driver of land use change.

There is growing consensus in the literature that increase of agricultural production predominantly needs to be realised in non-industrialised countries with relatively low productivity levels (Cassman *et al.*, 2003; Tilman *et al.*, 2011). Increasing agricultural production through land expansion is less likely because of the scarcity of land of sufficient quality and the increasing demand for land used for non-agricultural purposes. It will most likely be achieved by the intensification of agricultural production systems, which will in turn lead to a higher consumption of fossil fuels, partly related to increased mechanisation and increased use of inorganic fertiliser (Smil, 1997; Pingali, 2006) and pesticides. Storage, transport and processing of agricultural products also require energy and any increased use of fossil fuel will exacerbate climate change. Defining a low-emission pathway is a key challenge that has so far been neglected. Innovations, technology and knowledge exchange on managing emissions in the agricultural sector, on farms and in value chains have not received the attention needed for the sustainable development of agriculture (Oenema *et al.,* 2001). The IPCC (2007a) indicates that a variety of options exist for mitigation of GHG emissions in agriculture and can be implemented using currently available technology. The most prominent options are improved crop and grazing land management (e.g. improved agronomic practices, nutrient use, tillage and residue management), restoration of organic soils that are drained for crop production and restoration of degraded lands. Lower but still significant mitigation is possible with improved water and rice management; set-asides, land use change (e.g., conversion of cropland to grassland) and agro-forestry; as well as improved livestock and manure management (IPCC, 2007b).

During the Conference on Agriculture, Food security and Climate Change in The Hague (2010) (http://www.afcconference.com/) the term 'Climate-Smart Agriculture (CSA)' has been coined to achieve the 'triple win' of sustainable development, adaptation of agriculture to climate change, and reduction of GHG emissions. Although the link between sustainable development, agriculture and climate change is clear the issues are still addressed separately at national and international policy levels. In an attempt to overcome the existing barriers among these inter-related issues, the FAO defined CSA as *agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes GHGs (mitigation), and enhances achievement of national food security and development goals (FAO, 2010).*

Because the goals of CSA in the end needs to be realised by farmers in this report, we link and integrate CSA and Good Agricultural Practices (GAP). GAP is defined as *practices that address environmental, economic and social sustainability for on-farm processes, and result in safe and quality food and non-food agricultural products (FAO, 2007, a.b.).* We go beyond a technical inventory and assessment of management practices with respect to their contribution to productivity, adaptation and mitigation, but also include an analysis of the institutional and market barriers to adopt management practices that contribute to CSA objectives. The ultimate goal is to come to scientific underpinning and elaboration of the methodology to a practical tool to decide on policy and investment in CSA in view of GAP. This note serves as a working paper to initiate discussion between researchers of Wageningen UR on the development of a CSA-GAP policy tool. Given the limited resources we are not able to explore the entire food system from production to consumer, but will focus on the primary production at the field and farm level.

First, we provide a short background on GAP and CSA followed by the framework for developing CSA options based on FAO (2012).

# 1.1 Background to GAP

In accordance with the various origins GAP is worked out in many different ways. The term is used in a range of private sector driven voluntary schemes but is also used in regulatory schemes on e.g. food safety. GAP offers a process to discuss and identify available knowledge to address environmental, economic and social sustainability for on-farm production resulting in safe and healthy food and non-food agricultural products (see e.g. FAO, 2007c). The growing concern from consumers and the food industry in the developed world about the way food is being produced (e.g. related to food safety, labour conditions and environmental impact) has resulted in a number of standards, codes of practice, regulations on food safety. For example, a limited definition of GAP is used within established codes of practice for food safety and quality under *Codex Alimentarius* to minimize or prevent the impact of contamination of food products. In this Codex GAP is defined mainly with respect to the use of pesticides and sanitary issues. Currently standards for carbon foot printing food and non-food are being developed as part of competition profiles and to inform consumers.

On the one hand, such standards can act as a barrier for producers to enter markets, especially export markets because compliance with standards requires not only technical capacity and skills at producer level, but also the institutional capacity for their implementation and auditing. On the other hand, compliance with standards may offer opportunities for producers for increased market access or even market premiums. The various drivers of GAP and the consequences are discussed in Chapter 3.

In all standards, the underlying assumption is that the standard codifies some form of good practice at farm level. Although the general scope of GAP is clear, i.e. from production up to the farm gate, there is little common ground in these codes as to how a 'good' practice is defined. GAP is used to refer to a wide range of elements, from monitoring of pesticides use and reduction of ammonia emissions, to post-harvest handling and labour conditions. To provide guidance on the development of common principles of GAP the FAO has recognized eleven groups of resource concerns and practices. Within these components detailed management guidelines can be prepared for individual farming systems and agro-ecosystems (FAO, 2007a):

- Soil
- Water
- Crop and fodder production
- Crop protection
- Animal production
- Animal health
- Animal welfare
- Energy and waste management
- Human welfare, health and safety
- Wildlife and landscape
- Farm business management

The components that need to deliver on the various GAP targets are, however, not clearly defined. GAP has been a top-down process based on the concerns of governments, NGOs and the private sector but the challenge remains to create the link between the objectives of GAP and operational management. Clear indicators and thresholds to guide field level management and report and monitor the process in achieving the objectives defined in GAP are lacking for most schemes.

# 1.2 Background to CSA

Climate Smart Agriculture seeks to support countries in securing the necessary policy, technical and financial conditions to enable them to sustainably increase agricultural productivity and incomes, build resilience and the capacity of agricultural and food systems to adapt to climate change, and seek opportunities to reduce and remove GHGs in order to meet their national food security and development goals (FAO, 2012).

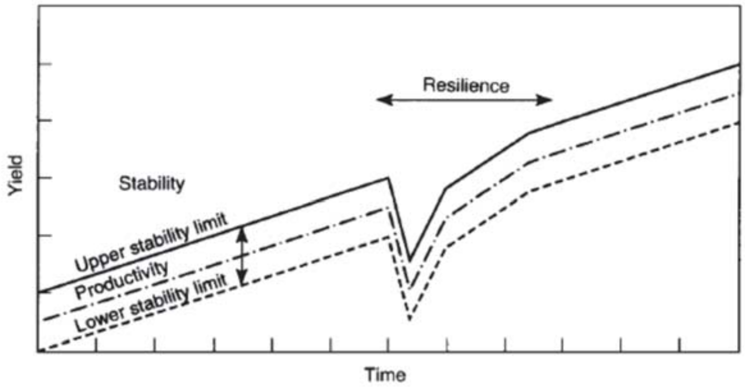



*Figure 1. Production, stability and resilience (from: Fresco & Kroonenberg, 1992).*

Keeping agricultural production in pace with the increasing demand is for many developing countries a key priority. Increasing and stabilising agricultural production has been focus research and recently regained political momentum. Directions on the complex issue off reconciling productivity and environmental goals have been proposed by e.g. Evans, 2003; Godfray *et al.*, 2010 and Spiertz, 2012. The key messages are too look for knowledge-based context specific solutions and develop a science and policy agenda to conceptualize and operationalize sustainable intensification. CSA links to these priorities and stresses the importance of climate change as a driver of change for agriculture and at the same time acknowledging the role of agriculture as a driver of climate change. The latter two points are discussed briefly.

The effects of climate change vary among systems, sectors and regions. Agriculture in temperate zones may benefit from temperature increase whereas agriculture in tropical regions will predominantly be negatively impacted. Climate change is mainly felt via increased temperatures and changing rainfall patterns, altering the risk of occurrence of droughts, flooding and extreme high temperatures. Rising $CO_2$ levels will have a positive effect on crop yields. In addition to these direct impacts climate change will also be felt via indirect effect, for example sea-level rise will increase salt water intrusion or climate changes induced changes in abundance and frequency of pest and diseases that can have a distinctive impact on crops yields.

Adaptation strategies will be required to counteract or exploit possible benefits of climate change. Given the location specific vulnerabilities, impacts and adaptive capacity CSA will need to be developed in location-specific contexts and conditions. The adaptive capacity of agriculture to respond adequately to climate change, however, differs depending mainly on available natural, financial and human resources.

Part of adaptation is dealing with shocks in changing ecological and socio-economic conditions. Resilient farming systems that have the ability to deal with shocks and surprise and that deliver stable and high production levels are needed to achieve food security. In agriculture, resilience is a component of sustainability (Fresco & Kroonenberg, 1992). Resilience in this study is the ability of a system to absorb changes in ecological conditions (climate, soil fertility, pest and diseases, water availability) that may cause (temporary) loss of production and restore production levels after a disturbing event (see Figure 1).

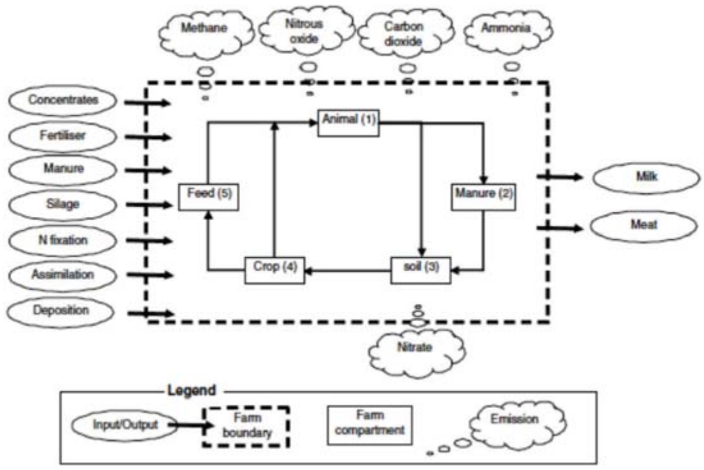



*Figure 2. Carbon and nitrogen flows in a ruminant livestock system (from: Schils et al., 2005).*

*Box 1. The evolving concept of csa (fao, 2012).*

CSA seeks to support countries in securing the necessary policy, technical and financial conditions to enable them to sustainably increase agricultural productivity and incomes, build resilience and the capacity of agricultural and food systems to adapt to climate change, and seek opportunities to reduce and remove GHGs in order to meet their national food security and development goals. CSA is site specific and takes into consideration the synergies and trade-offs between multiple objectives that are set in diverse social, economic, and environmental contexts where the approach is applied. CSA builds upon sustainable agriculture approaches, using principles of ecosystem and sustainable land/water management and landscape analysis, as well as assessments of resource and energy use in agricultural and food systems. Innovative financing mechanisms that link and blend climate and agricultural finance from public and private sector are a key means for implementation of CSA, as are the integration and coordination of relevant policy instruments. The adoption of CSA practices at scale will require appropriate institutional and governance mechanisms to facilitate the dissemination of information and ensure broad participation.

Besides being impacted by climate change agriculture contributes to climate change via emissions of GHGs notably via livestock and fertilizer use. Looking for low emissions development pathways adds to challenges faced by agriculture. Climate smart agriculture aims at combining the role of agriculture in food production including adaptation measures and at the same time reducing the GHG intensity of the harvested product.

