Adding Value to Smallholder Forage-Based Dual-Purpose Cattle Value Chains in Nicaragua, in the context of Carbon Insetting.

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"..efficiently developing agricultural production [...] it's a journey of a thousand miles which begins with one step"

- **Nicaraguan Chamber of Beef Exports (CANICARNE)**

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Declaration

I hereby declare that this dissertation is the candidate's own work and has not been submitted for another degree, either at the University of Hohenheim or elsewhere.

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Abstract

The thesis explores the extent to which payment for the ecosystem service of carbon sequestration provided in a value chain context, through an innovative climate change mitigation and adaptation strategy known as 'carbon insetting', could generate 'win-win' outcomes for all actors.

Drawing on examples of where the concept of carbon insetting has been adopted in coffee and cocoa value chains in Mexico and Honduras respectively, the thesis investigated the feasibility of providing a payment for ecosystem services (PES) where there was an explicit aim to generate social, economic, and environmental and productivity benefits.

Taking the dual-purpose cattle value chain in Nicaragua as a case study, the thesis used a mixed methods approach to assessing the current climate change scenario faced by actors in the value chain, and in analysing incentives to directly engage in or facilitate strategies leading to adaptation and mitigation of climate change impact. A household questionnaire was administered to a sample of 40 smallholder farmers, while a diverse range of national as well as international public and private sector actors were consulted through key informant interviews.

The results of the study indicate that while smallholder farmers in Nicaragua are most vulnerable to climate change, the ripple effect as regards impact is felt by the value chain as a whole, and there is growing consensus among actors as regards the need to work together in identifying and implementing innovative PES and climate change adaptation and mitigation strategies with the capacity to generate shared benefits.

Linking PES scheme outcomes to willingness to pay (WTP) and accept (WTA) payment for service provision, the thesis evaluates the scope for carbon insetting, in particular, to positively impact on and contribute towards the improved livelihood security and sustainability of the primary link in the value chain in Nicaragua - smallholder farmers engaged in dual-purpose cattle production.

Chapter 1: Introduction

1.1 Purpose of the Study

The thesis evaluates the extent to which 'Carbon Insetting' can serve as a climate change mitigation and adaptation strategy enabling actors throughout the dual-purpose cattle value chain in Nicaragua to realise 'quadruple-win' outcomes (social, economic, environmental and productivity benefits).

Assessing the incentives behind the willingness to pay (WTP) in coffee and cocoa value chains in Mexico and Honduras where the concept of carbon insetting has been adopted, the thesis examines the value placed by actors on carbon sequestration as an ecosystem service and the willingness to pay for its provision.

Linking actors WTP to realisation of desired PES outcomes, the thesis analyses the degree to which synergies between climate change mitigation and adaptation activities and economic objectives are identified by dairy and meat processors in Nicaragua, as well as by facilitatory actors responsible for creating enabling conditions underpinning 'Carbon Insetting' as a concept.

Analysing the constraints facing smallholder farmers and the commitment of actors towards improving the efficiency and productivity of dual-purpose cattle value chain, the thesis investigates the scope to improve the livelihood security of smallholder farmers through a Payment for Ecosystem Services (PES) for carbon sequestration realised through cultivation and use of improved forages in production systems.

There is significant potential for carbon sequestration activities to positively impact upon the livelihoods of smallholder farmers given the current vulnerability of that segment of the population, its dependence on agricultural production activities and the fact that a large proportion of land - previously forest land - is degraded. Encouraging smallholder farmers to adopt more eco-efficient agricultural practices requires other actors involved in the value chain to offer an incentive to underpin behaviour change.

The potential of improved forages to contribute to greenhouse gas (GHG) emissions reduction and carbon sequestration is often overlooked in climate change mitigation and adaptation strategy discussions. Forages, however, have the potential to contribute to as much as 60-80% of the total carbon sequestration from agricultural land when improved management practices are utilised to increase productivity and restore degraded lands (Peters et al. 2013).

1.2 Thesis Objective

The thesis investigates the degree to which there is willingness within the dual-purpose cattle value chain, namely among dairy and meat processors, to compensate farmers for provision of the ecosystem service of carbon sequestration.

Analysing the incentives underpinning processors' WTP and smallholder farmers' WTA payment, the thesis explores the extent to which synergies existing between climate change mitigation and adaptation activities, and economic objectives are identified by value chain actors.

Based on actors' recognition of opportunities to realise 'quadruple-win' outcomes, the thesis draws conclusions as regards the likely impact of a 'carbon insetting'-style PES on the productivity and efficiency of the value chain as a whole, as well as the resilience of smallholder farmers in the face of increasing climate-change-induced production constraints.

1.3 Study Research Questions

Responding to the objectives set out, the thesis addresses the following research question:

- Is there scope through an innovative climate change mitigation and adaptation strategy known as 'carbon insetting' to positively contribute towards the improved livelihood security and sustainability of smallholder farmers engaged in dual-purpose cattle production in Nicaragua?

In addressing this research question, the following hypotheses were examined:

- 'Carbon insetting' has potential to generate 'win-win' outcomes for all value chain actors.

- There is a relationship between PES scheme outcomes and value chain actors' willingness to pay (WTP) and accept (WTA) payment for service provision.
- It is feasible to provide a PES where there is an explicit aim to generate social, economic, and environmental and productivity benefits.

1.4 Study Methodology

The thesis investigated the extent to which carbon insetting could be considered an innovative climate change mitigation and adaptation strategy with the capacity to generate 'win-win' outcomes across the dual-purpose cattle value chain.

In this context, a number of different actors were interviewed:

- Smallholder dual-purpose cattle farmers
- Food processing enterprises (meat, dairy, cocoa and coffee)
- Export, Investment and Cooperative Development Promotion Organisations
- Carbon Standards Certification Organisations
- GHG Emissions Reduction Project Development Organisations

Based on information elicited through a household survey and key informant interviews, the thesis determined the likelihood of 'carbon insetting' leading to improved livelihood security and sustainability of smallholder dual-purpose cattle farmers.

To gain insight into how carbon insetting could impact on the value chain as a whole, the incentives underpinning processors' WTP and farmers' WTA payment for ecosystem service provision were evaluated, as this was an indication of commitment towards realising desired PES outcomes.

The degree to which 'carbon insetting' requires support from facilitatory actors committed towards creating enabling conditions was also analysed, with conclusions drawn from carbon insetting examples of coffee and cocoa value chains in Mexico and Honduras.

1.5 Layout of Thesis

The thesis investigates the extent to which carbon insetting can be considered an innovative climate change mitigation and adaptation strategy, resulting in poverty reduction specifically among smallholder farmers and a strengthened value chain benefitting all participant actors.

The first part of the thesis explores the idea of carbon insetting as a climate change mitigation and adaptation strategy with the potential to improve the livelihood security and sustainability of smallholder farmers engaged in dual-purpose cattle production. The nexus between poverty and environmental degradation, and potential poverty reduction resulting from PES schemes is examined through a review of published and grey literature. Poverty is conceptualised in terms of vulnerability to impacts of climate change and value chain power inequalities due to limited trust and knowledge sharing among actors; while poverty reduction is conceptualised in terms of empowerment, capacity building and increased knowledge sharing. Based on this, the degree to which poverty reduction and climate change mitigation and adaptation can result in improved functioning of the value chain - increased efficiency and productivity - is discussed.

The second part of the thesis builds on the idea of carbon insetting as a potential value chain-strengthening strategy. The impact on value chains where the concept has been adopted, namely, in coffee and cocoa in Mexico and Honduras, is examined to gain insight into the potential impact in the context of livestock value chains, and specifically, the dual-purpose cattle value chain in Nicaragua. In this context, the carbon sequestration potential of the production system, existence of a differentiated market and the strength of the network existing between value chain actors are determined.

The third part of the thesis focuses on the dual-purpose cattle value chain in Nicaragua as a case study to evaluate the potential for carbon insetting in the livestock sector. The production systems of smallholder farmers are characterised in terms of production system and individual, constraints impacting on production systems and based on this, the potential impact of a carbon insetting PES scheme.

The final part of the thesis explores the extent to which win-win outcomes can be realised through carbon insetting for all actors involved in the dual-purpose cattle value chain. The WTP of processors the ecosystem service provision of carbon sequestration is investigated, in terms of incentives, motivations and expectations resulting in preference for cash or in-kind payment. In addition, the role of facilitatory actors is considered. Based on this, the extent to which win-win outcomes can be achieved – poverty reduction, improved climate change adaptation and mitigation capacity and a more productive and efficient value chain – will be evaluated.

1.6 Importance of the Study

In terms of exploring the extent to which an innovate climate change mitigation and adaptation strategy such as 'carbon insetting' has the potential to generate 'win-win' outcomes, the thesis provides preliminary, relevant and invaluable insight into the potential impact of a PES for carbon sequestration on the livelihood security and sustainability of smallholder dual-purpose cattle farmers in Nicaragua.

The strength of the thesis lies in the fact that it establishes and evaluates not only potential impact of carbon insetting, but also the divergent and convergent priorities of value chain actors as regards WTP and WTA payment for carbon sequestration.

As a study, the relevance of the thesis derives from the fact that it explores the idea that climate change can constitute as much an opportunity as a constraint for individuals, communities and institutions within a value chain context where innovative strategies climate change mitigation and adaptation strategies are pursued.

Taking the dual-purpose cattle value chain in Nicaragua as a case study example, the thesis investigates the extent to which theoretical win-win outcomes can result from a strategy known as 'carbon insetting'. Positing that realisation of social, economic, environmental and productivity benefits across value chains is contingent on identification by participant and facilitatory actors of synergies and trade-offs in engaging in a PES scheme, the thesis examines the incentives, motivations and expectations underpinning WTP and WTA payment for carbon sequestration.

Analysing value chain actors capacity and committing towards working together towards common goals, the thesis draws conclusions as regards the potential impact of carbon insetting on the livelihood security and sustainability of smallholder farmers, as well as the productivity and efficiency of the dual-purpose cattle value chain as a whole.

Chapter 2: Literature Review

2.1. Nicaragua: Dual Purpose Cattle Value Chain

2.1.1 Agricultural Production

Agricultural production has long constituted an important economic activity in Nicaragua, contributing to 17.2% of GDP in 2012, with livestock production contributing to 39% of this GDP share and creating permanent jobs equivalent to 59.2% of employment in rural areas, in addition to seasonal temporary jobs (Holmann 2014).

Although the poultry sector has experienced the more dynamic growth than the cattle sector over the last decade - 9% compared to 6.5% and 4.6% for beef and milk respectively - cattle production is the most important livestock activity in Nicaragua, in terms of land use with 54% of land under agricultural production used for grazing of cattle on permanent pasture (Holmann 2014).

2.1.2 Dual-Purpose Cattle Production

In Nicaragua, there are five types of cattle production systems - specialized dairy breeding, pure-bred cattle breeding, dual-purpose, development and fattening - of which the most predominant is the dual-purpose system. Less productive than specialized dairy farms which typically obtain 6-10ltr per cow per day through a mostly concentrate-based diet; dual-purpose farms obtain an average of 4ltr per cow per day through a mostly native and improved forages-based diet (Holmann 2014; Schütz et al. 2004).

For small and medium-sized farmers, dual-purpose is attractive form of production as it involves lower levels of risk than specialization in either dairy or beef production. In addition to diversifying their source of income, they reduce their exposure and vulnerability to milk and beef price fluctuations, as well as likely animal health care costs associated with cow susceptibility to mastitis, as the milking activity takes place with the calf suckling and in close proximity (Holmann 2014).

At a national level, the number of households engaged in dual-purpose cattle production is 136,687. Managing an average farm of 70ha, these small to medium-sized farm households own as much as 49% of the national herd (4.14 million heads of cattle) and have an average of herd size of 30.3 heads of cattle. 60% of the national herd are *Bos indicus* (Brahman) mixed with *Bos taurus* breeds (Swiss Brown, Holstein-Friesian, Jersey) (Holmann 2014).

Focusing primarily on dairy production - 56.7% of the national herd is female (cows and heifers) - these dual-purpose farms also engage in calf development activities, with most utilising 25% of milk produced to wean bull calves to a weight of 100kg for sale to intermediaries for further fattening (220-280kg). Some farms continue the fattening process, however, developing calves to a weight of 280-300kg, selling directly to regional abattoirs or national slaughterhouses (Galetto et al. 2007; Schütz et al. 2004).

Calf development leading to beef production provides a source of income and cow calves can be weaned to replace discard milking cows, however, dairy production constitutes the main source of income for dual-purpose cattle farms, with milk sales providing daily revenue equivalent to 75% of income. In 2003, smallholder farmers produced a litre of milk at a cost of US$0.23, receiving US$0.27 and therefore making a profit of 18.6% but in doing so, capturing just 42% of the final milk price received by the industry (Holmann 2014; Schütz et al. 2004).