The actual activities and efforts needed to reach an appropriate balance between food production, adaptation and mitigation will strongly depend on the conditions under which the farmer has to operate.

Because of the complex nature and diversity CSA is without any clear criteria and thresholds. The concept aims at mainstreaming climate change concerns into development and food security policies, considering both adaptation and mitigation. Management scales vary from field to landscape. In essence CSA is climate inclusive decision making at all levels. Identification of the means to achieve CSA goals and of the possibility to link CSA and GAP is context-specific. Therefore, in this study we focus on different case studies to study the possibilities to link CSA and GAP and to identify institutional barriers that needs to be lifted and policy recommendations required to realize these options identify critical decision points.

## 1.3 Cross cutting issues

Beside the overarching concepts of sustainable development and food security in which CSA and GAP will have to be worked out some issues like water, health and gender require special consideration.

Water is for agriculture an important production factor. Acknowledging the integrative nature of water is essential in evaluating mitigation and adaptation options for agriculture. Water management at field and farm level will have consequences for water quality and quantity at higher scales at the same time water availability for agriculture will depend on other users.

Changes in agriculture will affect the livelihoods of the rural population in various ways, to avoid imbalance or bias in approaches and outcomes participatory and gender-sensitive approaches need to be applied when addressing and implementing CSA.

# 2. Framework

The importance of agriculture in sustainable development of developing countries is obvious. Moreover food security remains a top priority for many countries. In any CSA strategy priority is to address development needs linking to on-going development plans and policies on food security.

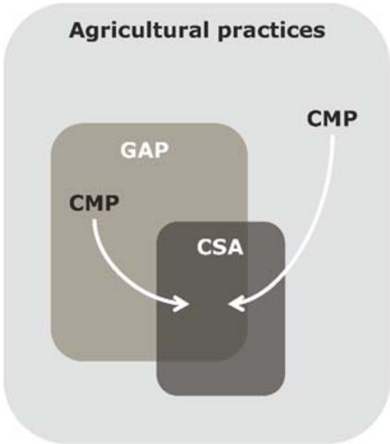



*Figure 3. Linking of Current Management Practices, Good Agricultural Practices and Climate Smart Agriculture.*

Shaping the transition from current management practices (CMP) to CSA/GAP management will in require the alignment of farm level goals and objectives with CSA/GAP. Operational farm and field management needs to be adjusted to reflect the new goals and objectives. In Figure 3 this transition is depicted, please note that there is a possibility that agricultural practices associated to CSA and GAP will not have a subset. A major challenge is to link operational management and the desired effects requested by CSA and GAP, so far clear indicators and thresholds are lacking.

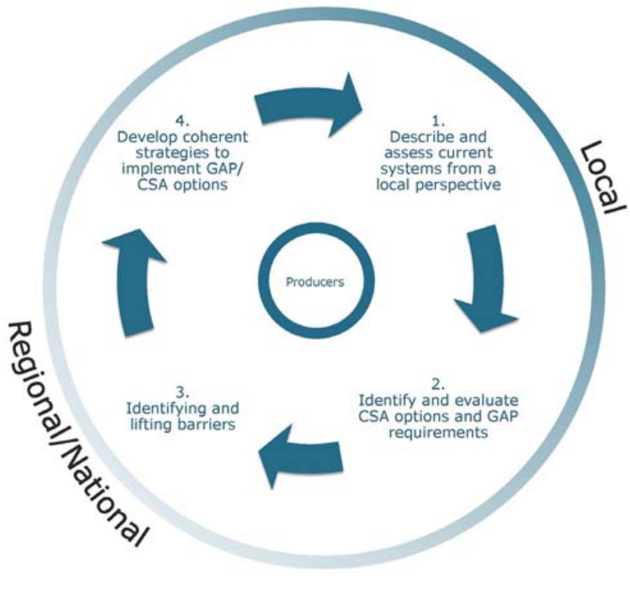



*Figure 4. Framework for developing Climate Smart Agricultural strategies.*

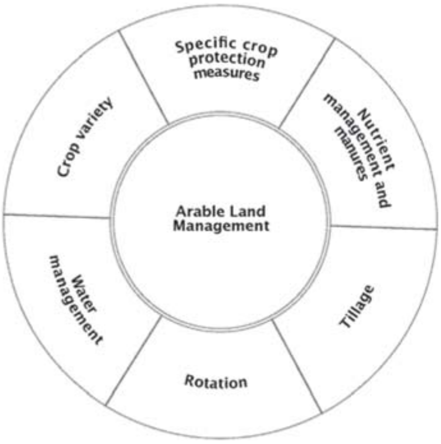
The framework identifies four steps (see Figure 4) to make the transition from current management to GAP/CSA oriented management. The first step is to assess the existing production systems and from a local perspective. Second, relevant GAP/CSA practices are identified including potential mitigation options. Third, the identification and lifting of potential barriers that may hamper the implementation of GAP/CSA practices is needed. The fourth step is the development of strategie s that enable the implementation of appropriate GAP/CSA measures by farmers.

## 2.1 Describe and assess current systems

The local context shaped by history, culture, socio-economic, legal and biophysical characteristics resulted in characteristic agricultural systems and practices. Acknowledging the local specific character of agricultural systems the framework for developing GAP/CSA activities begins with an assessment of the current agricultural system and their vulnerability to climate change. Understanding of the current and expected future situation forms the basis for the identification of options to increase and stabilize productivity and to develop potential adaptation and mitigation options. Baseline studies can serve as reference material for the effectiveness and efficiency of activities aiming for stable and high production levels, reduced vulnerability and increased resilience and emission reductions.

Management is the instrument for farmers to achieve production, socio-economic and environmental goals. Starting from acquiring inputs, sowing, soil, crop and water management and ending at harvesting and selling of the end product farmers in arable systems follow this sequence annually.

a.




b.


*Figure 5a. Management categories in arable farming and Figure 5b. Management options in dairy farming.*

Obviously in perennial systems the sowing will not be an annual event. In dairy farming management options will not per se follow a sequential path. In Figures 5a and 5b the broad management categories for arable and dairy farming are presented. The actual management activities will be worked out for the case studies.

## 2.2 Identify and evaluate CSA options and GAP requirements

The key issue in this step is to identify options to move from current management to management that is inline with CSA and GAP requirements. For both CSA and GAP maintaining or increasing production levels ensuring that farm income and food security goals are not undermined are important provisions.

How to comply with GAP will vary depending on the targets and priorities of the relevant GAP. Governments, industries or NGOs define GAPs targets. These targets will differ not only per stakeholder but may also per location and system. For example GAPs may relate to sanitation, health, environmental, biodiversity or a combination but even for a specific GAP actions will strongly depend on the local conditions. Changes needed for current management are therefore not only GAP but also case specific.

CSA connects to climate change by addressing the impacts (adaptation) and the GHG emissions of agricultural practices (mitigation). Adaptation to climate change is an intrinsic part of medium and long term development planning. Mitigation is a choice to take responsibility to move towards more sustainable production systems. As with GAP also CSA options are location and system specific.

Based on the description of the current field management and the specific GAP and CSA targets an array of potential GAP/CSA options can be identified. These options will need to be evaluated with respect to their contribution to food security, mitigation and development objectives. Such evaluation is needed to identify synergies and trade-offs. How to deal with trade-offs, e.g. production vs. GHG emissions, will strongly depend on national, local and value chain stakeholder priorities, the prioritisation can be made in consultations with relevant stakeholders.

In addition it has to be noted that effects of changes in management are not instantaneous or independent of each other. Nutrients and water provided during the growing season will have a direct impact on yield levels. But increasing soil organic carbon will require a long-term commitment of increased input of organic materials but a single event of disturbance via e.g. soil tillage has the potential to release part the stored carbon. Coordination at landscape or watershed level is needed to account for spatial effects of management and maximise success. Especially for water management interventions at field or farm level will need to be backed up with higher scale action.

## 2.3 Identifying and lifting barriers

The identification of barriers to adoption of identified GAP/CSA options is a critical one, as the adoption will determine the success of options in practice. Barriers may be related to finance, availability and access to technology or knowledge but often will include a mix of various factors including institutional, financial, cultural, legal, gender and organizational. Most barriers have a strong local presence but can also originate from regional or national arrangements.


*Figure 6.* *Examples of barriers to adoption.*

Understanding the nature of the barriers is needed to formulate appropriate policies and actions to overcome or lift the barrier so creating an enabling environment for the adoption at farm level. Insight in the costs and benefits of GAP/CSA forms the basis for developing policy strategies to support and enable adoption of promising GAP/CSA options by farmers.

In this study the barriers are classified using the livelihoods framework (Carney *et al.*, 1998). The availability and access to the five capitals or assets (i.e. natural, human, physical, financial and social) provide options to farmers to shape their livelihood.

Creating an enabling environment requires a multi-scale assessment in which the options to lift barriers are addressed in an integrative manner.

## 2.4 Develop coherent strategies to implement GAP/CSA options

The implementation of GAP/CSA options at farm level can be simple and executed at the field and farm level. No-regrets measures at farm level can be found in increasing resource use efficiencies and will have in most cases a positive impact on yields, farm income and reduce the negative effects like emissions of N to the environment.

Creating the enabling environment will be more difficult, finding the right stimuli for farmers and partners in the value chain to align to GAP/CSA practices will require a joined roadmap and commitment by all stakeholders including policy makers, private sector and producers.

This study will concentrate on options at the field level and identify processes needed in the value chain and policy context.

# 3. Certification schemes and standards in agri-food sector

Good agricultural practices (GAP) are embraced in a range of certification schemes and standards adopted by the agri-food sector. A historic overview of these schemes helps understand why these schemes emerged, how they are used and whether climate smart agriculture (CSA) is integrated into existing standards and is further necessary.

This section provides an overview of the standards, their modes of governance and the main players. It highlights that there is a wide proliferation of standards and certification schemes in the agri-foods sector have evolved in the last few decades. These range from voluntary to mandatory schemes and include private and voluntary schemes, market-based private and public standards. Following (Jongeneel & Herzfeld, 2012), certification is defined as the (voluntary) assessment and approval by a (accredited) party on a (accredited) standard. While the terms 'standard' and 'scheme' are sometimes used interchangeably, the distinction is important.

Private food standard (PFS) schemes comprise a standard and the governance structures and organisations involved in certification and enforcement. They range from individual company, to collective schemes on a national and international level. In contrast, to private standards, public standards schemes are those framed by a regulatory system and occurring on a national and/or regional level, such as the European Union and voluntary in nature. They are often based on mandatory regulations specifying food hygiene, production standards, such as pesticides, fertiliser and production emission limits and food and packaging labelling voluntary labels and standards.

The first standards for agricultural commodities arose in the 1940’s for organic agriculture. These standards were systematised with the establishment of the International Federation of Organic Agriculture Movements (IFOAM) in 1972. The IFOAM served as a mechanism for communication among what were then many separate initiatives. Since then, many other standards have emerged, following diverse pathways. Some standards have emerged as a response to a series of crises around food widely publicised in the media in the late 1990’s and early 2000’s, with consumers and governments placing pressure on retailers and food manufacturers to make their suppliers liable for the safety of their products, notably through the development of standards for good agricultural practices (GAP). Among the most well-known GAP certifications are the USDA GAP certification and EUREGAP or Global GAP certification organisation, good manufacturing practices, social and environmental impacts (Chan & Pound, 2009), demonstrating this through traceability schemes and a requirement that suppliers are certified (Amekawa, 2009).

Commodity-based 'roundtables' emerged in the mid 2000’s with a slightly different approach to standards development. Where standards systems had previously been focused on sectors (e.g., fisheries, forests, agriculture) or on issues (e.g., child and slave labour and the economic viability of small scale producers), these new roundtables represented a strategy by NGOs, such as World Wildlife Fund (WWF), in particular to develop standards based upon ethical premises, and potentially certification systems, for specific commodities that had the most impact on the environment. Commodity roundtables were initiated for palm oil – the Roundtable on Sustainable Palm Oil RSPO) (2004), the Round Table on Responsible Soy Association (2006) (RESOLVE, 2012), the Better Sugarcane Initiative (2007), the Roundtable for a Sustainable Cocoa Economy (RSCE) in 2007 and the ICO Round Table On Equitable Trading And Coffee (2004). This follows an increasing trend in globally to use multi-stakeholder public-private and support partnerships to solve persistent environmental and social problems in agro-food commodity chain (Bitzer, 2012; Van Dijk, 2012; Vermeulen & Kok, 2012).

Other standards have emerged focussing on climate, and specifically on carbon. The Voluntary Carbon Standard (VCS, 2007) is a voluntary carbon offset programme launched in 2007 by the Climate Group, the International Emissions Trading Association, the World Economic Forum, Global Greenhouse Register and the World Business Council for Sustainable Development. It includes guidelines for the development of projects in the agriculture, forestry and other land use sectors.

*Table 1. Overview of selected standards.*

| Standard | Fair Trade (FLO) | UTZ Certified 'Good Inside' | 4C Association | Organic | GlobalGAP |
|---|---|---|---|---|---|
| Main objective | Improve position of farmers in trade with a guaranteed minimum price as main attribute. Focus on development/ poverty alleviation | Achieve sustainable supply chains, meeting needs of farmers, industry and consumers | Baseline standard to improve situation for producers, workers, rural communities, trade and industry, consumers and the environment | Develop standards for organic agriculture and facilitate its adoption. Unite the organic movement worldwide | Food safety issues, improving natural resources use and working conditions, creating new market opportunities |
| Start launch | 1988 | 1997 | 2004/2007 | 1972 | 1997 |
| Initiator | Social movement/NGO | Firm (Ahold Coffee company) in cooperation with Guatemalan coffee supplier | Government / industry | Social movement / NGO | European retail associations |
| Commodities | 18 different product categories, including coffee | Coffee, cocoa, palm oil and tea | Coffee | Wide range of agricultural commodities, including coffee, dairy, potatoes | Fruits and vege-tables, Combinable crops, coffee, tea, dairy, pigs, poultry, cattle and sheep, turkey, aquaculture |
| Target Group | Small farmers organized in cooperatives | Big and medium sized estates | Coffee producers of all sizes | Coffee producers of all sizes | Producers and Suppliers |
| Governance structure | FLO is umbrella organisation whose membership consists of fairtrade producer networks and 20 labelling initiatives (eg, Fairtrade Foundation). FLO Board of Directors represents different stakeholders and regions and is elected by General Assembly which is open to all members | Not for profit organisation governed by Board of Directors | Governed by the General Assembly made up of all Members (producer's chamber, a trade and industry chamber and a civil society chamber). In addition, there is a Council, Executive Board, Technical Committee, Secretariat and Mediation Board. Each are represented by the various association members. | International umbrella organisation (IFOAM) sets international standards and accredits national certification bodies, who define national standards which are aligned to IFOAM basic standards. | Governed by Board of Directors. The standard receives rigorous review and undergoes improvements on a 3 to 4 year cycle to ensure the most up-to-date market developments. |
| Who sets the standard? | Fairtrade Labelling Organisations International (FLO) Standards Committee, in which stakeholders from FLO's member organizations, producer organizations, traders and external experts participate. | Utz Certified. Standard reviewed every year by producers, agronomists and certifiers. | ISO/IEC Guides. Standards are continuously improved. | The International Federation of Organic Agriculture Movements (IFOAM) defines basic standards. For international recognition, national/ regional certification bodies need to align their standards with the IFOAM basic standard. | Sector Committees are responsible for technical decision-making on elements of the standards that are relevant to their sector. Public consultation as part of standard setting process. |

| Standard | Fair Trade (FLO) | UTZ Certified 'Good Inside' | 4C Association | Organic | GlobalGAP |
|---|---|---|---|---|---|
| Who monitors/ audits? | FLO-CERT GMBH, an independent international certification company responsible for inspecting and certifying producer organisations and traders. | UTZ approved independent certification bodies (mix of local and international organisations). | Independent third-party companies that are accredited against ISO/Guide 65 or the equivalent. | Mix of public and private inspecting organisations. | About 150 third-party accreditation bodies. |
| Are GAP used? | yes | yes | yes | yes | yes |
| Environmental issues | Adhere to standards on reducing agrochemical use, reduction/ composting of waste, maintaining soil health, reducing water use and contamination, prevention of fires and avoidance of GMOs.<br>No specific guidance to Energy Conservation. | Minimise soil erosion, minimise use of agro-chemicals, integrated pest management, minimise water and energy usage, reduce contamination of water resources, no deforestation of primary forest, use of native species, protection of endangered species. | Elements of Soil, Biodiversity Water, Energy and Air conservation are addressed but require stronger rigorous details and guidance | Standards banning use of synthetic herbicides, fungicides, pesticides, and chemically treated plants. Minimal use of synthetic fertilisers only as part of integrated system. Restrictions on land clearing/soil management. Requirements to preserve local ecosystems including setting aside conservation areas. Water conservation is addressed via irrigation management strategy only and requires improvement | Soil, Biodiversity Water conservation; Integrated waste and crop by-product management are well addressed. Energy and Air conservation are less rigorous in its details and guidance. |
| What climate related actions? | Strict environmental standards, climate change workshops, training funding, Fairtrade Premiums are invested carbon projects on farm level. Stronger focus in FairTrade Africa. | Translating environmental standards into adaptation and mitigation measures, developing carbon footprint measures. | Capacity building on climate change adaptation and mitigation. Facilitated access to climate data. Early warning systems for extreme weather events are supported and facilitated. Targeting greenhouse gases stored in the coffee ecosystem are kept at the same level or increased. On-farm emissions are minimized. | None specifically | None specifically |
| Further info | www.fairtrade.net<br>www.fairclimatedeal.net | www.utzcertified.opg | www.4c-coffeeassociation.org | www.ifoam.org | www.globalgap.org |

The Gold Standard is currently the only independent standard and label globally for emission reductions projects under the Clean Development Mechanism (CDM), Joint Implementation and Voluntary Carbon Market. It aims to ensure that carbon credits are real and verifiable and make measurable contributions to sustainable development. It allows carbon credits generated by new and existing initiatives to be bought and traded by countries that have a binding legal commitment according to the Kyoto Protocol.

An overview of the main elements of selected standards which use GAP is provided in Table 1. This table highlights the diversity of objectives, the different stakeholders who driven the initiation of standards. Despite this, a common choice in the governance structure- with members and observers represented in governing boards. Standards cover a wide of commodities, although there is a focus on tropical and consumer cash crop commodities. The focus of standards on target producer groups differs widely, depending on the peculiar socio-economic contexts in which these crops are grown, and encompasses small to large scale farmers, from small holdings to plantations.

Next section elaborates on the role of stakeholders in setting up standards. The rise in private food standard schemes is seen to have precipitated a shift in responsibility from what used to be the domain of the public sector to third-party certifiers and the stakeholder organisations involved in certification schemes (which generally do not include the public sector, but include the private sector, NGOs and producers).

## 3.1 Roles of stakeholders in agri-food standards and GAP

The myriad of agri-food certification schemes have brought together a wide range of organisations of many types: farmers and producers, business in the agro-food value chains, researchers, sustainability and social advocates and lobbyists, civil society and non-government organisations, and governments. A multi-stakeholder approach to developing and implementing standards has created space for cooperation but also strongly depends on the level of collaboration and negotiations, for example, to agree feasible standards for improved production practices (RESOLVE, 2012). Many of these organisations also play more diffuse roles in developing, shaping, monitoring, and working with standards and certification systems, in accordance with their particular capacities, goals, and theories of change.

This section highlights that the processes of defining good agricultural practices in agri-food standards are complex. There are many actors shaping and defining what are 'good’ agricultural practices and for whom they are good (farmers, consumers etc.). This occurs at many different levels and at different times and points in the cycle of development, implementation, use and evaluation of standards. A tendency towards 'top down' definition of standards can be seen: that is, standards are defined by certification bodies, international organisations and consultative groups including experts, with some reference to members i.e. producer groups, rather than being bottom up (from the farmer/producers). The role of the government has often been absent or indirect in standards themselves, although many elements of standards are built around mandatory national and international food quality and safety regulations. However, an increasing tendency for governments, particularly in developing countries at the consumer end of agri-food chains, to be indirectly involved, for example though partnerships and setting guideline, is apparent.

**Standard-setting organizations**: create and adopt standards on different levels and include public and private sector organisations. These organisations can be engaged by policymakers. Global standards setting bodies include the International Organisation for Standardisation (ISO). ISO is a hybrid body composed of public and private national standard setting bodies that is an international NGO that develops standards across a wide range of areas and sectors, from product specifications through to management systems. The technical work of ISO is decentralised, carried out through a hierarchy of technical committees, subcommittees and working groups. Participants in these committees include representatives from industry, research institutes, government authorities, consumer bodies and international organisations. The ISO has reviewed how ISO standards can help towards addressing climate change (ISO, 2010). The report does not discuss specific agricultural practices but sees a way forward to supplement professional and personnel standards, for example, ISO 14066, with additional competency requirements for practitioners in for example, the agriculture sector, and to incorporate GHG accounting in product level and supply chains.

The Codex Alimentarius Commission is another global standards organisation, established in 1963 to develop food standards, guidelines and related texts as part of the Joint FAO/WHO Food Standards Programme. It now sets standards on food quality and safety, including food commodity standards and codes of hygienic or technological practice. It also evaluates pesticides, food additives and veterinary drugs and establishes limits for pesticide residues and guidelines for contaminants.