2.1.3 Production for Domestic and Export Markets

The cost of producing milk in Nicaragua under semi-intensive conditions is US$0.22 per litre and US$0.30 under intensive conditions. The lowest price in Central America and 25% lower than the international price, Nicaragua is very competitive in the export market for dairy products. The volume of exports has risen by 21.9% per year, with the value of products increasing at a rate of 11.8% per year, indicating a gain in value addition. In total, 80% of dairy products (milk powder, evaporated milk, fluid milk and cheese) are exported, of which 50.3% goes to El Salvador, 15.8% to Guatemala and 14.5% to Venezuela (Holmann 2014; Schütz et al. 2004).

In contrast to the wealth of information available regarding milk production, little is known as regards the cost of beef production and profit margins realised by Nicaraguan small and medium-

sized farmers in this context. The country is highly competitive in export markets for beef; however, with export growing by 17.4% per year since 2000, and the value of beef exported increasing by 6.6% per tonne per year, reflecting a continuous value addition gain. The current price received by smallholder farmers for a kilogram of beef is US$0.88, which is 11% and 20.4% lower than the international comparison country beef prices of Argentina and Australia, respectively. 81% of beef produced is exported, with 46.4% going to Venezuela as frozen meat and 34.7% to the USA as fresh and chilled beef (Holmann 2014).

The trend in growth of Nicaraguan dairy and beef exports is forecast to continue into the next decade. In terms of milk and milk equivalent products, recently, two large regional dairy players have looked to enter the market; namely, the Mexican dairy group Lala and the Costa Rican cooperative Dos Pinos. Both are expected to demand significant amounts of fluid milk from Nicaragua's producers, which notably was not exported prior to 2000, given the competitiveness of milk production. Similarly, in the context of beef production, Nicaragua is currently in the process of establishing a cattle traceability system at national level and is expected to sign a free-trade agreement with the EU which will provide a new export market opportunity generating higher revenues than the current trade with the USA (Holmann 2014).

Although sales of dairy and meat products have increased over the last decade, smallholder farmers have remained 'price takers' as opposed to 'price setters', capturing a price which is low relative to the final price captured by value chain actors such as processors, packing plants, distributors and retailers. This has led to speculation that a bottleneck will develop in the future, affecting the competitiveness of the chain as a whole, given that the gains made in terms of chain competitiveness have not transferred into better production conditions or access to technical assistance, credit or resource inputs for smallholder farmers (Holmann 2014; Galetto et al. 2007).

2.1.4 Productivity and Efficiency

In Nicaragua, dual-purpose production systems are characterised by low productivity, and farmers face many constraints which act to disincentivise them from investing to improve their production systems. Among the many constraints faced are low quality and quantity of feed and forage available particularly during the dry season, low genetic potential of cattle, limited access to credit at a low interest rate, poor access to technical assistance, information and services such as artificial insemination and animal health care, and adequate on-farm as well as off-farm infrastructure. In addition, diseases and parasites constitute a major constraint on production. Market access is also a challenge, with low milk and beef prices as a consequence of seasonality and many intermediaries involved in the dairy and beef value chain, leading to high transaction costs and translating finally into low profits (Holmann 2014).

At an international level, dual-purpose production is regarded as a competitive production system. A measure which is commonly used to gauge system productivity is cow yield (i.e. litres of milk). In the context of dual-purpose production, however, this is an inappropriate measurement given that the product derived is both milk and beef (calves). In the case of Nicaraguan smallholder farmers, the productivity of their livelihood choice and the attractiveness of engaging in dual-purpose production is determined first and foremost by the costs involved and profit margins which can be realised through dairy and beef production (Galetto et al. 2007).

Production costs are both short-term and long-term, and as there is a significant opportunity cost associated with production factors such as land, capital and labour, these are considered more appropriate indicators of the productivity or efficiency of dual-purpose systems. In a Nicaraguan dual-purpose context, the opportunity costs are estimated as 2% of the value of land, 4% of the value of capital invested for farm improvements, 6% of the value of machinery and equipment, and 8% of the value of livestock (Galetto et al. 2007).

Smallholder dual-purpose farms in Nicaragua are technically inefficient, producing less output per unit of input used. At the same time, however, these farms are efficient in the sense that they maximise the productivity of scarce resources in terms of allocation, using less labour and land per unit of output produced, compared to larger more specialised, capital intensive farms. As a

result, the cost of production is lower, enabling these farms to be competitive despite the constraints faced (Galetto et al. 2007).

In Nicaragua, 49% of dual-purpose farms produce less than 30,000 litres of milk per year, with 33% of farms producing between 30,000-60,000 litres. In terms of daily production, 82% of farms produce less than 160 litres per day. In the last decade, productivity per cow has decreased by 15.5% in the context of milk production, but on the contrary, has increased by 66.4% in the context of beef production (66.4%), indicating smallholder farmer preference for beef over milk production (Galetto et al. 2007; Holmann 2014).

Overall production value per cow has increased by 18% in the last decade, however, there is still significant scope to improve productivity and reduce production costs, through investments in improved technologies to support higher livestock stocking rates per unit land area and thus resource use efficiency. The increase in productivity observed to date has been attributed to the adoption of improved forage-based technologies (improved and native pasture) during the rainy season and alternative technologies (hay, silage, cut-and-carry forages, sugarcane, protein bank) during the dry season to compensate for the feed gap (Holmann 2014).

Current feeding practices characterised by extensive pasture grazing result in low productivity and seasonality in terms of quantity, with 70% of milk produced during the rainy season. In addition to increasing productivity, improving feeding strategies through establishment of forages adapted to drought and poorly drained soils, silvopastoral and pasture management practices, and finally improved hygiene practices can significantly increase the volume and quality of milk and beef produced per head of cattle (Holmann 2014).

2.1.5 The Future of the Livestock Sector in Nicaragua

Livestock growth is private sector-driven in Nicaragua, with feed and forage technology currently promoted by NGOs, cooperatives and large dairy plants as opposed to the Government extension services. There is also limited support from the public sector in terms of investment in infrastructure and provision of technical assistance and animal health services, as well as no quality control of seed and concentrate feed. The Ministry for Agriculture and Forestry (MAGFOR),

however, is in the process of developing a 'Program to Improve the Competitiveness of the Livestock Sector'. Focusing on increasing productivity per animal and hectare to improve milk quality and quantity, through promotion of silvopastoral practices and the use of improved grasses, shrub legumes and trees as feed and fodder (Holmann 2014).

Enforcement by the Nicaraguan government at national, regional and local level of environmental regulations is weak, meaning that GHG emissions and the level land degradation resulting from dual-purpose cattle production is currently very high, affecting both biodiversity and the quality of water bodies. In this context, adoption of improved land management practices incentivised, for example, through Payments for Ecosystem Services (PES), have the potential to contribute significantly to improved environmental management and product quality. Investment by smallholder farmers in their production systems to incorporate silvopastoral and pasture management practices contributing to the recovery of degraded areas. Facilitating carbon sequestration, these practices can also lead to the generation of carbon credits enabling smallholder farmers to be compensated at a local, regional, national or even international level (Holmann 2014).

Compensation for the ecosystem service provision of carbon sequestration through carbon credits could constitute an important additional source of income for smallholder farmers in Nicaragua, given that very few receive credit. In 2011, just 3.5% of farmers had access to credit for livestock production. Credit is more often provided for crop production than livestock production, as activities involved are typically regarded as less risk, being short term (4-6 months) compared to livestock production (18-24 months) for livestock production (Holmann 2014).

2.1.6 The Dual-Purpose Value Chain

Relative to other actors, smallholder farmers are limited in the extent to which they have bargaining power and can assertively participate in the dual-purpose value chain, producing only a limited quantity of milk of poor quality and at a variable price. Fluctuating significantly between the dry and rainy season, the price of milk is related to supply and demand. On-farm infrastructure is often poor, milking practices are unhygienic and inappropriate, and collective investment in milk

cooling systems is limited by the degree to which smallholder farmers are empowered or organised in a cooperative, thus having the required resources and capacity (Holmann 2014).

The dairy manufacturing sector is both formal and informal in Nicaragua. The formal sector is characterised by relationships governed by contracts, which offers smallholder farmers a more stable price based on quality. 42% of milk produced in Nicaragua is collected and processed by the formal sector, dairy plants capable of processing between 50,000 to 200,000 litres per day for domestic and export markets, and semi-industrial plants which process cheese. Industrial processing capacity is growing, driven by the establishment of milk collection centres and an efficient milk cooling network (Holmann 2014).

Milk cooling has resulted in a segmented dairy market - formal and informal, with the price paid by the formal sector, 25% higher than the informal sector. Smallholder farmers who belong to the cooling network are in a position to supply quality milk for export; while farmers who do not belong to this network instead supplying small artisan cheese factories and intermediaries who pay a low price for milk and do not demand high quality produce (Holmann 2014).

Figure 1: The milk collection and cooling network

The milk cooling network consists of milk collection centres with a capacity for 877,000 litres per day. Milk collection centres collect milk from smallholder farmers who produce small quantities of milk, and are owned by milk plants, private entities and cooperatives. 45.2% of the milk cooling network belongs to producer cooperatives and 42.9% to private individuals. The volume of milk delivered to the cooling network decreases by 30% during the dry season, and prices are typically higher (Holmann 2014).

Figure 2: Milk collection centres

The commercial relationship between the cooling network and producer cooperatives is characterised by liquidity. Payment is instant and often on a weekly basis. There is usually no written contract and agreements are verbal. The relationship existing between cooling centres and milk processing plants is similarly verbal as opposed to being governed by a written contract (Holmann 2014).

47% of the milk destined for domestic and export markets (fluid milk, fresh/mature cheese, yoghurt, ice cream, butter, milk powder) is processed by milk plants including Parmalat, Eskimo, Prolacsa, Centrolac, Nilac, La Exquisita. The other approximately 50% is processed into cheese for local consumption or export to El Salvador by small rural artisan cheese factories (Holmann 2014).

In the context of beef production, income is irregular and limited due to the fact that most smallholder farmers do not undertake any value-adding activities, selling cattle as live discard animals to local abattoirs and calves at weaning age to intermediaries for further fattening, reproduction and slaughter. 90% of beef in Nicaragua is processed by slaughterhouses certified for export, with 85% of all beef exported (Holmann 2014; Schütz et al. 2004).

The institutional arrangements governing the relationships between individual farmers, cooperatives and the dairy and beef industry (processors, packing plants, distributors and retailers) are weak, characterised by low levels of trust, knowledge sharing and coordination. In the context of the bottleneck as a consequence of smallholder farmers' limited value addition, final price capture, access to services and technical assistance, there is growing awareness among private sector of the bottlenecks developing in the value chain, and the need and scope to intervene innovatively to improve the efficiency of resource use and productivity of the dual-purpose cattle production system (Holmann 2014).

2.2. Climate Change

2.2.1 Climate Change as a Phenomenon

A change in the state of climate over an extended period of time - identified by changes in mean and/or variability of certain properties - climate change is regarded by the Intergovernmental Panel on Climate Change (IPCC) and the United Nations Framework on Climate Change (UNFCC) as a phenomenon stemming from natural variability, and directly or indirectly from human activity. It involves an increase in sea levels, a shift in climatic zones due temperature and precipitation changes, and an increase in the frequency and magnitude of extreme weather events (Carter & Mäkinen 2011; Vermeulen et al. 2010; World Bank 2002).

A product of geographic location; economic, social and cultural conditions; prioritizations and concerns of individuals, households and social groups; and institutional and political constraints, climate change impacts on climate-sensitive sectors such as agriculture. Climate variability undermines economic growth, as well as the livelihood security and sustainability of vulnerable population groups such as smallholder farmers who have limited human, institutional and financial capacities (World Bank 2002).

2.2.2 Climate Change and Agriculture

Agriculture and food production activities contribute to 25%, 50% and 70% of anthropogenic CO2, CO4 and N2O emissions respectively. Estimated at a global level as 5.1-6.1 Gt CO_2 equivalents, the share of GHG emissions resulting from agriculture is expected to increase to 8.2 Gt CO_2 by 2030. Atmospheric carbon concentration (currently 400 ppm) is considered to be increasing at a rate of 2.2 ppm per year according to the Intergovernmental Panel on Climate Change (IPCC), primarily due to fossil fuel burning, but in part also due to land use change and specifically, conversion of forests to pastureland to meet growing global demand for meat and dairy products, particularly in developing countries (Lal 2011; O'Mara 2012),

As an agricultural sub-sector, the livestock sector has in recent decades come under particular scrutiny, and indeed criticism, for its contribution towards global GHG emissions. In 2006, the Food and Agricultural Organisation (FAO) released a report entitled 'Livestock's Long Shadow: Environmental Issues and Options', citing the urgent need to encourage smallholder farmers to adopt more eco-efficient agricultural practices and adopt climate change adaptation and mitigation strategies leading to a reduction in GHG emissions, while taking into account pressures to improve food security and agricultural productivity in an era of limited land availability (FAO 2006).