On a national level, an example is the Ethical Trading Initiative (ETI), a tripartite standard setting organization with government, businesses and trade union representation in the United Kingdom. On a sectoral level, an example is the ISEAL Alliance, an international non-profit organisation that codifies best practice for the design and implementation of social and environmental standards systems. ISEAL Alliance members are social and environmental standard setting and certification bodies, committed to compliance with ISEAL Codes of Good Practice. ISEAL and its members define what good practice is for the sector and by influencing how external stakeholders consider and engage with credible standards systems. Since 2004, ISEAL has been facilitating international consultations to determine what good practice should look like for voluntary standards systems. This aims to develop and maintain an evolving suite of credibility tools that support the effective implementation of voluntary standards systems. Various Codes of Good Practice each contribute to that goal, such as Codes of Good Practice focused on standard-setting procedures, measuring impacts of standards systems and verification practices.

**Research and universities**: there are many universities and research organisations, especially those that work in conjunction with local extension services in developed and developing countries, that offer GAP. These organizations for example, provide training and advice on GAP and may assess how well a farm's current production practices meet GAP standards and government standards (for example, the USA Food and Drug Administration). For example, the in the USA the University of California – Davis, University of Maryland and Family Farmed offer guidance and a format to create a Food Safety Plan. The Joint Institute for Food Safety and Applied Nutrition (JIFSAN) in the USA, a multidisciplinary research and education program jointly administered by the FDA and UM, published 'Improving the Safety and Quality of Fresh Fruit and Vegetables: A Training Manual for Trainers' and the JIFSAN Good Aquacultural Practices Manual.

**NGOs, consumer and worker representatives:** play an array of roles in standards. Foundations and civil society organizations have in the past taken the lead into the formation of multi-stakeholder standards and certification systems (which themselves were often established as NGOs) leading market campaigns to engage consumers and create pressure for certification (RESOLVE, 2012). Examples of such civil society organizations include environmentalist groups, faith-based associations, trade unions, animal rights movements and other organizations involved in social progress. Their ultimate objective has been to promote and reward sustainable or ethical business practices. Standard-setting NGOs may themselves be umbrella organizations of smaller NGOs, each with their own constituencies. By mobilizing coalitions of producers, manufacturers, retailers, scientists, and sustainability advocates, NGOs and foundations have helped to create space for collaboration and negotiations that seek agreement on feasible standards for improved production practices. These organizations have roles in developing, monitoring, and working with standards and certification systems. When these goals diverge, NGOs often realign their activities around other strategies (RESOLVE, 2012).

**Businesses** (producers/retailers/wholesalers/exporters): are involved in the creation, proliferation, implementation and licensing of standards. Companies often seek to gain competitive advantage through using certification. Businesses play other roles when they develop their own standards. Businesses are key players in scaling up standards and certification systems. They are in an influential position driving innovation and continuous improvement. Exporters are in a good position to finance and maintain compliance systems, and have considerable vested interest. The importance of exporters as gatekeepers to external markets and key actors in developing countries has been emphasized by (Gibbon, 2009) and by (Henson *et al.*, 2009). Businesses in the form of auditing companies are also involved in auditing and verifying if standards are met, who may verify at individual farmer, producer organisation and corporate level.

**Small scale farmers/producers**: are major actors involved in the implementation and revision of standards. The main 'trigger' for farmers to adopt and implement GAP, has been through private sector and supply chain demand for the 'assurance' (certification) that drives the implementation and acceptance of GAP based schemes. This is because consumers and business to business buyers require assurances that farmers comply and deliver. Farmers and their organisations (cooperatives, associations, enterprises) have and do also use standards to secure access to markets. As a general rule, direct representation of producers in developing countries is most significant among standards organizations that formally institutionalize positions for these stakeholders. For example, Sustainable Agriculture Standard Committee of consists of 58 seats who represent a broad range of perspectives from across all areas of agriculture, including commodity producers; specialty crop producers; agricultural product processors and distributors; food retailers; environmental, labor and development organizations; NGOs; industry trade associations; government representatives; academics; regulators and certifiers[1]. Standards that do not have a formal structure specifying producer representation tend to have higher representation from upstream segments of the value chain - particularly from larger, corporate sector players.

**Governments:** governments and their agencies have played a critical role not only in creating an enabling environment for certification but in providing mandatory and complementing standards through regulations, policy frameworks and other measures that set minimum acceptable performance and ensure food safety and food quality (ITC, 2011). Insights into the different roles governments play in such certification constellations include:

- Facilitating: providing resources to facilitate the development of a standard, enabling legislation; strategic stakeholder dialogue; awareness raising among respective industry, consumers and producers (UNCTAD, 2006); incentives, subsidies, tax rebates; procurement policies; capacity building; supporting the dissemination and uptake of labels and certificates; facilitating national stakeholder dialogue (UNCTAD, 2006) and self-governing agencies (Carey & Guttenstein, 2008; Van Tulder *et al.*, 2004; Van Tulder & Van der Zwart, 2006). They may also facilitate linking national to international standards and organisations.
- Users: certifying own operations, explicitly requiring products purchased or imported to be certified to a specific standard or to be compliant with a certain standard's criteria. Governments have also become more directly engaged with certification by supporting or preferring certified products as part of government procurement programs.
- Supporting: encouraging suppliers to get certified to public and private standards by providing financial incentives, technical assistance and dissemination of information on new legislation in importing countries (UNCTAD, 2006).
- Endorsing: offering political support; publicity and praise are given to sustainability efforts, including endorsement (such as government adoption) of labelling; support for civil society initiatives and publishing of 'best practices' and providing infrastructure facilitating and measuring compliance (UNCTAD, 2006) (Carey & Guttenstein, 2008; Van Tulder *et al.*, 2004; Van Tulder & Van der Zwart, 2006);
- Standard setting: Governments have been involved in standards setting for voluntary standards, especially when these have implications, for example, for food quality and for international trade and competition. An example is the discussions about timber standards in use in the Netherlands (Vermeulen & Kok, 2012). According to Lui, 2009), using the example of the Africa Observer Project, supported by GlobalGAP, a German government agency: Deutsche Gesellschaft fur Technische Zusammenarbeit, and a UK government agency, Department for International Development DFID, participated in National Technical Working Groups. They also provided funding for innovative activities by public institutions such as Codex and OIE to take the leadership in developing transparent, non-discriminatory and science-based standards setting and to involve developing countries governments. Similar developments have happened in the coffee and cocoa sectors where the Dutch Sustainable Trade Initiative (IDH), a government supported initiative, has been activity involved through its Cocoa Quality Improvement program in helping setting impact standards and developing measurement and reporting mechanism for sustainable cocoa generally and in the Dutch market. Adherence to and use of standards have also grown as confidence in the capacity of the government to manage risk (for example food safety and quality) has decreased by both producers, retailers and consumers (Fulponi, 2006).

[1] Sustainable Agriculture Standard, Committee Members https://sites.google.com/site/sustainableagstandards/standards-committee-members-1.

- Assessing: the impacts of standards and if they are tools that contribute towards wider public policies, such as food quality, development or trade (McDermott *et al.*, 2008). They may use their powers to regulate advertising and trade to keep misleading or unsupported claims about the impact of certification.
- Government agencies can and do look to certification programs for demonstrations of potentially useful and adaptable technologies, practices, and approaches.

Given the continued proliferation of public, private and firm standards, a number of these key groups of actors have called for and supported harmonization across standards, such as the ISEAL Alliance. This process has been supported by the development of 'meta systems' such as Good Agricultural Practice (GAP)- and similar meta-systems such as hazard analysis critical control point (HACCP) procedures, good manufacturing practice (GMP) and the International Food Standard (IFS)[2] for food safety management systems. A number of standards now incorporate these meta systems, such as the food safety management system ISO 22000 and ISO 9000 developed by the ISO, as well as those developed by individual firms (Hagen & Alvarez, 2011).

## 3.2 Climate smartness in agro-food standards

This section shows that there is a disconnect between good agricultural practices and climate smartness. The majority of standards are currently not explicitly climate smart. They do not explicitly address climate (RESOLVE, 2012), nor are a focus on either mitigative or adaptive farming practices. Climate smart issues are addressed more implicitly through the environmental focus of many standards in their recommended or obligatory GAPs. The environmental aspects which also have implications for climate change includes: biodiversity loss, conversion of natural ecosystems, pollution and degradation of natural resources - such as water, air and soils and attendant issues such as degradation, erosion and/or desertification.

Climate relevance and impacts are only just starting to become a consideration in standards. However, as good agricultural practices have environmental and social relevance and impacts, a number of these practices can also be used to enhance the climate smartness of schemes. One way of doing this as a first step has been to assess the climate (or carbon footprint of farming and other processing and operations) in a agrifood chain. Standards for specific commodities (RSPO for oil palm and Bonsucro for sugar) on carbon have started to do this, although this focus has not yet been translated into the agricultural practices that form the building blocks these standards, and debates are on-going about if GAP are the best way to be climate smart, or emissions targeting setting - leaving the agricultural practice open - is a better option. These discussions and approach to climate smartness reflect the entry point and preoccupation of different actors, mainly NGOs, private sector and large scale growers, rather than of small scale farmers and consumers. Table 1 also provides information on how environmental issues are addressed in a selected set of standards. For a handful of commodity specific standards (UTZ and 4C for coffee), steps have been made to make climate issues more explicit, by reviewing which GAP also have climate implications. The UTZ Certified's position paper (UTZ Certified, 2012) and website[3] affirms the their commitment to focus on climate change in agricultural supply chains, with investments and partnerships at every level of the chain and strengthening their Codes of Conduct to be more explicit on climate change such as in soil conservation, water management and protecting biodiversity (see Table 2). FairTrade will require the registration of greenhouse gas emissions savings in case initiatives are in place as of 2017. From 2014 onwards, FairTrade farmers are responsible for the waste disposal. They will be required to have designated areas for hazardous waste disposal and storage, in absence of a disposal system. FairTrade also launched a website that focuses on climate issues and thus manifests the intentions of FairTrade to keep climate adaptation and mitigation issues in focus (www.fairclimatedeal.net).

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[2] In 2002 German retailers developed the IFS and were joined in 2003 by French food retailers (and wholesalers) to develop of a normative document. The IFS standard is a uniform tool to ensure food safety and monitor the quality level of producers of retailer-branded food products. The standard apply to all steps of the processing of foods subsequent to their agricultural production and allows for certification at a the "foundation level' is considered as the minimum requirements for the international food industry and a "higher level' giving a superior standard.

[3] See http://www.isealalliance.org/online-community/blogs/utz-certified-sharpens-focus-on-climate-change, Retrieved 25 March 2013.

*Table 2. Climate change in the UTZ Code of Conduct.*

| How climate change is addressed | Relation to an effective response to climate change | |
|---|---|---|
| | Adaptation | Mitigation |
| Soil Management | Assessing and conserving soil fertility and securing a good soil texture supports climate change adaptation by increasing the soil's resilience against changes in precipitation and temperature. | On a more aggregated level conserving and improving soil fertility, delivers the base for sustainable yields. This can ultimately reduce the pressure to expand agricultural boundaries by making new land arable. Such land use changes are releasing large amounts of greenhouse gases. |
| Fertilizer use | By securing good soil texture and fertility the soil will be better prepared to cope with small temperature changes and, for example, prolonged drought periods. | Reducing the (relative or absolute) use of chemical fertilizers, emits less greenhouse gas through fertilizers production and in application. In some cases adequate fertilizer application may lead to increased amounts of chemical fertilizers applied. However, increasing productivity, emissions per unit of product will be reduced. Suitable record keeping can support the monitoring of emissions. |
| Integrated Pest Management and Crop Protection | | Appropriate application of chemical pesticides supports climate change mitigation, if resulting in a reduction of total chemical pesticides applied. Keeping records of applied pesticide amounts, types of application, can support the monitoring of greenhouse gas emissions on the farm. |
| Water Management and Irrigation | Protecting water streams and bodies near agricultural production zones especially in areas where decreasing amounts of rainfall are predicted. Conserving riparian areas and avoiding water pollution through agro-chemicals supports adaptation. By looking into adequate use of irrigation water, the Codes supports climate change adaptation. Water availability changes throughout the year, therefore careful handling of water resources is crucial. | |
| Post-harvest Product Handling (coffee) | Re-using coffee by-products supports adaptation, by using mulch, which retains moisture in the soil. Furthermore, the Code asks for wastewater treatment in coffee wet processing. This contributes to climate change adaptation by minimizing contamination of water streams and sources, no or less additional human induced stress on available water resources is achieved. | Re-using coffee by-products such as pulp, hull, husk and parchment as fertilizer, mulch or source of energy supports climate change mitigation, if resulting in reduced chemical fertilizer application or reduced deforestation, for example, for household cooking. Furthermore, the Code asks for wastewater treatment in coffee wet processing. This contributes to climate change mitigation as wastewater emits methane if not treated. |
| Natural Resources & Biodiversity | Maintaining or increasing forest cover in and around production areas provides organic matter for composting, supports water infiltration in soils and regulates local temperatures and partially rainfall patterns. Producing more than just one crop can support food security and potentially leads to the diversification of income sources, helping to hedge losses in yield quality and quantity caused by climate change. | Shading practices and reforestation mitigate climate change by removing greenhouse gases from the atmosphere and storing them in biomass. Limiting deforestation reduces emissions. |
| Energy Sources and Use | | Looking into energy efficiency, renewable energy and record keeping contribute to climate change mitigation by reducing emissions and providing data for monitoring these reductions. |

*Source: (UTZ Certified, 2012).*

Only one broad agricultural standard, the Sustainable Agriculture Standard, has gone a step further by explicitly creating add-on modules to make their standards and agricultural practices more climate smart. The SAN Climate Module (Sustainable Agriculture Network, 2011) continues promoting sustainable agricultural production through a specific voluntary set of climate change adaptation and mitigation criteria. The climate-friendly criteria reinforce existing certification criteria and provide additional value. Those farmers that achieve compliance with the module will be able to assess the risks posed by climate change to their farms and communities; analyse their practices to quantify and reduce the GHG emissions generated by growing, harvesting and processing activities; and increase the levels of carbon stored on their farms through the restoration of degraded lands, reforestation and improved soil conservation while also be able to better adapt to altered growing seasons and other conditions.

## 3.3 Ways forward: making agri-food standards climate smart

Even though only for example 8% of globally exported green coffee is certified (Giovannucci, 2010), the trends of certified products are exponential. Since the market of certified products is the fastest growing market segment in traditional (developed country) markets, implementing climate smart agricultural (CSA) practices through existing certification schemes seems inevitable. Many whole-farm standards (oriented at farming practices) already include good agricultural practices and thus converting 'good' into 'climate smart' seems as just one step ahead. However, climate smartness is currently not integrated into the majority of GAP in agri-food standards and these two steams of thought (GAP for environmental and social improvement and climate smartness) are largely separate. Even the major proponents of both of these systems, such as the FAO and the majority of standards using GAP, do not link the two. This reinforces the need for greater consistency between agriculture, food security and climate change policy-making and practice at national, regional and international levels.

Barriers to the adoption of climate smart GAP vary, and mirror general problems implementing GAP as part of standards and certification systems (Hatanaka *et al.*, 2005). These include difficulties to access land, a lack of land, problems of (climate smart or improved) seed availability, the need for technical assistance and training to implement given practices and capital and labour constraints. Further, implementation of a given practice needs to be assessed in the local context to minimize the risk of adverse impacts (Rainforest Alliance, 2011).

Smallholder farmer adoption of climate smart GAPs will only be realistic when they contribute tangible economic benefits to farm economics, such as reducing input costs, enhancing yields, and improving land management. There are a number of reasons why poorer farming communities in developing countries are at a particular disadvantage to be able to react to climate change. FairTrade names two important reasons: (a) Lack of funds and resources and (b) Lack of knowledge about alternatives (FairTrade, 2013). First, there is always a cost associated with a switch to different farming practices and poorer farmers often do not have the knowledge and money to support a switch. For example to combat reduction in water availability, irrigation methods can be changed to drip irrigation, but it is expensive. Poor rural areas often lack insurance and credit services. Second, switching away from what you know is inherently risky. Farmers can see the changes that are occurring but are unsure how to adapt to the changes. For example their extensive knowledge of the seasonal rains is no longer useful due to erratic weather, the increase/decrease in rainfall and/or an altered rainy season. Poorer farmers are less able to accept risk than the relatively better off and will tend to diversify towards lower risk and therefore (sometimes) less profitable activities. Thus standards which already place onerous costs (particularly short term costs) and who's benefits are either long term or not economic in the short term, may struggle to be accepted if further climate smart GAPs are not economically attractive.

The development of standards addressing climate change, adaption and mitigation, such as REDD (Reducing Emissions from Deforestation and Forest Degradation) and carbon have been lengthy, and the relationship with agricultural practices has only recently started to occur. For example, the UN Framework Convention on Climate Change has only recently decided to define parameters for how REDD will address incorporate on agricultural carbon by 2012 (RESOLVE, 2012). Certification programs that already address carbon and greenhouse gas emissions have tended to use different carbon calculators with different methodologies and boundaries and thus their role in the REDD debate could be strengthened when these methodological issues are clarified and addressed.

Integrating climate smartness into standards creates a non-tangible dimension of the a product's certification. As standards can be both a market differentiation and competition tool, as well as providing a level playing field, a clarification of their status in international trade is critical. The lack of clarity by World Trade Organization (WTO) on private voluntary labels may be a major barrier for adopting climate smart add-ons. Acknowledging their complexity and concerns about their negative influence on developing countries' and small businesses' ability to export, WTO members have been struggling with the question of how standards and labelling is used to inform consumers about environmental and social protection without jeopardizing or discriminating against these 'weaker' players. Opinions have been divided since discussions started on how to regulate production and process methods (PPMs) since the creation of the WTO in 1995. Little progress has been made towards an international agreement on how to deal with PPMs, with strong reactions provoked whenever PPMs are mentioned (Borregaard & Dufey, 2005). A particularly thorny issue in the debate has been the use of criteria linked to PPMs. WTO Members agree that countries are within their rights under WTO rules to set criteria for the way products are produced[4], if the production method leaves a trace in the final product, for example coffee grown using pesticides leaving residues in the beans. However, they disagree about discriminatory measures based on 'unincorporated PPMs' (or 'non-product related PPMs'), that is process and production methods which leave no trace in the final product. For example one cannot tell whether a coffee bean has been farmed sustainably or climate smartly simply looking at it. Thus a barrier is whether these certification standards are consistent with WTO agreements, as many countries, particularly developing country producers, argue that measures which discriminate between products based on unincorporated PPMs, such as in some standards, should be considered inconsistent with WTO agreements as constituting unfair trade barriers to export.

It is expected (RESOLVE, 2012) that the growing awareness and global attention to address climate change will mean that by 2020 certification programs will have to take account of the carbon footprints of agri-food product chains. Despite this encouraging scenario, to holistically address both sides of climate change and be climate smart, standards will need to move from a focus on mitigation to include adaptive options, which are linked to good farm and agricultural practices.

Research (Rainforest Alliance, 2011) has highlighted that a crop- and country-focus is needed to determine climate smart GAPs. Currently practices concerning shade cover and agroforestry are the most documented and evidenced, however additional knowledge on the relative carbon storage impacts across different gradients of shaded systems and for different countries is advised, with definitions of various types of agroforestry practices (e.g. simple production shade; complex production shade; hedgerows; boundary planting; complex rustic agroforestry) and also on the impacts of crop processing on GHG emissions.

New partnerships between standard setting organizations with partners, such as NGOs, governments and international organisations, has been shown to bear fruit in terms of creating new dynamics, modifying and extending standards. This has both generated more business and provided greater services to clients of the standard, and added-on new issues, such as climate smartness, in standards. Given the large number of major standard setting organisations which have not yet addressed the climate smartness of their schemes (e.g. ISO, IFS), there are major opportunities for up-scaling. Given the intense competition in the standard-setting business, climate smartness could be an opportunity for standards to differentiate them levels and to expand the product attributes covered by a standard.

Private and public standards can be mutually reinforcing when governments engage with private standard setting bodies and coalitions through international organisation such as the WTO, FAO, WHO and OIE in standard setting mechanisms. Examples of such initiatives are government efforts which promote standards through the Dutch Sustainable Trade Initiative, benchmark corporate social responsibility efforts, such as the Netherlands Transparency Benchmark. Public support has also been seen to go beyond regulation to providing facilitating, endorsing and

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4 http://www.wto.org/english/tratop_e/envir_e/labelling_e.htm#top. Retrieved 15 March 2013.

enabling environments in support of adoption of and compliance with standards, including technical assistance for their implementation, as part of aid-trade deals, based on examples from public private partnerships in the Netherlands (Braga *et al.*, 2010; Drost *et al.*, 2012). Another positive opportunity for government engagement is where local governments to strengthen the role of national legislation. In the case of the EU this has been done in twinning projects (e.g. introduction of cross-compliance system in New Member states) and between south-south country exchanges (RESOLVE, 2012). Donor agencies and development partners support for building the scientific and technical capacities in developing countries that would facilitate their compliance to food safety (and to climate smart practices) is another possibility for partnerships, where it translates prescriptive private standards into good practices. Examples of this are the work of the Centre for the Promotion of Imports from developing countries (CBI)[5] in the Netherlands and the FAO (Liu, 2007). The role of governments in producer countries is profound in developing obligatory regulations from voluntary standards, for example, in response to the chronic overuse and misuse of pesticides in agriculture, governments in Southeast Asia (Indonesia, Malaysia, Philippines, Thailand, and Vietnam) have introduced public GAP standards (Schreinemachers *et al.*, 2012).