2.2.3 Climate Change - Adaptation vs. Mitigation

The degree to which a deviation from 'normal' average climate conditions has the capacity to undermine is determined by the degree to which climate risk is managed, i.e. through climate change adaptation and mitigation strategies. Adaptation and mitigation strategies are complementary and as such, neither should be regarded in a vacuum but rather as important components of an overarching holistic climate change strategy (McCarthy 2001).

The extent to which adaptation activities take precedence over mitigation activities is dependent on costs-benefit trade-offs. Adaptation - adjusting of practices and processes, and the mobilisation of capital to respond to actual as well as the perceived threat of climate change - is often regarded as more pertinent as it is builds resilience to short-term shocks. The rate at which climate change takes place is determined by the extent to which GHG are emitted or emissions reduced, however,

and as such mitigation is equally important as it prevents future climate change damage(Carter & Mäkinen 2011).

Regardless of the degree to which mitigation takes place; adaptation is required as it buys time for the initiation of cost-effective mitigation responses with more long-term implications as regards poverty reduction and sustainable development. Transforming social and institutional structures, adaptation at a fundamental level facilitates climate change mitigation by creating incentives for the monitoring of GHG emission reductions and verification of carbon sequestration activities. Adaptation can occur as a technological, behavioural, managerial and policy response in either short-term for risk management or long-term to build resilience against climate change (Howden et al. 2007; Parry 2007; Thornton et al. 2009).

Adaptation is required at a systems level rather than at a farm-activity level, as resilience is a product of interfaces of socio-economics, cultural and institutional factors, political and technological drivers. It requires recognition of climate variability and market dynamics as market opportunities are essential to farmer adoption of improved or good agricultural practices. Adaptation options only become adaptation actions when risks are comprehensively taken into consideration and managed (Howden et al. 2007).

Currently, adaptation capacity and vulnerability reduction are undermined by costs; environmental, economic, informational, social, attitudinal and behavioural barriers; as well as by informational and institutional knowledge gaps as regards the impact of climate change on livestock-based production systems and livelihoods. There is collective knowledge among supply chain actors from farmers to agribusiness and policymakers, however, which can be leveraged to a greater extent to enhance the resilience of agricultural production systems and the livelihood productivity and efficiency of smallholder livestock farmers (Howden et al. 2007; Thornton et al. 2009).

Climate change constitutes both an opportunity and a threat as regards impact on agricultural production. Adaptation and mitigation are increasingly being recognised as important in a supply chain context, with public-private partnerships formed to find solutions to climate change-induced

risks to minimise spill over and feedback effects along the chain as a consequence of a lack of mitigation and adaptation to climate change (FAO 2013; Howden et al. 2007).

2.2.4 Climate Change - Role of Smallholder Farmers

As a sector, agriculture is extremely vulnerable to climate change and specifically, to variability in temperature and precipitation which leads to an altered hydrological cycle and a shift in land use as a consequence of changed suitability of production areas. Climate change destabilizes production systems - livestock and crop patterns and productivity - and in the context of maintaining or improving production per unit of land, it must be recognised that climate change can first and foremost be tackled by strengthening the resilience and capacity of smallholder farmers who are vulnerable to climate variability and contribute significantly to GHG emissions through their agronomic practices (Vermeulen et al. 2010; McCarthy 2014).

Climate risk management by smallholder farmers can be undertaken autonomously or as a consequence of external promotion by agricultural value chain actors, policy-makers and development organisations. Investment and disinvestment decisions are made based on perception of climate-sensitivity and adaptation by smallholder farmers can take the form of ex-ante activities (adoption of risk-tolerant varieties, diversification, irrigation, erosion reduction etc.), ex-post activities (off-farm employment, sale of assets etc.) or in-season activities (adjustment of labour and other factors of production according to yield expectation) (Howden et al. 2007; McCarthy 2014).

2.2.5 Climate Change Impact on Livestock Production Systems

In developing countries, change in livestock production systems has traditionally been driven by population increase, urbanisation, demand for animal products, natural resource use and availability. To date, there has been limited research on climate change as a driver of change, however, the extent to which it may be a key factor influencing the decision-making and action-taking of smallholder farmers with limited capital assets (natural, physical, human, social and financial) is increasingly being investigated. In the face of uncertain and complex production conditions, farmers are compelled to adjust their behaviour towards practices which enable them

to take advantage of opportunities and overcome constraints (World Bank 2002; Thornton et al. 2009).

The IPCC has developed a number of climate change scenarios, with outcomes determined by the GHG emission levels taken into consideration. Although the extent to which global climate models are currently capable of satisfactorily predicting the impact of climate variability on livestock production systems is the subject of intense debate; an adverse impact on livestock productivity is expected. An increase in temperature of between 1.8 and 4 degrees Celsius in addition to changed precipitation patterns leading to reduced water availability, undermined crop productivity and increased disease incidence and severity (Thornton et al. 2009).

Technological, political and institutional innovations - improving feed and nutrition, genetics and breeding, animal health and environmental management - are required to enhance smallholder farmers' capacity to adapt and mitigate climate change. The far-reaching implications of inter-annual and seasonal climate variability on smallholder farmers' livelihood security and sustainability will vary based on geographic location as well as production system type - grazing, non-grazing or mixed. Those most affected will be farmers located in climate-sensitive areas, with grassland-based production systems and high dependency on the climatic conditions and natural resources accessed in arid and semi-arid areas at low altitudes (McCarthy 2014; Thornton et al. 2009; World Bank 2002).

2.2.6 Climate Change Impact on Nicaragua

One of the regions which will be most affected by climate change, and where the impact on smallholder farmers and agricultural production systems will be most severe is Latin America and the Caribbean (LAC). The IPCC has developed a number of temperature change scenarios for the region, of which the most moderate is a 0.4-1.8 degrees Celsius change by 2020. The El Nino phenomenon and the Southern Oscillation (ENSO) circulation pattern of the tropical Pacific results in high temperatures, high precipitation events and low solar radiation leading to exacerbated drought and flood events (McCarthy 2014; World Bank 2002).

Ranked as the second most vulnerable country to climate change at a global level, in the period from 1997 to 2006, a decade later, Nicaragua is still one of the countries in the LAC region which is most at risk of human and economic impact stemming from climate variability. This vulnerability stems from its geographical position, poverty status, dependence on natural resources, and the limited level of investment to date in clean production technologies, and adaptation and mitigation activities (MARENA 2000; World Bank 2009).

Climate change in Nicaragua will lead to an increase of 1-2 degrees Celsius in average temperature between 2010-2050, and 3-4 degrees Celsius by 2100; a decrease in precipitation from approximately 8% to 36% between 2010-2100; and a decrease in cloud cover from approximately 4% to 17% between 2010-2100. The highest temperature increase will occur on the Pacific coast of Nicaragua, and while precipitation intensity will increase on the Atlantic coast, overall there will be a decrease in precipitation at a national level (World Bank 2008).

Nicaragua's government has long recognised its vulnerability to climate change. In 2001, it submitted its National Communication to the United Nations Framework Convention on Climate Change (UNFCCC), establishing a National GHG inventory and developing climate change impact scenarios. An updated version, a Second National Communication is currently being developed, as is a second National GHG Inventory (World Bank 2008).

In 2007, it launched its National Climate Change Action Plan (PANCC), outlining adaptation measures for agriculture and water resources, and measures to mitigate GHG emissions. In the same year, it also put forward a Strategy of Adaptation to Climate Change of Water Resources and Agriculture outlining water and soil management practices to improve the sustainability of agricultural production and reduce vulnerability to climate change (World Bank 2008).

A key aspect of the National Climate Change Plan was to identify mitigation measures, and explore the scope for payments for ecosystem services (PES) to incentivise improved environmental management. Intense deforestation activities as land is cleared for cattle grazing are the biggest contributors to climate change in Nicaragua, with 93% of GHG emissions identified by the first national communication as stemming from land-use change and forestry. In the period between

1990-2000, Nicaragua - with 46.5% of land area covered by forests - had the third highest rate of deforestation in LAC, at 3% per year (World Bank 2008).

2.2.7 Climate Change Impact on Dual-Purpose Cattle Production

Smallholder dual-purpose cattle farmers in Nicaragua will be severely impacted by climate variability - changes in temperature, precipitation and the frequency and intensity of extreme weather events. Grazing of cattle on permanent pasture accounts for 54% of land use, and as a consequence, for a large share of the 93% of anthropogenic GHG emissions stemming from agricultural land use and deforestation. As the agricultural frontier shifts and further land is cleared for expansion of dual-purpose cattle production systems, the GHG emissions associated with milk and meat production will therefore increase (Holmann 2014; World Bank 2008).

As temperatures increase and temperature thresholds are reached, closure of stomata in plants will be triggered as a mechanism to reduced transpiration and water loss. This will lead to water stress in plants which will improve water use efficiency of cattle production, however, at the same time, adversely impact on plant growth, physiology and development. Research on the impact on tropical forages has to date been limited, however, the IPCC's scenarios suggest that, in particular, temperature rise will lead to increased lignification of plant tissues and reduced digestibility, rates of degradation and nutrient availability (Thornton et al. 2009).

Although livestock adjust their consumption according to quality, availability and distribution in favour of the most nutritious species, animal productivity will nevertheless be impacted by climate change. In terms of biomass and yield production, C3 species are better able to cope with conditions of elevated CO2 concentration than C4 species, which is significant given that C3 species are more nutritious than C4 species and that if the composition of a grassland area therefore changes, livestock will consume more protein-rich C3 species (Thornton et al. 2009).

Forages, feed and crop residue quality is ultimately determined, however, by the water-soluble carbohydrate concentration and nitrogen content. An increase in dry matter content as a result of drought will offset a reduction resultant from a so-called CO2 fertilisation effect, while

precipitation variability will lead to N-leaching and therefore, decreased nitrogen content (Thornton et al. 2009).

Increased temperature leads to heat stress in livestock, with heat and humidity adversely impacting on livestock behaviour and metabolism - resulting in reduced productivity, physical activity, feed intake, production potential (regardless of feed intake) - with a deficit in energy leading to a decrease in cow fertility, fitness and longevity. In terms of milk production, higher ambient temperatures lead to increased maintenance energy requirements, however, lead to decreased intake of dry matter and thus a reduction in milk yield (Thornton et al. 2009).

In comparison to increased temperature, little is known as to the extent to which climate change impacts on water flow and recharge rates of the aquifers underpinning extensive grassland-based livestock production systems, and the degree to which water demand requirements of livestock change with increased drought frequency, evaporation, and a change in precipitation patterns and runoff, intensity of precipitation events and incidence of flooding (Thornton et al. 2009).

Climate change will affect the distribution and abundance of disease vectors' competitors, predators and parasites, and new livestock diseases may emerge as genetic resistance is eroded and immunity to disease suppressed by increased exposure to ultraviolet-B radiation associated with ozone depletion, due to increased GHG emissions. Climate change vulnerability will be superimposed on vulnerability stemming from genetic resistance erosion due to global livestock production practices changes as traditional production systems and local breeds are marginalised under the auspices of intensification (Thornton et al. 2009; World Bank 2002).

The behaviour of disease vectors (midges, flies, ticks, mosquitoes and tsetse) is altered by precipitation and temperature variability, in addition to increased intensity and frequency of extreme weather events. Infection of livestock by disease vectors is influenced by temperature, as is feeding frequency on host animals. Vectors typically need to feed twice before transmission of disease occurs, and as such, there will be greater likelihood of successful disease transmission as temperature increases. The development rate of pathogens which spend a significant part of their

life cycle outside the host animal is also influenced by sensitivity to high temperatures and moist as well as dry conditions (Thornton et al. 2009).

2.2.8 Climate-Smart Livestock Production Systems

Livestock production systems will become increasingly important as a reduction in climatic suitability and growing period length in LAC leads to conversion or shift away from mixed crop-livestock systems to rangeland-based systems, and crop cultivation is increasingly regarded as a risky livelihood strategy. The concept of climate smart agriculture and the idea of improving resource use efficiency in production is often used in the context of crop production, but can equally be applied to livestock (FAO 2013; Thornton et al. 2009).

Livestock production systems generate CO2, CH4 and N2O emissions equivalent to 18 percent of the total global anthropogenic GHG emissions. There is growing recognition of the fact that that these emissions need to be mitigated; and that intensification of production systems in order to satisfy growing demand for livestock products needs to occur as a process decoupled from adverse environmental impacts(FAO 2013).