Those interested in standards setting have a range of alternatives in how to make standards climate smarter, making it possible to adapt to the nature of a standard scheme and its products, location s and actors. One is to use a GAP approach and create clearly defined and verifiable criteria and associated climate smart practices that supplement or replace existing GAP. This can add value to a product and standard, and the benefits for its users, especially farmers, who should be able to better assess the risks posed by climate change to their farms and communities; analyse their practices to quantify and reduce their GHG emissions generated by growing, harvesting and processing activities; and increase the levels of carbon stored on their farms through the restoration of degraded lands, reforestation and improved soil conservation while also be able to better adapt to altered growing seasons and other conditions. A variant of this is to specify a range of practices, making some voluntary and other mandatory, particularly if they coincide with other environmental and/or social objectives of standards. An alternative is not to specify GAPs, but the emissions targets which could help to mitigate climate changes. This could involve offering a range of (proven) mitigative and adaptive practices which could help achieve targets. Monitoring and measuring may however be a practical problem of this approach. A third route could be a hybrid of targets and practices.

## 3.4 Findings

Climate-smart agricultural practices do already exist in standards. Standards offer a good possibility to out-scale and up-scale such practices further in developing country agricultural systems. However evidence of their effectiveness in mitigating climate change and increasing resilience and adapting to negative climate changes often still remains to be proven. Examples from different commodity based standards, such as coffee, cocoa, tea, oil palm and sugar, and general agricultural standards offer a range of models for how climate smartness can be assessed and different ways of implementing it into existing standards. The growing range of carbon based standards offer another possible route to address climate change in agricultural practices.

However, climate smartness is currently not integrated into the majority of GAP in agri-food standards and these two steams of thought (GAP for environmental and social improvement and climate smartness) are largely separate. Even the major proponents of both of these systems, such as the FAO and the majority of standards using GAP, do not link the two. This reinforces the need for greater consistency between agriculture, food security and climate change policy-making and practice at national, regional and international levels.

Signs have emerged however in the last two years of some cross-fertilisation between these fields. For example, a handful of standards have started to calculate and monitor their carbon footprint, others have assessed which good agricultural practices they currently embrace are climate smart, and one has actively added on climate smart GAPs. It is too early to be able to assess the implications of this for actors in the value chains of agri-foods, and if these

[5] http://www.cbi.eu/marketintel_platform/Fish-and-Seafood-/177443/trendmapping Retrieved 26 March 2013.

practices are really effective in being climate smart, reducing vulnerability, increasing adaptability and mitigating the impacts of climate changes.

The majority of voluntary and mandatory GAP schemes in standards are top down driven (i.e. from government, consumer and retailer) to farmers. This has implications for their uptake. If the incentives for farmers to adopt climate smart GAP are costly and involve long term payback, with farmers bearing the burden of additional certification costs, the longer term and non-direct financial benefits may be outweighed by the need for short term financial returns from farming. Thus making GAP climate smart as part of standards should also be economically smart, and not impose additional financial or technical burdens on farmers.

Integrating climate smartness into GAP thus means that the benefits on a global level from reduced GHG emissions also need to be demonstrated at the local, farmer level and be clear to those proposing and aiding farmers to implement such schemes into standards.

There is a clear need for the involvement of not just all the different business and producer actors involved in private standards, but other stakeholders to become more engaged. This is particularly so for governments from consumer, end-of the chain countries but also producer countries, on the impacts of climate smart GAPs. This includes the social-economic impact, implications for food safety, quality and security, and for competition and trade. The role of NGOs, consumer and work representative organisations and research community is also critical to make climate smart GAP work. Transparency, monitoring and impact evaluation are key aspects in making existing practices climate-smarter and developing new practices feasible and acceptable.

Governments and their agencies have played a critical role not only in creating an enabling environment for certification but in providing mandatory and complementing standards through regulations, policy frameworks and other measures that set minimum acceptable performance and ensure food safety and food quality. CSA strategies need to be incorporated into legal and regulatory frameworks if they are to be implemented. Strategies also need to take account of current legislation and regulations, where a strong role of government is expected. As standards become more and more international, a role for governments is to ensure science-based standards setting and the involvement of developing countries.

More detailed information can be found in Ingram *et al.*, 2013.

# 4. Case studies

The elements of GAP/CSA are context and location specific. We will use cases to explain and illustrate the elements of the framework. The focus will be on field and farm management.

The choice of cases studies reflects different crops and farming systems in developing and developed countries. The following guiding criteria were used to arrive a set of case studies. Need to build on existing studies and data sets and work within the boundaries of the available resources. Tap into the Wageningen UR network and projects to avoid time-consuming data collection. Look crop that contribute to food security via income security (cash) and nutritional security (food). Include crops based and livestock based production systems to capture a large range of adaptation and mitigation options. Aim at including perennial and annual cropping systems sequestration to capture differences in carbon management options. Aim at countries that have a link with the Netherlands via either the government or the private sector. Based on these guiding criteria the following cases were identified:

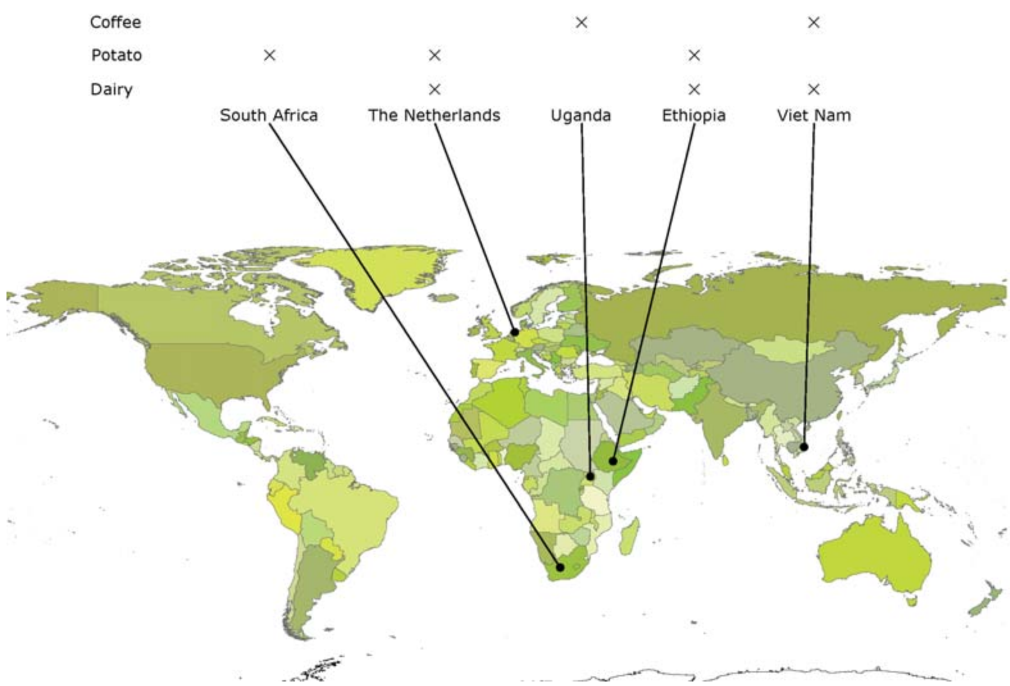


*Figure 7. Case study areas.*

The cases are partly based on-going or finished research projects and partly on expert knowledge. To reduce the length of this document the findings for the components on dairy and potato separate are summarized detailed information is available in (Groenestein *et al.,* 2013) and Hengsdijk and Verhagen (2013) respectively.

## 4.1 Dairy

Smallholder farmers using mixed livestock-crop systems dominate Kenyan dairy systems. The cattle not only gives milk and meat but in addition also provides insurance, a financial buffer and has cultural value. The animals are free ranging (grass, roughage) only some are given concentrate. Half of the farmers conserve feed for the dry season, but given the low feed quality the risk of undernourishment is high. The commonly used breed is a crossbred between local breeds and high-yielding cows. However given the low inputs the output of these systems, and in particular the output of milk, is low. Current strategies focus on increasing the outputs via improved and more efficient use of inputs and breeding of more robust animals.

Good agricultural practices specifically for dairy in Kenya do not exist for this study the FAO defined GAP is used. The FAO GAP is especially designed for developing countries and focuses on animal health and food safety. Climate change is expected, via higher temperatures and more erratic rainfall patterns, to be an extra stressor for the system and has the potential to lower the quantity and quality of feed and water and increasing risks for diseases. Disease is already a critical issue for the non-local breeds that are more susceptible than the local breeds. For example currently these introduced breeds already require a weekly tick treatment.

Identified strategies to overcome the problems which have a direct effect and are expected to have longer term positive outcomes are improved access to water via wells and introducing more adapted species and start breeding programs for productive animals that are less susceptible to diseases and can cope with hot and dry conditions.

The mitigation options in these low input mixed farming systems are low. Main entry point is manure collection and storage which could be improved to reduce nutrient losses to the ground water and atmosphere. Usually the manure is collected and used to fertilise vegetables and other crops. Losses from manure stored in the open outside the stables are large.

Farmers prioritise the following development activities: improving the breed by using artificial insemination, (semi-)zero-grazing, buying more cows, fodder production, improved feeding, feed conservation, improve skills and knowledge, and installing water at the farm. To provide extension services an institutional frame is needed, currently this is done via 'hubs' that combine a market and services aimed at dairy farmers. The identified development activities related to adaptation and mitigation can be integrated into the portfolio of these hubs. It is also clear that farmers prefer activities that bring short-term effect and profit.

Dairy production in CuChi Vietnam is characterized by smallholder mixed livestock-crop systems. The dominant cattle breed is a high yielding non-local crossbreeds. The systems in CuChi are zero grazing, grass is cut and carried to the animals. Prospects for dairy farming in Vietnam are positive; the demand from the growing population is expected to increase. To fulfil the rising demand increasing productivity and product quality are key elements. Climate change impacts will impact the production potential and future options of the dairy systems via drought and increased temperatures but also via coastal flooding and storms. Already farmers experience a drop in milk production related to higher air temperatures and have to cool their animals more than before. The Vietnamese government already subsidizes investments in cooling equipment.

Because of the high yield potential the crossbreeds are fed as much as possible. Unfortunately this results in low N efficiency with high N-losses to the environment. In addition manure management is very inefficient and nutrients are lost to the water systems.

Although at a first glance the dairy production systems in Kenya and Vietnam seem quite similar, for both are small holders, mixed farming, with high yield crossbreeds in a tropical climate. Both regions have a strong focus on production increase via improved breeds and feed. Some lessons can be shared for example the organisation of the production chain and the institutional framework in which government, farmers and researchers can work together to make innovations possible. But differences in for example vulnerabilities to CC, management, housing and manure handling do exist which prompt for tailored approaches and solutions.