GHG emissions stem from direct and indirect activities - land use and land-use change (36%), manure management (31%), animal production (27%), feed production (6%) and processing and international transport (0.1%). In the context of Nicaragua, agricultural production contributes to 70% of the country's nitrous oxide emissions and 63% of methane emissions, with 89% of methane emissions stemming from enteric fermentation, 3% from farm manure management and 2% from the burning of pastures (FAO 2013; World Bank 2008)

The productivity of dual-purpose cattle, specifically in the context of dairy production, is inversely related to GHG emissions. A cow with output of 200 kg of milk per year produces emissions of 12 kg CO2 equivalent, while a cow with output of 8000 kg produces 1.1kg CO2 equivalent. Per unit GHG emissions (CO2 equivalent per kg fat and protein corrected milk) vary by region, with emissions for LAC (3-5 kg) higher than the global average of 2.8 kg and European/North American (1.6-1.9 kg), but lower than emissions for sub-Saharan Africa (9 kg) (FAO 2013).

Livestock production constitutes a coping mechanism for resource-poor smallholder farmers in variable environments and as a livelihood strategy is of increasing value as variability of agricultural production conditions increases, for example, due to climate change. Inefficiency in livestock production stems from the fact that the prices of production factors such as land, water and feed do not reflect resource scarcity. Adoption of climate-smart practices can improve the ratio between resources used as inputs and outputs in production; and in addition to enhancing resource use efficiency, can reduce enteric CH4 emissions and increase carbon sequestration in soils (FAO 2013).

In the context of a low-input, grazing-based form of livestock production such as dual-purpose cattle production in Nicaragua, climate-smart practices include grazing management, pasture management, animal breeding, animal and herd management, animal disease and health, supplementary feeding and agroforestry. Climate-smart agronomic and animal husbandry practices have the capacity to improve system productivity, soil carbon sequestration, pasture quality and animal performance, leading to reduced GHG emissions per unit live weight gain (LWG) of cattle and per unit of product - meat or milk (FAO 2013).

Grazing management entails balancing and adapting grazing pressure to optimize productivity through agronomic practices taking into account prevalent plant species, soils and climatic conditions. Rotational grazing can enhance efficiency of production, as livestock needs - as regards frequency and timing of grazing - are matched to pasture availability. Yielding more than native grasses, improved forages (perennial fodders, pastures and legumes) contribute towards a reduction in enteric fermentation emissions, as livestock - not subject to grazing pressure - experience rapid LWG, having the opportunity to consume forages of high nutritive and digestive quality (FAO 2013).

Land degradation can be reduced and degraded lands rehabilitated, where pasturelands is managed through cultivation of improved forages and intensified through fertilisation, cutting regimes and irrigation practices. A reduction in overgrazing and land degradation can also be realised where agroforestry or silvopastoral practices are adopted. Production of trees with non-tree crops or livestock facilitates an intensified and more diverse form of agricultural production which is

resilient to climate variability. In the context of livestock production, trees can reduce heat stress and increase productivity by providing a source of high quality and quantity feed and fodder (FAO 2013).

Animal and herd management improves productivity by enhancing efficiency of feed conversion, with augmented nutrition leading to improved animal health, reduce mortality and slaughter age - and ultimately, lower emissions for the same level of output. Reductions in methane emissions can also be realised through selective cross-breeding, which also facilitates improved productivity through increased heat tolerance, disease resistance, fitness and reproductive tolerance to heat, poor nutrition, parasites and disease (FAO 2013).

In Nicaragua, climate-smart livestock practices have been promoted by CATIE through a network of farmer field schools since 2004, encouraging incorporation of improved pasture with trees, cut and carry fodder banks of forage grass and woody fodder as part of silvopastoral systems. In addition to increasing milk output per cow per year (both during the rainy and dry seasons), silvopastoralism is considered superior to traditional production systems in terms of income generation (US$ per hectare per year) and carbon sequestration (tonne per hectare) (FAO 2013).

2.3. Carbon Sequestration as a Climate Change Strategy

2.3.1 Greenhouse Gas Emissions

Carbon sequestration - the capture of carbon from the atmosphere to the biosphere or the anthrosphere, and storage in plant biomass and soils, leading to reduced terrestrial emissions - constitutes an important climate change mitigation and adaptation measure. Sequestration is increasingly recognised by academics, development practitioners and policy makers, as having current and significant future potential to contribute towards global efforts to reduce greenhouse gas (GHG) emissions. Given the fact that deforestation and forest degradation are considered to contribute to 17 percent of GHG emissions, it is evident that carbon sequestration has the potential to unleash a significant amount of financial PES transactions (Brandão et al. 2012).

Although, the percentage reduction in GHG emissions which can be realised through soil carbon sequestration, constitutes just 3-6% of the amount which is possible through a reduction in fossil fuel use, the capture and storage of atmospheric carbon in soils is an important and cost-effective strategy. In particular, there are many positive externalities associated with adoption by smallholder farmers of improved land management or good agricultural practices (GAPs), which lead to reduced carbon loss and increased atmospheric CO2 accumulation(O'Mara 2012; Soussana et al. 2010).

2.3.2 Carbon Sequestration as a Process

Carbon sequestration is facilitated through land use practices which minimize disturbance of soils and vegetation, and through maintenance of trees. Conservation becomes a competitive land use paradigm when it is supported, for example, by PES or similar market-based instruments (Adhikari & Agrawal 2013; Soussana et al. 2010).

A dynamic process consisting of an accumulation phase and a maturation phase, carbon sequestration occurs both above, and below ground, with an initial carbon loss occurring as an agricultural production system is established or modified through land use change. Effective sequestration is considered to take place if there is a positive net carbon balance after a significant period of time (Albrecht & Kandji 2003; Brandão et al. 2012; Soussana et al. 2010).

Although agricultural lands as a whole can be conceptualised as a sink for carbon; tropical and subtropical soils in particular have significant capacity for carbon sequestration given that they are often depleted of, or low in soil organic carbon (SOC) content as a consequence of soil disturbance, vegetation degradation, use of fire to clear land, erosion and nutrient or water deficits (Lal 2010; O'Mara 2012; Soussana et al. 2010).

The IPCC has encouraged adoption of practices leading to carbon sequestration in soils, as there is significant potential for this to positively impact upon the livelihoods of smallholder farmers given their current vulnerability to climate change, dependence on agricultural production activities and decreasing availability of land for expansion (Soussana et al. 2010).

Reducing the extent to which soil aggregates are mixed and broken, soil organic carbon (SOC) is decomposed; GAPs increase the residence time, amount and quality of SOC content remaining in the root zone. Improved soil structure and quality leads to increased agricultural productivity (net primary production and food production), water storage and quality, and ecosystem biodiversity (Lal 2010; Soussana et al. 2010).

In addition to the agro-ecosystem outcomes as regards primary productivity, there is also considerable interdependence between GAPs leading to carbon capture and storage in soils, and the climate and weather patterns observed. Increased atmospheric carbon concentration improves plant productivity and efficiency of water to nutrient-use where soil moisture is deficient, however, it also leads to increased temperature and frequency of extreme climatic events such as drought and floods (O'Mara 2012).

In the context of smallholder livestock production systems, GAPS include reduction in tillage, utilization of crop residues, application of manure, conservation of water bodies, conversion of arable to grassland, intensification of nutrient poor permanent grassland and conversion of grass to grass-legume or permanent grassland. Sequestration is greatly increased where an agricultural landscape comprises exotic deep-rooting grass species and where trees are incorporated as live fences, posts or barriers and hedges (O'Mara 2012; Post & Kwon 2000; Soussana et al. 2010).

Although, carbon sequestration takes place primarily below-ground between 0 to 30cm - three times more than above-ground - overall potential is greatly enhanced where the agroecosystem above-ground is diversified to include multi-functional fertilizer- and fodder tree species. These species increase capacity to buffer physical disturbance and thus the stability of carbon sequestered (Henry et al. 2009; Soussana et al. 2010)

The potential of grasslands and more specifically, improved forages, in contributing towards GHG emission reduction and carbon sequestration is often overlooked in climate change mitigation and adaptation discussions. Forages are considered to have the potential to contribute to as much as 60-80% of the total carbon sequestration potential of agricultural land and where improved

management is utilised to increase productivity and restore degraded grasslands, forage pastures have a potential for carbon sequestration exceeded only by that of forests (Peters et al. 2013)

At a global level, grassland soils are currently responsible for the sequestration of approximately 343 Gt of carbon. Although this figure is lower than for croplands, given that 800 million people are dependent on grasslands for their livelihoods, the positive externalities associated with carbon sequestration realised through grassland management and adoption by smallholder livestock farmers of GAPs are significant (O'Mara 2012; Soussana et al. 2010).

Formerly degraded agricultural croplands and pasture lands can be transformed into sinks for carbon through judicious management of livestock grazing time and intensity. Prevention of over and under grazing reduces carbon loss; with intensively managed grasslands have the capacity to sequester 2t C more per hectare than extensively managed grasslands. The intensity and length of time of grazing directly influences net primary production, leaf area treading and defoliation by livestock, and finally the return of carbon to the grasslands by excreta. Degraded pasture lands average 26.4 tC per hectare compared with an amount of 114-143t C per hectare for improved and natural pasture with trees (O'Mara 2012; Soussana et al. 2010).

Carbon sequestration projects are often implemented at an international level, through REDD and CDM schemes, for example in Chiapas, Mexico. If land use and environmental services are perceived to be closely aligned by actors, a local level PES scheme can function effectively. However, PES schemes are often considered to only have a modest impact on poverty alleviation, despite improving incomes and enhancing sustainability of farming systems. Risk prevents smallholder farmers adopting practices and technologies such as conservation agriculture. There are often short term risks involved before productivity increases and smallholder farmers are basically risk averse. The benefits in terms of profit stem from adoption of technologies which lead to increased SOC and productivity increases (McCarthy 2014; Porras et al. 2011; O'Mara 2012).

2.4. Payments for Ecosystem Services (PES)

2.4.1 History of PES

In the 1960s, a field of economics emerged – Environmental and Resource Economics – building on Neoclassical economics, as it attempted to value and internalize economic impact on the environment and the contribution of nature – ecosystem goods and services, typically neglected or non-marketed – to societal well-being. This new branch of economics conceptualized ecosystem services as positive externalities, with an economic or monetary value, to be considered in economic decision-making (Gómez-Baggethun et al. 2009).

The concept of ecosystem services as it is understood today originated in the 1970s, framed by a utilitarian ideal of societal dependence on ecological life support systems, intended to increase public interest in conserving biodiversity. In the 1980s, the field of Ecological Economics was consolidated, with ecosystem services considered to have monetary value given that economic benefits are generated for society (Gómez-Baggethun et al. 2009; Tacconi et al. 2009).

During the 1990s, ecosystem services were mainstreamed and economic value estimated. Since 2000, ecosystem services have been framed in an economic decision-making context, with Payments for Ecosystem Service (PES) schemes becoming increasingly popular. Ecosystem services are now framed in a manner that was not the original intent, initially the idea was to educate society, while today the emphasis is rather on how to commodify services on markets (Gómez-Baggethun et al. 2009).

2.4.2 PES and Environmental Policy

The nexus between environmental degradation and poverty has long been recognised, with poor smallholder farmers considered to deplete and degrade natural resources at rates incompatible with long term sustainability due to their reliance on these resources to supplement their income and sustain their livelihoods (Dasgupta et al. 2003).

Recognition of the significance of economic incentives in inducing environmental stewardship, conservation and protection, has given rise in recent years to the design and implementation of environmental policies underpinned by economic incentives. One incentive- or market-based

policy mechanism which has emerged as popular, and a viable alternative to ineffective traditional command-and-control policies, is the 'Payment for Ecosystem Services' (PES) (Bulte et al. 2008; Jack et al. 2008).

A form of environmental policy-making involving government, society or third-parties - individuals, corporations and NGOs - offering compensatory payments to smallholder farmers to encourage them to arrest or reverse environmental degradation, PES schemes have to date been applied to a wide range of contexts including species conservation, climate regulation, watershed protection and carbon sequestration (Pattanayak et al. 2010)

PES is based on neoclassical environmental economics thinking, which deems degradation to result from chronic failure of market to internalize externalities. PES schemes are intended to make conservation an attractive proposition, facilitating the internalization of positive externalities such as carbon sequestration and biodiversity conservation, which are associated with agricultural land uses (Van Hecken & Bastiaensen 2010; Van Hecken et al. 2010)

PES is underpinned by Coasean economics and by the belief that a socially optimal outcome can be achieved or reached through market or quasi-market bargaining. Schemes are user-financed, meaning that as per coasean economics there is efficiency due to involvement, impact evidence and feedback, as well as easy renegotiation of contracts. Third party schemes involve indirect service provision buyer-seller interaction, leading to reduced efficiency and subject to political pressure or influence (Porras et al. 2011).

Transaction costs are kept low and individuals trade their rights until a Pareto-efficient provision of environmental goods and services is realized. A market is created in response to the market failure or lack provision of such environmental services. The underlying premise is that there are individuals who own or manage natural assets and associated services, while there are also individuals willing to maintain or enhance provision of services through payment – providers and buyers. PES schemes essentially commercialize services derived from or associated with natural assets (Pattanayak et al. 2010; Tacconi et al. 2009).

PES schemes utilise market forces to enable social and environmental objectives to be realised, and are seen as offering an opportunity to alleviate poverty. PES are regarded as generating double dividends. The degree to which a PES achieves set objectives within a specific context depends on the structure (form of payment or incentive), service provided, actors, eligibility rules for participation and payment funding source (Bulte et al. 2008; Jack et al. 2008).

PES schemes involve a voluntary transaction between buyers and providers and are based on a degree of conditionality – the relationship between land use and ecosystem service is clearly defined, additionality in terms of the ecosystem is assumed, stakeholders are in a position or have the capacity to terminate a contractual relationship, and there is a monitoring system to ensure service provision takes place. In practice however, few PES schemes can satisfy all these criteria (Jack et al. 2008; Porras et al. 2011; Vatn 2010; Wunder et al. 2008)

PES initiatives redefine land ownership use and property rights, as providers are contractually obligated to maintain or undertake specific land use activities, and buyers can gain the right to trade service units such as carbon sequestration credits for their own commercial purpose (Vatn 2010; Muradian et al. 2010; Ferraro 2008).

Underpinned by the premise that the smallholder farmers are unlikely, in the absence of an attractive incentive, to engage in natural resource management or refrain from livelihood strategies considered detrimental to the environment, PES offer direct and tangible economic benefits to smallholder farmers, in return for their commitments to participate in environmental conservation and protection activities (Porras et al. 2011).

Viewing smallholder farmers as actors, with an important role to play in conserving or indeed protecting natural resources, marked a paradigm shift. PES marks a paradigm shift as it is premised not on imposing sanctions but rather rewarding positive environmental externalities. If interests are misaligned in terms of the individual versus society, intervention is needed in the PES scheme design to ensure externalities are internalised (Jack et al. 2008; Porras et al. 2011).

PES are a policy response to society's failure to internalize the public value of intact ecosystems and acknowledge functions performed by the environment which are life-supporting, life-enhancing and critical to human well-being. Rather than enforcing strict regulations or imposing sanctions, PES highlight the negative impact of a particular land use on the provision of an environmental service, with the associated market price signalled by the identified opportunity cost of service supply forgone (Pattanayak et al. 2010).

PES schemes seek to support and acknowledge good practices. PES are a mechanism to overcome collective action problems associated with socially-suboptimal Nash equilibrium – stalemate of individual non-cooperative strategies – to instead realize win-win scenarios. PES initiatives are based on the premise that individuals act rationally to maximize or optimize their self-interest. A PES is designed to induce human behavioural change, regarded as both socially optimal and sustainable, through incentives, and increase the profitability of certain economic activities that promote eco-friendly land-use practices (Van Hecken & Bastiaensen 2010).

Van Hecken et al. 2010 argues that while PES is motivated by an innovative pro-conservation approach aimed at supporting private land users, schemes often fail as there is a lack of appreciation of the reality that both economic and non-economic factors are important and PES is not simply a matter of financial incentive provision. He suggests that PES must be conceptualized as constituting part of a broader process of local institutional transformation (Jack et al. 2008; Porras et al. 2011; Van Hecken et al. 2010).

For a PES scheme to function, the context and institutional setting into which it will be introduced is of fundamental importance as this determines complexities which will determine its success or failure. The degree to which a PES is socially embedded, distribution is realized, as well as power relations governing interactions all influence a PES. Both in the design and implementation of PES schemes, and in the literature, such institutional and political economy issues are often overlooked. In order for a PES to be effective, and its outcomes to be win-win, key institutions must fulfil their respective roles and shared beliefs must underpin the design and implementation of the scheme (Bulte et al. 2008; Jack et al. 2008; Muradian et al. 2010).

2.4.3 PES as an Innovative Instrument

Underpinned by Coasean economics, which emphasizes the possibility to achieve theoretical win-win situations, PES is an instrument where a variable payment is provided, conditional on an agreed land use leading to provision of an environmental service. Governed by a contract, participation in a PES scheme is usually on a voluntary basis, with a contract governing the relationships and transaction costs involved, from compliance and service provision to the opportunity cost associated with alternative land uses foregone (Jack et al. 2008).

It is increasingly recognized that the feasibility of a PES scheme is dependent on the socio-institutional context, and thereby it can be constrained or supported. Institutions have an important role to play in influencing perceptions, values and social norms, as individuals have both extrinsic and intrinsic motives, including social responsibility and obligation. A PES considered to be working efficiently engages actors in such a way that there is an incentive to ensure and monitor service provision, renegotiate agreements and access information (Wunder et al. 2008).

The organization of payments and determination of price for a PES scheme requires input from different actors at national and local level. A land use proxy measure is often utilized to describe a relationship between the land use and its environmental service-providing effect. Payments under PES schemes must cover at a minimum the land users' opportunity costs of more environmentally-sound land use, in order to provide an incentive to initiate improved land use management practices. The extent to which direct payment is received by the environmental service provider is limited, as payments are often in-kind, with rewards made through investments. Conditional continuous payments are considered to promote growth and welfare, particularly if given in the form of asset transfers (inputs such as tree transplants) and non-income gains (training) (Bulte et al. 2008; Jack et al. 2008; Porras et al. 2011).

Incentive-based mechanisms modify relative prices to make environmental degradation costly and eco-friendly activities beneficial and profitable. In addition to making it unattractive to pollute, PES schemes also make it more attractive in monetary terms to enter or continue operating in a particular value chain. Additional environmental benefits can be compromised, however, as incentives may cause negative externalities or spillover - clearing of additional plots, or other

degrading practices, as income received from a PES scheme is used to expand agriculture. These are so-called secondary effects, which counter benefits (Jack et al. 2008).

PES is innovative as direct payments are tied to investment goals rather than to indirect conservation actions. It is a model which differs from government 'command and control' and community based governance as it is regulated by a market, with decision making is contingent on economic incentive. PES schemes can be output-based meaning that indicators are used to monitor service provision delivery (tons sequestered), while input-based are monitored changes resulting from predetermined land-use activity impact assumptions (Grieg-Gran et al. 2005; Porras et al. 2011; Wunder et al. 2008)

2.4.4 PES in Practice

Some PES schemes bundle services, while others focus on a specific ecosystem service. Among the most famous PES example is the GEF-World Bank 'Regional Integrated Silvopastoral Ecosystem Management Project', which took place over a six-year period between 2002-2008. Implemented in Colombia, Costa Rica and Nicaragua, the project looked to incentivise smallholder farmers to engage in ecosystem conservation with payments made on a per hectare basis for silvopastoralism, agroforestry and agriculture. The overall aim of the project was to determine whether silvopastoral practices could be promoted in degraded pasture areas through the introduction of a PES scheme and technical assistance support, leading to increased carbon sequestration and biodiversity conservation (Van Hecken & Bastiaensen 2010; Porras et al. 2011).

In Nicaragua, the PES scheme focused on two micro-watersheds in the Matiguas-Rio Blanco region. In 2003, 50% of the pasture land included in the project was classified as degraded, with forests cleared for pasture land for cattle. Significantly, during the first two years of the project in Nicaragua, land use change led to a significant reduction in the level of degraded pasture and increased density of trees in pastures, fodder banks and live fences. More generally, PES schemes have to date not been regarded as adequately compensating opportunity costs of non-conservation alternatives (Van Hecken & Bastiaensen 2010)

2.4.5 PES and Poverty Reduction

PES is associated with poverty reduction as the poor typically rely on natural resources for their livelihoods and are located in rural areas. Considered to generate double dividends, PES schemes enable social and environmental objectives to be realised, and are seen by advocates as offering an opportunity to alleviate poverty, provided the opportunity costs are low enough to facilitate participation by the poor and they have capacity to provide services (Grieg-Gran et al. 2005; Bulte et al. 2008).

PES schemes reduce poverty if they provide an income significantly higher than otherwise earned through alternative land use. If lands owned are high sloped and low quality soil, the opportunity cost associated with leaving the land in fallow to increase ecosystem service provision is low and the PES can be targeted successfully at the poor (Jack et al. 2008).

Debate surrounding PES has focused on evaluating the extent to which PES schemes improve the livelihoods of smallholder farmers by increasing their well-being. However, Wunder posits that the debate is inaccurate, as PES should not be framed in terms of poverty reduction and an alternative perspective is required. Restricted PES schemes aimed at achieving poverty reduction criteria is counterproductive as environmental objectives should be the primary goal. A more realistic view is therefore required, which acknowledges the fact that PES schemes do not necessarily achieve both poverty and environmental goals (Grieg-Gran et al. 2005; Wunder et al. 2008; Pattanayak et al. 2010).

PES schemes are not intended to be instruments to improve livelihoods, however, they can impact on the poor given the nexus relationship between environmental conservation, degradation and poverty. The extent, to which poverty is reduced, however, depends on participation capacity and size and form of payment provided. Participation is limited by insecure land tenure, small land holding and lack of credit. PES can indirectly influence poverty reduction, however, PES payment schemes are based on service value rather than specifically designed to directly benefit the poor. Although PES schemes are not always pro-poor in outcome, they are generally considered to deliver win-win mechanisms for environmental protection and poverty alleviation (Tacconi et al. 2009).

One aspect which is often undervalued is the positive impact that PES can have on food and labour security and land prices. Actors providing environmental services differ in terms of their farm size, quality of service provided and wealth or well-being. Poor quality lands in the context of agricultural production have high environmental service potential, and in this case PES schemes can thus benefit the poor (Bulte et al. 2008; Jack et al. 2008).

2.4.6 The Social Impact of PES

PES schemes involving the poor have the potential to realise positive social outcomes - improved capacity, skills and knowledge; access to resources, perceived value of natural resources; community cohesion and influence on institutions and decision-making processes. Equity, defined by access (participation), decision-making (fairness, recognition and inclusion) and outcome (distribution of benefits) is increased without compromising the efficiency of a PES scheme, when the latter successfully targets the poor (Tacconi et al. 2009; Porras et al. 2011).

In-kind payments from PES schemes are seen as an equally valid form of compensation and can benefit poor communities by providing quality seed and fertiliser supplies and their neighbours with infrastructure improvements (roads, schools, health centre) by way of grants to community-based organisations (Porras et al. 2011).

PES can strengthen resource management and social coordination capacity of communities, enhancing knowledge and skills, as well as relationships between actors. In addition to tangible benefits, non-tangible benefits are generated such as changes in perceptions and relationships regarding bargaining power (Tacconi et al. 2009).

2.4.7 PES and Markets

It is argued that payments for ecosystem services is only attractive to the private sector market when conservation or sustainable use of resources can lead to a return on investment (business profit) or it is philanthropically attractive. The private sector require motivation – a business opportunity realized through carbon offsetting or environmental risk reduction, or alternatively, an opportunity to secure, sustain or reduce costs of key natural resource inputs (Mulder et al. 2004).

In addition, private sector companies, through participation in PES schemes, have the possibility of creating differentiation in a market and improving public relations, leading reputational gain – 'green branding'. Interest from the private sector in PES schemes is most acute when natural resource products are not available to the required quality standard from conventional market sources, leading to an opportunity for the introduction of 'green branded' products in a specific market segment. However, the benefits for private sector clients investing in PES schemes are often only realized in the medium to long term as market differentiation of products is a long term process (Mulder et al. 2004).

2.4.8 Criticisms of PES

It is argued that certain conditions characterizing the environments into which PES are introduced are ignored in the scheme design, such as the lack of well-functioning markets, inevitable trade-offs between equity and efficiency and the value placed on one at the expense of the other, and the lack of social embeddedness of schemes (Muradian et al. 2010; Porras et al. 2011).

As ecosystem benefits derived from PES are not always easy to estimate in monetary term – value is not expressed in a common measurement unit - the cost-benefit valuation inherent in a PES scheme is often questioned and even heavily criticized by many opponents (Gómez-Baggethun et al. 2009).

Many PES schemes are open to criticism in not being underpinned by a clear causal relationship between land use practice and expected enhancement of environmental services. Conditionality cannot be satisfied, there is little monitoring in practice and payments are upfront rather than continuous, made in good faith rather than contingent on service provision (Muradian et al. 2010).

Opponents of PES criticize the requirement for additionality in the scheme design, arguing that perverse incentives are created. Specifically, smallholder farmers are incentivised to engage in land degradation activities prior to the signing of contracts as this means the baseline for compensation estimation is favourably altered. Moreover, the establishment of a baseline and monitoring of its compliance by buyers is contentious. Also, PES schemes are characterized by uncertainty due to the biophysical complexity on which the measurement of additionality is based,

which means that the relationship between land use and service provision is not clear-cut. (Porras et al. 2011)

PES programmes are not always designed to take account of all impacts. Activities must not generate negative (leakages) and positive (spillage) externalities, as well as wastage of resources in other areas – the degree to which this occurs must be assessed and mitigated (Porras et al. 2011)

PES schemes have a tendency to be constrained or undermined in situations where a limited number of actors, so-called patron-gate-keepers, have access to and control information and resources. Collective inaction results, or actions initiated which is dominated and skewed in terms of power leading to manipulation. Mutual mistrust or distrust among actors leads to opportunistic behaviour, double standards and pessimism, which undermine the PES (Hecken et al. 2012).