In the Netherlands the milk chain is highly organised both control and transparency are key elements. The national and local governments work together with farmer's organisations and researchers to improve dairy production systems and the milk chain.

Current production level is high, issues related to dairy sector are pollution (mainly related to manure) and diseases. Dairy farmers in the Netherlands do not feel the urgency to adapt, as long as flooding risks are managed properly.

In fact higher air temperatures may even benefit the yields of feed crops. The case of 'De Marke' shows the possibilities of optimization, rather than the need for innovation concerning CSA in Dutch dairy production.

## 4.2 Potato

Except for the general guidelines for sustainable potato production in developing countries (Lutalido *et al.*, 2009) there are no good agricultural practices defined for consumption potatoes in each of the case study areas. Only the Biodiversity Best practice Initiative (BBI) in Sandveld provides a set of guidelines for good agricultural practices from a biodiversity point of view. Guidelines for good agricultural practices need to be location and context specific. Some of the guidelines go beyond the management at field level but also address farm and landscape levels. Especially in the Sandveld case, which is endangered by over-exploitation of groundwater resources and conversion of natural habitat by agriculture, the need to address the landscape level in GAP is evident. Results of the CSA/GAP framework applied in the cases further support the conclusion that location and context specific GAP guidelines need to be formulated with a broad spatial and temporal focus allowing to account for impacts of climate change.

In general, global potato productivity is expected to benefit more from an increase in atmospheric $CO_2$ concentrations than productivity is reduced due to anticipated changes in climate conditions such as temperature and rainfall (Haverkort & Verhagen, 2008; Wolf *et al.*, 2011). The effect of climate change on the frequency and severity of weather extremes affecting potato productivity remains highly uncertain. Some plausible, but hard to verify effects associated with climate change such as changes in abiotic pressures are also uncertain. Despite these uncertainties, the anticipated impacts of climate change in the case study areas show a very divers picture: A decline in ground water resources (South Africa), shorter and drier growing seasons (Ethiopia) and increased frequency of wet soil conditions (The Netherlands) are among the most important effects associated with the expected change in climate in each of the case study areas. Local potato producers will face these impacts and will have to adapt their current management practices to these new conditions. Acknowledging such potential climate impacts adds a dimension to GAP or reiterates the importance of sustainability aspects already addressed in existing GAP. For example, the water management guidelines in Sandveld's BBI to use water more efficiently are based on biodiversity concerns. The importance of these water management guidelines is further stressed by the potential impacts of climate change in Sandveld, i.e. the expected decline in ground water resources due to reduced recharge of groundwater reserves.

Based on the smallest yield gap of the three cases, potato production in Flevoland is most developed and is least affected by expected climate change. More rainfall during planting and harvesting may require adaptation of machinery to be better prepared for wetter soil conditions. However, changes in mechanization fit in the usual period of depreciation and renewal of machinery considering the time horizon of expected climate impacts. An expected shorter and drier growing season may require adaptations of the current system in the Rift Valley, for example, through the introduction of irrigation. Such adaptation would allow a fundamental change in the potato systems as it allows producing potatoes during the dry season. If water resources are available and used with care such a transformation of the potato system potentially could create synergy, lower biotic pressure in the dry season could result in higher potato yields. In terms of development, Sandveld takes an intermediate position but its current dependency on limited ground water resources and anticipated decline in ground water resources probably poses the largest adaptation challenge of the three cases.

The Rift Valley case shows that in the least developed case (largest yield gap) priorities primarily are related to the productivity attribute of CSA. Closing this yield gap will inevitable result in trade-offs among the attributes of CSA. Increasing potato productivity in the Rift Valley will require considerably more inputs, particularly (nitrogen) fertilizers, pesticides and mechanization. Inputs that all require directly or indirectly fossil energy and the higher input use will be, therefore, accompanied by higher GHG emissions per unit of land and initially also per unit product. The challenge will be to increase yield levels such that GHG emissions per unit of produce are more favorable compared to the current situation. The other case studies also include such trade-offs but not as prominent as in the Rift Valley. Research may be needed to identify possible trade-offs among CSA attributes of options. For example, changes in the type of mechanization may serve adaptation of potato cultivation in Flevoland to expected wetter soil conditions during planting and harvest. However, this option may also result in increased fuel use and GHG emissions. Such considerations can be made explicit by research resulting in better-informed decisions, which may differ depending on the local context and priorities.

None of the case studies shows immediate and large potentials to address the mitigation agenda of CSA. This is largely related to the biological characteristics of the potato. About 80% of the biomass is harvested while for most cereals this percentage is less than 50%. The potentials for conservation tillage as mitigation option in potato are limited: Potato crop yields are sensitive to proper soil preparation (Riley & Ekeberg, 1998), crop residues of the previous year hamper planting, while harvesting of the belowground potato biomass requires anyway disturbance of the soil. In an indirect way potato management can serve mitigation goals by more efficient use of fertilizers, irrigation water (energy use), pesticides and less field traffic. Also options that go beyond the spatial and temporal system boundaries of potato cultivation can contribute to mitigation goals, for example, through the inclusion of crops with a high residual carbon biomass in potato rotations.

In contrast with trade-offs among CSA attributes such productivity increase and mitigation some options present synergies. For example, potatoes have high fertilizer requirements but low utilization efficiency. Using fertigation with drip irrigation instead of sprinkler irrigation as in the Sandveld case has potentially benefits in terms of increased productivity, decreased water use (adaptation) and reduced nitrogen input (mitigation). It is important to grasp these opportunities in an early stage (low hanging fruit, or no-regret options), which may require high initial investments.

The three case studies Sandveld in South Africa, Flevoland in the Netherlands and the Rift Valley in Ethiopia differ in socio-economic development conditions, which explain largely the differences in institutional and financial barriers to make CSA options reality. The strong dependency on ground water resources in Sandveld will require collaboration between the agricultural sector, local water authorities and nature conservation organizations. In the Rift Valley Programmes to upgrade the skills and expertise of potato producers need to be matched by government initiatives to privatize the agriculture input supply chain, reform land use policies and facilitate financial institutions to invest more in agriculture. In general, CSA strategies should be integral part of the development agenda in developing countries such as Ethiopia. Last but not least the case studies show that an R&D agenda for CSA should go beyond the common call for crop species or livestock breeds adapted to projected climate conditions (e.g. Wollenberg *et al.*, 2012). Equally important for such an agenda is the identification of location-specific technical options and institutional and financial barriers to facilitate adoption of such options. Such options are not necessarily innovative from a global perspective as they often will have shown their suitability in other regions, and they should be the result of location-specific R&D agendas aimed at efficiency and productivity improvements as part of climate smart agriculture. The main contribution of CSA and the tested framework to GAP and development in general is that long-term thinking on productivity, adaptation and mitigation goals becomes an explicit and integrated component of sustainable intensification of agriculture.

## 4.3 Coffee

Today, coffee is a global industry employing more than 20 million people. With over 400 billion cups consumed every year, coffee is the world's most popular beverage (Kuit, 2004). Presently, coffee is grown in over 80 countries, it is a primary export for Uganda and Viet Nam while the US and Europe are the key importers of coffee.

The International Coffee Organization (ICO) is the main intergovernmental organization for coffee, it's mission is to strengthen the global coffee sector and promote its sustainable expansion in a market-based environment for the betterment of all participants in the coffee sector (www.ico.org, 2013). The link of the coffee traders with consumers is strong and sustainability has become part of the competitive force of brands and companies. This is also reflect in the wide range of schemes from bird oriented to producer oriented, to link to consumer groups. Most schemes apply to social responsible behaviour and reducing negative external effects of coffee production and are modelled between businesses (Ruben & Zuniga, 2011).

Key aspects of the value chain approach refer to mutual coordination amongst stakeholders regarding market access, improvements in product quality and batch consistency, and more reliable delivery. Delivery contracts tend to stipulate key conditions with respect to input use, good agricultural practices (GAP) for production and handling, product quality characteristics, production volumes, price and payment frequency.

In this report we will focus on two Robusta growing study areas:

1. Chu Se District in Gai Lai province in Vietnam.
2. Uganda Central district.

Coffee is for both countries an important export product and provider of jobs and income to large numbers of smallholders. For both cases we will draw from existing material made available via reports and papers.

Arabica (Coffea arabica) and Robusta (Coffea canephora) are the two major commercially grown coffee types. In general Robusta is the more forgiving crop whereas Arabica is more delicate. This is reflected in the growing conditions, Arabica prefers cool wet climates, rich soils mostly found at higher altitudes whereas Robusta is able to grow at lower altitudes, and endures harsher conditions. Robusta is also less susceptible to diseases. In economic terms Arabica gives higher returns and is favoured by the coffee processors. For both Arabica and Robusta qualities may vary strongly.

From Chapter 3 it is clear that there is no lack of GAPs in the coffee sector. The scattered nature of GAP for this sector however also makes it difficult to determine the importance for farmers. Climate change in coffee related GAPS is many addressed via the mitigation or carbon agenda, strongly hinging on the idea to obtain additional income via ecosystem services. Sometimes in combination with an adaptation strategy such as planting shade trees to avoid heat stress.

Because of the favourable temperatures and rainfall regimes coffee is predominantly grown in mountainous areas. Which are characterized by rapid and systematic changes in climatic parameters, in particular temperature and precipitation, over very short distances (Becker & Bugmann, 1997). Mountainous areas are among the most vulnerable to climate change. Projections of changes in precipitation patterns in mountains are however unreliable in most GCMs because the controls of topography on precipitation are not adequately represented (IPCC, 2007a). Elevation dependency of temperature is well known but using elevation as a proxy for temperature should be done with caution given the high spatial variability (e.g. McGuire *et al.*, 2012).

Laderach *et al.* (2008) predicted, using the elevation dependency of temperature, for Central America that climate change will shift the altitude range for coffee to higher elevations over time, with the optimal altitude shifting from 1,200 m at present to 1,400 m in 2020 and 1,600 m in 2050. Other studies in Uganda (Van Asten) indicate that areas below 1300 m may well become completely unsuitable for Arabica coffee production. In areas between 1300-1700 m, coffee will be severely affected if no adaptation measures are taken (http://www.newstimeafrica.com/archives/30048, 2013). Robusta may be a bit better of but still the overall picture will be comparable to Arabica. Besides the suitability of locations temperature also drives crop development, higher temperatures will quicken the ripening of coffee most likely leading to a fall in quality (Baker & Haggar, 2007).

In addition temperature increase will favour certain pests and diseases, e.g. the coffee berry borer, which currently has little impact over 1500 to 1600 m above sea level in many countries maybe move upwards (Bakker & Haggar, 2007). Likewise coffee rust will increase its height range. Coffee Berry Disease however, which requires milder temperatures to flourish, may tend to decline in importance.