PES detractors argue that conceptualizing of incentives solely in a market mechanism context leads to 'motivational crowding-out' and reduced value placed on ethics and social norms, the locus of responsibility is shifted and individuals are left to choose whether or not to partake in environmental management activities. The criticism is that effort made is conditional and thus contingent on perception of receipt of sufficient compensation. Responsibility is removed, and individuals grow to expect compensation for action previously undertaken voluntarily. The environment becomes a commodity which can be held as ransom and strategically used to demand greater compensation. Moral obligation is eroded and ultimately, payments have a reduced positive net effect on provision of an environmental service (Van Hecken & Bastiaensen 2010)

Another criticism levelled at PES concerns the sustainability of the initiative given the incentive based compensation dependency of the schemes. Sustainability and effectiveness is questioned, as environmental ethics and social outlooks are changed and respond to a payment for services scheme (Van Hecken & Bastiaensen 2010).

PES schemes are often stated to exclude poor landholders, and target relatively better-off farmers. In Latin America, most PES discriminate against the poor due to lack of formal land tenure titles as well as limited land endowment. Participation by the poor is increased where a project is flexible in terms of its design and implementation, enabling the smallholder farmer to choose what is most appropriate. In the absence of targeting, larger landowners benefit at the expense of the landless and smaller landowners (Muradian et al. 2010).

Constraints limit the capacity of the poor to participate - these include informal/insecure land tenure and the high transaction costs of working with many smallholder farmers, while economies of scale are an incentive for environmental service buyers to prefer large landowners over the small and landless. Transaction costs can be reduced or modified by increasing access and working with a cooperative of farmers. PES schemes can also explicitly target the poor through specification of farm size and other criteria. Risk of soil erosion and deforestation is greater in some areas compared to others, and as such, targeting needs to consider the heterogeneity of ecosystems (Bulte et al. 2008).

PES schemes are criticized for their unclear land-use and impact relationships, measuring difficulties, market approach, poverty and inequity, institutional preconditions (land tenure insecurity and overlapping claims), cost-effectiveness and institutional context(Porras et al. 2011).

2.5 Carbon Insetting

2.5.1 'Climate Strategies' adopted by Agro-Food Actors

In recent years, agro-food industry has increasingly come to recognise that there is an interplay between production and consumption behaviour, and that consumers' opinion regarding the '"social life" of a commodity' can be positively as well as negatively influenced. The 'meaning and value' of a product can, at a fundamental level, be shaped by characteristics and narratives which 'reassure consumers about what it is they are buying'(Lovell et al. 2009).

As stated by Finkbeiner (2009) there is 'an increasing market demand for "climate relevant" information along supply chains and towards consumers'; and in this context, as well as to improve their corporate social and environmental responsibility profiles, agro-food industry organisations are increasingly implementing 'climate strategies' ranging from carbon footprinting, emissions reduction, low carbon product development, carbon offsetting and most recently, carbon insetting.

2.5.2 Carbon Offsetting

Following a carbon footprint assessment and with the aim of reducing GHG emissions or developing a low carbon product, the most popular strategy employed by agro-food actors to date has been carbon offsetting - a strategy involving the purchase of carbon credits from a project where a certain quantity of emissions reductions or carbon sequestration has been realised to balance or offset their own emissions(Lovell et al. 2009).

A carbon 'offset' is essentially a measure of GHG emissions reduction or carbon sequestered, relative to an initial baseline level, and when traded, is referred to as a carbon 'credit' - representing one metric tonne of CO2 equivalent - on either the voluntary or compliance carbon market. Widely regarded as real, permanent, and additional and as not leading to leakage, carbon offsets are viewed as verifiable and regulated according to established and accepted standards such as the Clean Development Standard (CDM), Gold Standard (GS), Verified Carbon Standard (VCS) and Plan Vivo Standard (PV).

Originating outside the supply chain of an agro-food actor, carbon offset credits ensure that an agro-food actor compensates society, and specifically consumers, for the GHG emissions which it

cannot directly reduce or avoid producing. As noted by Lovell et al. (2009) and Malin et al. (2013) credits are frequently derived from energy efficiency and renewable energy projects making them easy to document, quantify, validate, monitor and entailing little risk of reversal (as regards CO2e removal from the atmosphere) compared to credits generated by agricultural based projects.

For agro-food actors, the purchase of carbon offsets from energy projects is easy, and as stated by Lovell et al. (2009), yields 'relatively quick carbon returns [...] in comparison with a sequestration project such as tree planting, where actual carbon benefits to the atmosphere are up to seventy years in the future'. However, offset credits do not involve the existence or fostering of a 'direct relationship between the supplier and the buyer', and as a consequence, agro-food actors do not realise any benefits in terms of improving, strengthening and increasing the resilience of their own supply chain to climate change.

2.5.3 Carbon Insetting

An innovative variation on carbon offsetting, carbon insetting entails reducing GHG emissions or sequestering carbon through an activity linked to a supply chain of a given actor or an activity in its direct sphere of influence.

Dependent on productive and well-functioning agroecosystems in terms of obtaining a supply of raw material, agro-food industry actors often stand to realise considerable performance-based benefits, in the context of vertically disintegrated value chains, from incentivising upstream supply chain participants - such as smallholder farmers - to adopt more "environmentally friendly", sustainable agricultural production practices.

By investing in their own value chain, and enhancing the resilience of the chain as a whole to climate change - including the most vulnerable link in the chain, namely, smallholder farmers responsible for primary production - agro-food industry actors can create shared value and generate mutual benefits, while reducing their carbon footprint and the GHG emissions associated with the goods produced.

As a climate strategy, carbon insetting builds on the application of carbon credit projects as a framework for climate change adaptation and mitigation. Providing agro-food actors with a funding mechanism through which to incentivise smallholder farmers' adoption of good agricultural practices or climate-smart practices, carbon insetting results in improved management of agricultural lands and natural resources, leading to greater productivity and a more stable supply of raw material.

Through carbon insetting, agro-food actors have the opportunity to sustain or realise a competitive advantage in international markets. Specifically, they can utilise carbon insetting as part of their 'overall climate engagement and communications strategy' - as opposed to utilising or referencing it for 'carbon accounting' purposes - thereby improving their corporate social and environmental responsibility profiles; and strengthening as well as gaining insight into the workings of their value chain to anticipate and manage risks posed by climate change, enhance resilience and in the process, realise 'potential triple win' scenarios.

Land-based credits are often regarded as entailing greater risk, due to their impermanence - smallholder farmers' behaviour is contingent on agro-food actors committing to providing an incentive and mobilising sufficient resources. Notwithstanding this fact, carbon insetting that it enables the experience, efforts, knowledge and resources of different actors - ranging from smallholder farmers, research and development organisations, to the private sector - to be leveraged; carbon insetting has the potential to generate win-win solutions for all actors participant in an agricultural value chain.

Synergies exist between climate change mitigation, adaptation and enhancement of the livelihood security and sustainability of smallholder farmers. The feasibility and therefore, success of a carbon insetting project depends highly on its legal and political context - factors such as whether or not smallholder farmers have secure land tenure - property rights and land titles - and are organised, for example, through a cooperative. In addition, it depends on the opportunity costs involved as well as whether smallholder farmers can afford investment costs.

Identifying agricultural production activities for the purposes of establishing a carbon insetting project, with GHG emissions reduction or adaptation potential in addition to carbon credit generation potential, necessitates assessing trade-offs, as well as of the extent to which smallholder farmer are already in a position to adapt to and mitigate climate change impacts. Agro-food actors can thereafter decide to provide an incentive in the form of a direct payment proportional to a certain amount of carbon sequestered, or provide in-kind payment in the form of capacity building - 'training, workshops and recommendations to improve practices and carbon performance'.

Carbon insetting aligns agro-food industry actor and smallholder farmers' incentives as regards engaging in environmental conservation and adapting to and mitigating climate change. In comparison to traditional climate strategies such as carbon offsetting, it enables agro-food actors to realise additional goals or objectives - such as improving smallholder farmer livelihoods, reducing supply pressures, enhancing their reputation as environmental stewards and generating carbon revenue (from low carbon or carbon neutral products).

The success of an insetting project also depends on the vulnerability of the target group - smallholder farmers - and the carbon accounting methodology utilised, the 'final price paid for carbon' and the extent to which this facilitates development of 'additional adaptation opportunities [...] from carbon credit revenue flow'. In general, however, there is considerable scope to combine investment in carbon with the goal of strengthening the resilience of a value chain, given that life cycle analyses typically identify primary production as having the greatest 'environmental impact of all stages of product life'.

Enhancing the competitiveness of a value chain, the concept of carbon insetting is becoming an increasingly popular 'paradigm' among agro-food industry actors who 'seek to respond to the challenges' in transitioning to the 'low carbon economy' and who consider it a 'trend' enabling them to be 'leaders in the corporate sector' in moving towards carbon neutrality - a 'power communication tool' (Tipper et al. 2009).

For agro-food actors, carbon insetting is an effective strategy to reduce GHG emissions, specifically scope 3 emissions - those associated with 'use of their products [...] with the processing

of purchased materials' - as opposed to 'direct emissions from operations and the emissions from electricity used by the organisation (scope 1 and 2 emissions)'. Carbon insetting and carbon offsetting are not regarded as 'mutually exclusive' - indeed, carbon insetting is often utilised as an additional strategy to complement traditional 'offsetting' of unavoidable GHG emissions in a manner which has a more environmentally and socially sustainable impact (Tipper et al. 2009).

Those who engage in carbon insetting are typically 'forward-thinking', innovative agro-food actors, who are interested in transforming their relationship with other value chain actors - namely, smallholder farmers - beyond simply, a 'financial transaction'. They recognise the need to establish a partnership to 'identify emissions reduction opportunities' in the context of increasing the climate change resilience of the value chain (Tipper et al. 2009).

Consequent to the fact that insetting is central to a 'broader business strategy' and that there are 'additional benefits [...] increased customer loyalty or supply chain efficiencies that can be factored in to the overall economic assessment', agro-food actors are often more willing to accept the 'higher notional cost of abatement than would be acceptable under a standard offset arrangement'(Tipper et al. 2009).

Unlike traditional carbon offsetting, insetting currently does not require 'verification or certification' against agreed formal industry carbon standards. Nevertheless, many agro-food actors choose to 'use an independent verifier or auditor to check results' according to aforementioned standards (PV, GS etc.) already applied by the agro-food industry in the context of offsetting projects. In doing so, they acknowledge the fact that although carbon insetting projects are fundamentally sustainable - designed in such a manner that they are 'embedded within the boundaries' of the business interests of participating value chain actors - verification gives an insetting project more credibility.

Although carbon insetting projects has not yet been extensively documented at an academic level, in peer-reviewed journals or otherwise, there are a number of ongoing projects across Africa, Asia and Central and South America. Designed and implemented by project developers such as South Pole Carbon and Pur Projet, these carbon insetting project have to date been certified according to

the Plan Vivo Standard and Gold Standard, and primarily implemented in the tea, cocoa and coffee sectors. As the concept of insetting is relatively new, however, the reports which exist are empirical in nature - commissioned or written by those initiating or implementing the projects - and thus their objectivity cannot be verified. For this reason, an analysis of documentation of existing carbon insetting projects has not been included as part of this literature review.

2.6 Value Chain Approach to Poverty Reduction

Agricultural value chains do not often function very well as actors perceive little incentive to improve, collaborate or cooperate with others in the chain (KIT et al. 2006). By adopting an intervention approach which is inclusive, consultative, and participatory; and most importantly, draws attention to the synergy between the agendas of different interest groups, however, development organisations can encourage value chain actors to work together more closely (Hall et al. 2004)

At a fundamental level, a value chain intervention approach seeks to improve the conditions under which small-scale producers operate and participate in markets; as well as the circumstances governing their involvement in activities which are 'required to bring a product or service from conception through different phases of production, delivery to final consumers' (Kaplinsky et al. 2001, p.4). Value chains are frequently characterised by unequal power balances; and as such, a value chain intervention approach aims to effectively forge or strengthen the position of small-scale producers relative to other actors engaged in a market chain.

Underpinned by a belief that value chains are made more efficient and effective when the system of vertical linkages which exists between actors performing different functions along a chain is redefined; a value chain approach is intended to facilitate the renegotiation of intra-chain relationships. The overall functioning of a value chain is considered to be dependent not only on the capacity of actors participating in a chain, but also the degree to which these actors are enabled – at both an individual and collective level – to fulfil their respective roles (Kaplinsky & Morris 2000).