Water is needed to break flower bud dormancy and induce fruit setting. Drought stress related to a dryer and hotter environment will inevitably lead to lower yields.

## Current and CSA management

The main management operations in coffee production systems are listed in Table 4.

*Table 4. Major management operations in coffee cultivation.*

| Management operation | Description |
|---|---|
| Variety selection | The genetic characteristics of varieties determine the production potential under given conditions, sensitivity to stresses (diseases, drought etc.) and market acceptance. |
| Mixed cropping | The practice of growing different types of crops in on the same plot of land. |
| Land preparation/ tillage /planting | The practice to prepare soil for planting. |
| Pruning | Pruning is done to create a well-balanced crop, with a well-aerated structure, and remove unproductive branches. |
| Water management | Water management including prevailing rainfall is one of the most important factors determining yield and quality of coffee. |
| Nutrient management | Proper nutrition is crucial in determining coffee yield and quality, as well as the ability of the crop to withstand pest, environmental, and other stresses. |
| Crop protection | The application of chemical, physical and biological methods to minimize the yield reducing effects from weeds, pests and diseases. |
| Harvest | The manual or mechanical removal of the berries from the tree. |

For farmers in the Chu Se District (Vietnam) a field book is kept as part of the PPP Project Quality and Sustainability Improvement of Robusta Coffee Production and Trade. This report provides and detailed account on field management in the region and including timing and amounts. The aims are monitor farmer management and assist farmers in the decision making process. Basis of the monitoring is the crop cycle starting with pruning and ending with harvest (see Figure 8).

Irrigation and fertilizer application are important measures that determine yield quality and quantity. Weeding efforts aim to reduce nutrient and water competition, and to some extent to reduce pest and disease pressures.

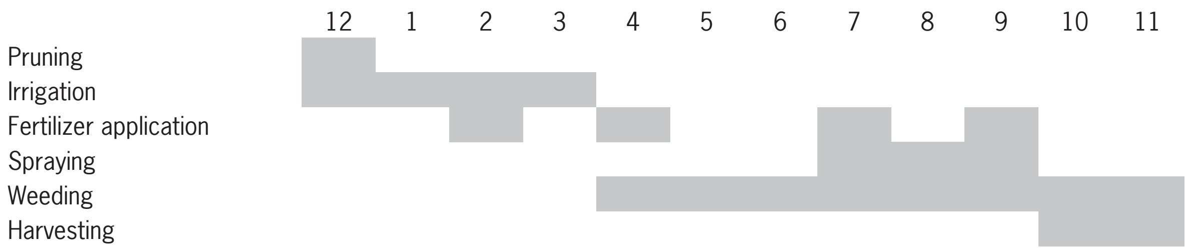


*Figure 8. Crop cycle coffee cultivation in Vietnam.*

The collected data for the 2007 - 2008 period indicates that farmers tend to over irrigate and over fertilize, resulting in very low efficiencies. With the expected temperature rise and increased occurrence of dry spells water will be a co-determining factor in the future of coffee. Increasing the efficiencies of the current irrigation system is a relative simple first step to prepare for changing rainfall patterns. Shading will become more important with increasing temperatures.

For Uganda coffee is a critical export product, it accounted for almost a quarter of Uganda's formal export earnings in 2008 - 2009 (World Bank, 2011) is about 2.5% of global coffee production exports. Coffee is often intercropped with banana, a major food and cash crop in the region.

Most of Uganda's banana and Arabica coffee producing areas have a total annual rainfall exceeding 1000 mm and modest temperatures between 24 - 14°C relating to the altitude of 800 - 2500 meters above sea level. Robusta is found at lower altitudes (800 - 1500m) (Jassogne, 2012). Rainfall distribution is critical for flowering and cherry development and hence production and product quality. Besides temperature, rainfall also impact pressures of pest and diseases.
No data is available on farm level management, but it seems that irrigation is less important in Uganda.

At common farm level strategy is to focus on intercropping as it combines food and cash crops, reducing costs and increasing production and product quality via improved nutrient management (Van Asten *et al.*, 2011). As farm sizes are decreasing it is also a clear response to the increasing land scarcity. An additional benefit of intercropping with fruit trees or banana is the shading effect provided. Shaded coffee is better protected against extremes and via the microclimate from rising temperatures.

Variety selection in response to improve the production potential under given conditions, sensitivity to stresses (diseases, drought etc.) and market is an important focus in Uganda.

### 4.3.1 Summary

Farmers in Viet Nam and Uganda are strongly linked to the coffee market. Field data from Viet Nam was available suggesting a functioning communication and documentation system for farmers to learn and exchange, this infrastructure seems to be less strong in Uganda.

Field level adaptation options relating to irrigation, shading, and fertilizer management are within the reach of farmers. The focus in Viet Nam is on irrigation, in Uganda on shading and intercropping/nutrient management. Information is lacking to do a full analysis, but it seems in both cases training farmer and providing technologies has the potential to improve production levels and increase input efficiencies.

Shade trees and improving fertilizer and irrigation efficiencies can also have a positive effect on the GHG balance. Introducing shade trees will add carbon to the field. More efficient use of fertilizer can in some cases mean reducing input levels and so reduced energy needs for the production and transport fertilizer in addition improved fertilizer application can also reduce $N_2O$ emissions. Improving irrigation systems will in most cases result in a reduction of the energy needs related to pumping

Long-term adaptation strategies outside the reach of most farmers are linked to technology development and plant breeding (production and stress) and require efforts by the sector and or research.

An overview of the different management operations and links to adaptation and mitigation are given in Table 5.

*Table 5. Different management operations and links to adaptation and mitigation are given in table (-, -/+, +: negative, neutral, positive).*

| Operations | Specific | Adaptation | Mitigation |
|---|---|---|---|
| Variety selection | | + | + |
| Mixed cropping | Shade trees | -/+ | + |
| | Food crops | + | -/+ |
| Land preparation/ tillage /planting | | + | -/+ |
| Pruning | | | + |
| Water management | Irrigation | + | -/+ |
| Nutrient management | Fertilizer application | | -/+ |
| Crop protection | Spraying | | - |
| | Weeding | | -/+ |
| Harvest | Harvesting | -/+ | -/+ |

## 4.4 Findings

The findings of this study are mapped following the four steps and presented in Table 6. From the case studies we can learn that altough the variety in situations is diverse.

*Table 6. Findings of the case studies.*

| | Country | Kenya | Vietnam | The Netherlands | Ethiopia | South Africa | The Netherlands | Ugands | Vietnam |
|---|---|---|---|---|---|---|---|---|---|
| | crop/ commodity | dairy | dairy | dairy | potato | potato | potato | coffee | coffee |
| 1. Describe and assess current systems | System | small scale, focus on local market | small scale, focus on local market | large scale, focus on export. | small scale, focus on local market | large scale, export | large scale, export | small scale, export | small scale, export |
| | Type | mixed system. grazing | mixed system. zero grazing | specialised | mixed | specialised | specialised | mixed | mixed |
| | Input level | low | medium (feed) | high | low | high | high | low | medium |
| | Production Levels | low | medium | high | low | medium | high | medium | medium |
| | Aims | productivity | productiviy & product quality | product and environmental quality | productivity | productivity | productivity, product & environmental quality | productivity | productivity |
| | Current strategy | breeding & input | breeding & input | Increase of N and P efficiency | poor linkage with value chains | integrated in value chains | strong integration in value chains | | |
| 2. Identify and evaluate CSA options and GAP requirements | GAP | FAO | FAO/VietGAP | Sustainable program of milk cooperation (Friesland Campina) | | NGO | | NGO/private sector | NGO/private sector |
| | focus of GAP | Animal health, welfare and food safety | Animal health, welfare and food safety | Animal health, welfare, food safety and environment | | biodiversity | | biodiversity/ market | biodiversity/ market |
| | Vulnerability to CC | high | high | low | medium | high | low | high | high |
| | Type of impacts | droughts, animal diseases | droughts, coastal flooding | higher temperatures, wetter pastures, increased yield | high temperature, drought | (irrigation) water scarcity | high temperature, wet soils during planting & harvesting | erratic rainfall | drought |
| | Adaptation strategy | breeding | breeding | | better plant material | more efficient irrigation | adapted machinery | | |
| | | water resources (wells) | cooling animals | | irrigation | breeding (heat tolerance) | breeding (heat and wet soil tolerance) | | |
| | | | | | nutrient management | nutrient management | soil management to improve drainage | | |
| | | | | | capacity building | | | | |
| | GHG emissions | low | medium/high | high | low | high | high | | |
| | Mitigation options | Feed management | Feed management | Feed management | | irrigation | nutrient management | pruning | pruning |
| | | Productivity increase | Productivity increase | Crop management | | nutrient management | energy-saving machinery | waste managemen | waste management |
| | | Disease control | Disease Control | Biogas production | | | | nutrient management | nutrient management |
| | | | Manure management | Manure management | | | | | irrigation |
| | Mitigation potential | | | | low | medium | medium | low | medium |
| 3. Identifying and lifting barriers | Human | Training of farmers, Extension service | Training of farmers, Extension service, | Knowledge of innovative opportunities | capacity of farmers, extension and value chain actors | | | Training, farmers field schools | Training, farmers field schools |
| | | Management guidelines | Recognition of value chain | Training of farmers | information & knowledge gap | | | | |
| | Social | Social status of having cows | Social status of having cows | Consumer's awareness and willingness to pay | Seed potato system | water use conflicts with biodiversity and other interests | water management serves multiple purposes | | |
| | | Cultural value of livestock | Need of local feed source, silage | | | lack of monitoring institutions | | | |
| | Physical | access to feed and new breeds | Active involvement of public sector (government, social organisations, consumers) | | access to inputs | access to water | Availability of suitable machinery | | |
| | | | Handling or transport of liquid manure | | | | | | |
| | Natural | | Flood risk | | availability of irrigation water | limited water resources and nature conflics | heavy clay soils | | |
| | Financial | Bridal value of cows | Uncertain investment | no economic incentives | access to agro-finance | high investments | | | |
| 4. Develop coherent strategies to implement GAP/ CSA options | 1 | Breeding programs tailored to local needs | Breeding programs tailored to local needs | Incentives policy | Support development of seed potato sector | improve irrigation efficiency | Develop new machinery | clear management guidelines from value chain partners | |
| | 2 | develop training material and delivery methods | Nutrient management | Information programm for consumers | Develop fertilizer recommendations | Improve nutrient management | Dialogue with water boards | nutrient management | nutrient and irrigation management |
| | 3 | | Cooperation between public sector and private sector in a Public Private Partnership model | | Improve access to inputs (incl. credit) through private sector involvement | | Soil and crop residue management | | |
| | 4 | Training programs | Training programs | | Training programs | | | | |
| | | | Develop coherent transparant production chain with shared responsibilities | | | | | | |
| | | Create financial institutions | Create financial institutions | Create financial incentives | | | | | |

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