As actors in a value chain are typically conducting activities independent of, yet conversely dependent on each other; one of the strengths of adopting a value chain approach is that, regardless of the point of entry chosen, an intervention will implicitly impact on the functioning of the value chain as a whole. Indeed, interventions are often purposely delimited to, or focused on, a specific section of a value chain (Henriksen et al. 2010) .

Participating in agricultural value chains, small-scale producers are constrained in their ability to enter new markets, introduce new products or add value to an established portfolio of products. Ironically, despite increasingly being integrated into value chains, small-scale producers throughout the developing world are not yet able to engage in the market on an equal footing with other value chain participants as efficient and reliable providers of agricultural products and services (Vermeulen et al. 2010).

In addition to having the potential to significantly reduce poverty in rural areas and enhance the resilience of entire communities - through informal agricultural extension and knowledge sharing – interventions can increase overall effectiveness of an agricultural value chain by promoting cooperation, coordination and dialogue between upstream and downstream actors working together, but not necessarily motivated by the same goals and objectives.

At a disadvantage in comparison to other value chain actors, small-scale producers are unable to supply market agents with large volumes of quality products. As a consequence of their deprivation and exclusion from society, poor producers find themselves in the position of being forced to trade on relatively unfavourable terms with other chain actors. By bringing together producers, other market chain actors and service providers for the purposes of knowledge exchange; a value chain intervention approach can address market imperfections and thus empower producers to overcome bottlenecks to their inclusion in value chains and engaging with the market (Devaux et al. 2007)

Arguing that the ability to engage and negotiate for improved terms is ultimately more important than belonging to a chain, Roduner (2007) urges development organisations designing interventions to focus in particular on enhancing the role that producers play in value chains. An intervention can only add real value when it develops producers existing capacities, and in doing

so, increases their access to a greater share of the total value generated within a chain. Value chains should effectively be conceived of as frameworks enabling organisations to identify points of intervention where actions undertaken will most benefit small-scale producers.

Hall et al. (2004) observe that an intervention should be closely linked to the entire domain where a development organisation intends to bring about change. As such, a value chain intervention should aim to improve the overall efficiency of a value chain as a whole; as greater collaboration and cooperation results where actors actively seek to support each other, rather than only increase their own efficiency and competitiveness (KIT et al. 2006). In terms of promoting empowerment and capacity building, development organisations should therefore aim to induce systemic change throughout a value chain.

Noting that both the actions of other agents as well as environmental or contextual changes influence value chain actors, Biggs & Matsaert (2004) suggest that value chain interventions should look to stimulate the creation of partnership coalitions between key actors and strengthen the intensity of information and knowledge flows between these actors. Poor knowledge- and information-sharing within a value chain leads to a replication of effort, waste of resources, as well as an unproductive rivalry between different value chain actors; Biggs & Matsaert (2004) propose that interventions should promote innovation and encourage actors to share both technical as well as institutional knowledge existing with a value chain.

Although increasing small-scale producers' access to market information will enhance their bargaining power vis-à-vis other chain actors, a development intervention must also build their capacity to deal with future challenges and maintain competitiveness. Following an intervention, producers should have a better understanding of markets, display a greater willingness to innovate and take risks, and have the capacity to engage on a more equal footing with other chain actors. They should effectively be in a position to access resources, skills, and knowledge required to respond effectively to changing market demands and opportunities, and be sufficiently empowered to negotiate and thus earn a fairer share from involvement in a value chain (KIT et al. 2006; Devaux et al. 2007).

Chapter 3: Theoretical and Conceptual Framework

3.1 Theoretical Framework

As opposed to being situated within either the research paradigms of positivism or interpretivism, research undertaken for the purpose of this thesis was framed by the context of critical realism. The choice of paradigm was considered justified given that the thesis would explore constructs of an abstract nature such as carbon insetting, willingness to pay, livelihood security, poverty reduction and empowerment.

A positivist approach was considered inappropriate given that it would provide insight only into the frequency, distribution, and patterning of observable phenomena as opposed to abstract constructs; which are characteristically unquantifiable and therefore cannot be scientifically measured. It is argued that an interpretive epistemology is more useful in terms of addressing abstract constructs; however, in the context of the thesis, an interpretivist approach was considered equally unsuitable due to the fact that it would not be possible for the researcher to satisfy the paradigmatic criterion of taking an active role in observing research subjects; engaging in social dialogue and interaction, and creating constructs, ideas, and meanings in the subjects' everyday lives. Taking into account time and logistic constraints, and the fact that the research was undertaken by a researcher detached from the observed subjects of the study, it was concluded that the paradigmatic approach which best befitted the study was critical realism (Schwarzer et al. 2006; Le Compte & Schensul 2010).

A post-positivist paradigm, critical realism is underpinned by the premise that a researcher's view and understanding of the social world is only one interpretation of reality. Influenced and impacted upon by unacknowledged conditions and unintended consequences, this view is neither objective nor value free. Bridging the gap between the more popular research paradigms of positivism and interpretivism, critical realist research is underpinned by the premise that reality is both imperfect and probabilistic; as well as fundamentally a product of social structures which prevail at a given point in time. In addition to providing causal explanations for reality, it aims to enhance interpretative understanding. Epistemologically, critical realism is based on the idea that research should not make claims of perfectly mirroring reality, but rather should offer generalisable

explanations of reality, which should subsequently be closely scrutinised, tested, and validated or rejected (Hine & Carson 2007; Blaikie 2007; Grix 2010).

Embracing the personal subjectivity of both the researcher and research subjects, critical realist research draws heavily on beliefs and expectations. Knowledge is regarded as a product of the context from which it emerges; and given that experience is inescapably subjective, an objective reality is not considered to exist. As posited by Babbie (2010) at a fundamental level, reality is an amalgamation of several different subjective which are inherently subjective.

Although subjectivity is considered to undermine research studies, critical realism endeavours to increase the impartiality and applicability of findings by attempting to find deeper meaning within the construct of subjectivity itself. It aims to reveal the value positions and assumptions of both the researcher and research subjects, as well as the complex relationship which exists between them; recognising that subjective bias is introduced to a research process at a conscious, as well as subconscious level (Moran 2000; Williams & Vogt 2011).

The choice of research paradigm directly influences the design of the thesis as critical realist research aims to provide contextual, subjective insights into phenomenon, as perceived by the researcher and research subjects (Holloway & Wheeler 2002). In this context, in order to determine the extent to which carbon insetting could be considered a climate change mitigation and adaptation strategy capable of generating 'quadruple-win' outcomes, qualitative methods were utilised to ensure the realization of valid and reliable results.

3.2 Research Conceptual Framework

As posited by Gómez-Baggethun et al. (2009), PES schemes were originally conceptualised in terms of advancing the management of natural resources as opposed to improving the livelihood security and sustainability of the individuals or communities engaged in ecosystem service provision. An innovative variation on the traditional PES model, carbon insetting does not automatically translate into the realization of development goals such as empowerment, capacity building and poverty reduction.

Hypothesizing that carbon insetting is conducive to the realisation of win-win outcomes for all actors, the thesis explores the idea that the value chain context - in which ecosystem service provision and compensation of one actor group by another group occurs – facilitates the internalisation of processes and setting of common goals and objectives. Value chain actors' behaviour is directly influenced by contextual factors, in particular, institutionalised values and norms. As such, the thesis examines the extent to which successful intervention in the form of carbon insetting is contingent on adequate consideration of contextuality in terms of the incentives underpinning actors' willingness to pay (WTP) for carbon sequestration.

The following diagrams graphically illustrate the fact that the outcome of a carbon insetting PES scheme is directly related to the interaction between different actors – input providers, smallholder farmers, processors, retailers and consumers – and is impacted upon by enabling or disabling factors which stem from the institutional context of the value chain.

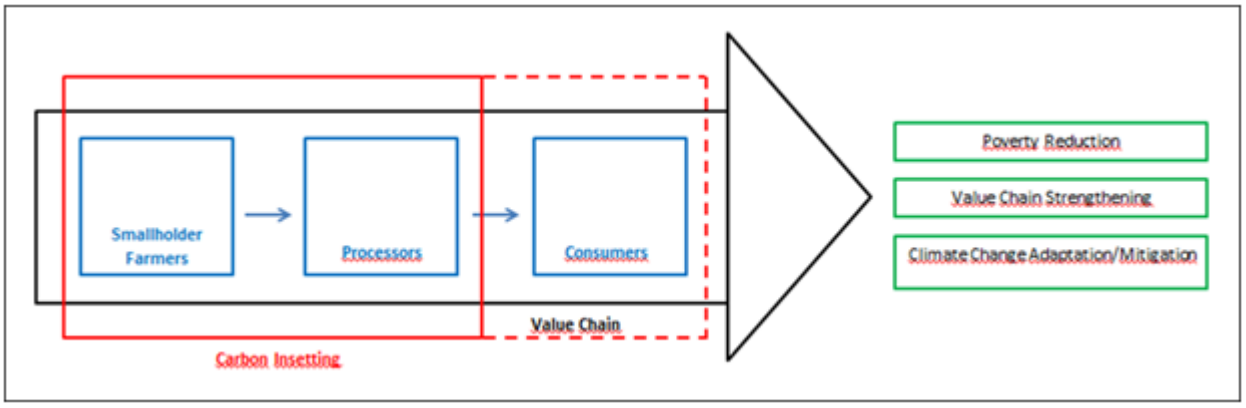


Figure 3: Carbon insetting in a value chain context, where realisation of desired intervention outcomes is determined by the level and nature of the interaction between producers, processors and indirectly, end consumers.

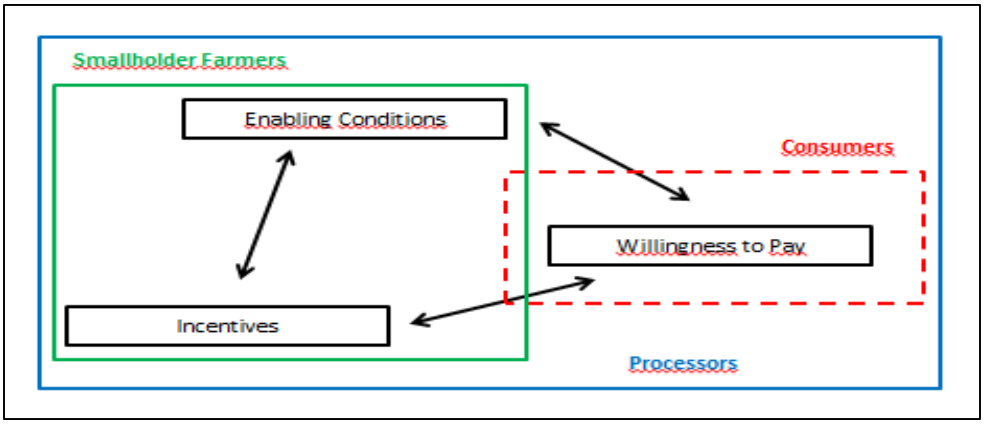


Figure 4: The nexus between incentives, WTP for service provision and the enabling conditions stemming from the institutional context and interaction between value chain actors.

Interaction in a value chain by its very nature is complex, with actors' commitment and willingness to engage hinged on their' ability to identify synergies and gains in working together. Through action-taking and decision-making, actors contribute towards the creation of an environment which either promotes or undermines the trust, collaboration and knowledge sharing required to realise the win-win outcomes envisaged as in theory being attainable though carbon insetting. In terms of value chain actors' WTP for, and willingness to accept (WTA) compensation for ecosystem service provision; processors respond to signals from smallholder farmers as well as end consumers, while farmers' WTA compensation is shaped by their perception of processors and end consumers WTP.

Although value chain dynamics are first and foremost a product of the interaction between directly participating actors, intermediary or facilitatory actors also play a key role in determining the extent to which value chain conditions are enabling or conducive towards the realisation of win-win outcomes. Shaping the external environment governing institutionalised power structures, norms and values; these organisations of a political and socioeconomic nature exert influence over and dictate the behaviour of smallholder farmers, processors and consumers. Indirectly and directly facilitating interaction and dialogue between actors with competing and complementing interests and motivations, these facilitatory actors are important contributors to the carbon insetting success, and improved productivity and efficiency of the value chain as a whole.

Chapter 4: Methodology

4.1 Research Plan

In the context of determining the extent to which carbon insetting could constitute a climate change mitigation and adaptation strategy with the capacity to generate win-win outcomes across the dairy and meat value chain in Nicaragua, leading to improved livelihood security and sustainability of smallholder farmers, a number of key stakeholders were consulted as part of the research process:

- Smallholder Dual Purpose Cattle Farmers - Nicaragua
- Food Processing Enterprises (Meat, Dairy, Cocoa and Coffee) – Nicaragua/International
- Agricultural Research Centres – Nicaragua/International
- Export, Investment and Cooperative Development Promotion Organisations - Nicaragua
- Carbon Standards Certification Organisations – International
- GHG Emissions Reduction Project Development Organisations – International

A. Smallholder Dual Purpose Cattle Farmers

To ascertain the degree to which carbon insetting could impact on smallholder farmers engaged in dual-purpose cattle production in Nicaragua, the thesis focused on production systems on two of the most important municipalities along the so-called 'Via Lactea' - namely, Muy Muy and Matiguas, located in the department of Matagalpa. To identify production constraints impacting on the productivity and efficiency of smallholder production systems, and undermining farmers' livelihood security and sustainability, the thesis elicited information from farmers associated with the cooperative Nicacentro.

In particular, emphasis was placed on production constraints stemming from or exacerbated by climate change, to gain insight into farmers' perception of their capacity to adapt to or mitigate climate-change-induced production impacts. This enabled conclusions to be drawn regarding measures required to enhance the productivity and efficiency of production systems, as well as the value chain as a whole, and appropriate entry points for value chain actors (processors) supported by facilitatory actors to intervene in the context of carbon insetting. It served also to tentatively

indicate the potential for win-win outcomes to be realised, in terms of improved value chain functioning as well as smallholder livelihood security and sustainability.

B. Food Processing Enterprises (Meat, Dairy, Cocoa and Coffee)

To ensure comprehensive understanding of the context of the dual-purpose cattle value chain and particularly, the level and nature of processors' interaction with smallholder farmers, the thesis elicited information from Nicaraguan dairy and meat processors - namely, MACESA and La Perfecta. Examining perceptions of climate-change-induced constraints on smallholder production systems as well as the on productivity and effectiveness of the value chain as a whole, the thesis explored processors' willingness and motivation to engage in carbon insetting.

Identification of the gains expected in providing a financial or in-kind incentive to smallholder farmers to adopt improved agricultural practices leading to carbon sequestration, enabled conclusions to be drawn regarding processors' commitment to work towards realising win-win outcomes, as well as the extent to which support would be required from facilitatory actors in creating enabling conditions in this context.

In addition to meat and dairy processors in Nicaragua, the thesis also elicited information from coffee and cocoa processors; namely, Keurig Green Mountain, Source Climate Change Coffee and Chocolats Halba based in the USA, UK and Switzerland respectively. While the former processor was responsible for commissioning a study in 2012 to determine the feasibility of engaging in carbon insetting with smallholder coffee producers in the north of Nicaragua, the latter two processors were consulted based on their ongoing engagement in carbon insetting in the central area of Mexico and south of Honduras.

In all three cases, the motivation and incentives of the processors to engage in carbon insetting was examined and their experience to date in terms of designing and implementing a PES scheme noted. Furthermore, conclusions were also drawn as regards the enabling conditions required to realise win-win outcomes in terms of improved value chain productivity and efficiency, but also strengthened livelihood security and sustainability of smallholder farmers.

C. Agricultural Research Centres

To understand the role which agricultural research centres should and could play as facilitatory actors, the thesis examined the position of the International Center for Tropical Agriculture (CIAT), the Tropical Agricultural Research and Higher Education Center (CATIE) and the Nicaraguan Institute of Agricultural Technology (INTA) and the Institute of Applied Research and Local Development Nicaragua (Nitlapan) on carbon insetting. This enabled conclusions to be drawn as regards their capacity and willingness to support processors in the design and implementation of a carbon insetting scheme in the context of smallholder dual-purpose cattle production in Nicaragua. In addition, information was elicited to determine actors' perception of the impact of climate change on smallholder production systems, as well as productivity and efficiency of the dairy and meat value chain as a whole, indicated the potential impact of carbon insetting in the given context.

D. Export, Investment and Cooperative Development Promotion Organisations

To further understand the context of smallholder dual-purpose cattle production in Nicaragua, and the impact which carbon insetting could have on smallholder farmers' livelihood security and sustainability, Heifer International and Catholic Relief Services (CRS) were consulted on their experience working with communities in the target areas of Muy Muy and Matiguas. In addition to these potential facilitatory actors, the Nicaraguan Centre for Exports and Investment (CEI), the Association for Producers and Exporters of Nicaragua (APEN) were approached to determine the extent to which they could and would be willing play in the design and implementation of a carbon insetting scheme.

E. Carbon Standards Certification Organisations

To situate carbon insetting as a concept within the broader context of the voluntary carbon market and gain insight into the carbon credit validation and verification process, the thesis elicited information from Plan Vivo, FLO-CERT and Rainforest Alliance. In addition to providing an overview of the different carbon standards available to value chain actors and their appropriateness in different contexts, these organisations were also invited to share their experience in terms of taking advantage of opportunities and overcoming challenges in the design, implementation and particularly, monitoring of carbon insetting projects.

F. GHG emissions Reduction Project Development Organisations

To gain an understanding of the business strategy and thinking behind carbon insetting, and its potential attractiveness in the context of the dairy and meat value chain in Nicaragua, the thesis consulted the not-for-profit Pur Projet and private sector company South Pole Carbon based in France and Switzerland respectively. Engaged in project development and tailoring of the carbon insetting concept to meet the needs and expectations of the agrifood and non-agrifood industries, both provided invaluable insights into the incentives and motivations underpinning private sector interest at a global level. Their multinational clients engaged in carbon insetting include Louis Vuitton, Chanel, Hugo Boss, Marks & Spencer and Guerlan, Vittel and the Clairins Group (PUR Project) and Coop (South Pole Carbon).

4.2 Research Methods and Tools

4.2.1 Primary data collection

A household survey consisting of 18 sections - a mix of closed and open questions - was used to elicit information from a total of 40 smallholder dual-purpose cattle farmers associated with the cooperative Nicacentro (both members and non-members) on their perceptions of:

1. Productivity and efficiency of production systems;
2. Climate change and climate-change-induced constraints;
3. Production risks and coping strategies;
4. Incentive or lack thereof to invest and improve production;
5. Level of agency/capacity - access to information, resources, markets, social networks;
6. Engagement with extension services and institutions;
7. Value of the environment and importance of natural resource conservation;
8. Agricultural practices conducive to environmental conservation;
9. Willingness to participate in a carbon insetting PES scheme and desired compensation.

For the purpose of conducting key informant interviews with the food processing enterprises as well as facilitatory actors, a series of questionnaires containing structured open-ended questions were designed. Each questionnaire was tailored to the individual interviewee, with topics covered ranging from:

1. Impact of climate change on smallholder farmers, production systems and the value chain;
2. Importance of environment and natural resource conservation;
3. Carbon insetting as a climate change adaptation and mitigation strategy;
4. Impact of carbon insetting on smallholder farmer livelihood security and sustainability;
5. Corporate social responsibility and PES schemes;
6. Incentives to engage in carbon insetting and enabling conditions required;
7. Creation of a niche market for products under the auspices of carbon insetting.

4.3 Research Sampling

4.3.1 Sampling Method

For the purposes of gaining insight into smallholder dual-purpose cattle production in Nicaragua and the impact of climate change on the livelihood security and sustainability of smallholder farmers, a sample of 40 farmers was drawn from five districts in the municipalities of Muy Muy and Matiguas (as indicated by the map below).

The thesis will sample a total of 40 smallholder farmers engaged in dual-purpose cattle production in the municipalities of Muy Muy and Matiguas, in a total of five districts (as indicated by the map below). Although the sample size can be considered relatively small, the chosen sampling method – stratified random sampling – is expected to compensate for this, and ensure that the sample nevertheless reflects key characteristics observed in the target population.

Also referred to as proportional or quota sampling, as a sampling method it is considered superior to simple random sampling as it involves dividing a population into strata prior to selection of individual units through a simple random sampling procedure. As a consequence, stratified random sampling results in a scenario whereby a sample is considered self-weighting.

In order to stratify within strata and realise proportional allocation - whereby the number of sampled units in each stratum is proportional to the size of the stratum - it is necessary to carefully decide what the strata should be and how many units to observe or sample in each stratum.

Proportional allocation is underpinned by the idea that probability of inclusion in the sample should be the same for each strata considered.

One of the main advantages of stratified random sampling is that it enables otherwise underrepresented groups to be included in a sample. If there are too few elements in a stratum, a disproportionate sample can be selected, ensuring that detailed statistical analysis can nevertheless be undertaken. This makes a sample more representative and less variable, with elements having a greater chance of inclusion - the size of a stratum is boosted to make its presence relatively greater within the sample than compared to within the population - thus enabling more meaningful statistical analysis to be undertaken and comparisons between strata to be made.

Sample Size and Composition

The framework selected for the purposes of determining the size of the stratified random sample is based on that of Trost who suggests that sampling in small qualitative studies should follow a simple 7-step model. Arguing that it important to ensure that samples are sufficiently varied in composition, Trost posits a so-called 'statistically non-representative stratified sampling' procedure or technique for qualitative studies, in response to a perceived lack of guidelines for sample selection in cases where a population is composed only of a small group of individuals (Trost 1986).

The thesis will utilise this approach to sampling as it constitutes a clear method for sample selection, and is furthermore considered appropriate give the population size (274 individuals satisfy predetermined sample inclusion criteria) and the interest of the researcher, through stratification, to ensure inclusion of otherwise underrepresented groups – specifically, cooperative non-member, and female smallholder farmers.

Below is a diagram of the sampling technique utilised, adapted from Trost (1986).

Selection Pool	Total Population							
Location	Matiguas				Muy Muy			
Cooperative Membership	Member		Non-Member		Member		Non-Member	
Gender	Male	Female	Male	Female	Male	Female	Male	Female

A sampling framework was created based on unit selection from two databases of smallholder farmers engaging in dual-purpose cattle production in Matiguas and Muy Muy. Within these municipalities, only villages where both male and female smallholder farmers - member and non-members of the cooperative Nicacentro - were observed were taken into consideration.

This facilitated multiple-level stratification giving rise to the following final sample proportions as indicated in the table below:

Selection Pool	274							
Location	219				55			
Cooperative Membership	210		9		53		2	
Gender	167	43	7	2	45	8	1	1
Sample Proportions	24	6	1	0	7	1	0	1

Although based on the sampling technique of Trost (1986), which is underpinned by the principle of proportionality, the sample is in fact disproportionate as inclusion of female as opposed to male non-cooperative members from Muy Muy is favoured over male non-cooperative members and also, at the expense of female non-cooperative members from Matiguas.

As such, the final theoretical selection was expected to consist of the following:

Matiguas (31)	**Muy Muy (9)**
Male cooperative members (24)	Male cooperative members (7)

Female cooperative members (6)	Female cooperative member (1)
Male cooperative non-member (1)	Female cooperative non-member (1)

Due to various factors beyond the control of the researcher - including non-participation by selection units drawn from the population pool and difficulties experienced in identifying suitable replacement population units - the disproportionality of the sample was increased. The composition of the final sample was nevertheless considered appropriate as it still compensated for underrepresentation of females compared to males across the strata.

Representative of the larger population, the final population units taken into consideration by the thesis were as follows:

Matiguas (32)	**Muy Muy (8)**
Male cooperative members (24)	Male cooperative members (7)
Female cooperative members (5)	Female cooperative member (1)
Male cooperative non-member (2)	
Female cooperative non-members (1)	

4.3.2 Data Analysis

The reliability, validity and representativeness of the results of a study is determined by the appropriateness of the sampling technique chosen, as well as the type of statistical analysis which is undertaken. Analysis of qualitative data collected will be undertaken utilising a statistical package tools SPSS and R Statistical Package. Themes running through the data will be noted, in addition to correlation between characteristics and frequency statistics generated (mean values and distribution of observations) enabling information regarding value chain stakeholders' perceptions and priorities to be determined.

For the purposes of data entry and analysis, the questionnaire will be transformed using Excel, with a database created utilising filters. This will enable differences between the two municipalities, male and female, member and non-member to be observed; as well as differences according to inclination towards risk, cultivation of forages, herd size and farm size.

The focus of the analysis will be to determine expectations of, and desired PES structure – cash or in-kind payment – and potential impact on value chain stakeholders, given their respective perceptions of constraints.

4.3.3 Limitations of the Study

Primary Research

The study will draw a sample of 40 from a relatively small population of 274 smallholder farmers- both member and non-members of the cooperative Nicacentro – residing in the municipalities of Muy Muy and Matiguas. Although the cooperative in reality comprises a greater number of members, only those located in villages where both female and male members observed, were considered in designing the sample frame and undertaking the final selection procedure.

The population and thus resulting sample could have been further stratified if additional stratification characteristics had been taken into account - for example, the number of heads of cattle, area planted to improved forages or indeed, farm size. Although inclusion of such characteristics would have led to the generation of a more representative sample, given the depth of information required - and lack thereof - for inclusion of these characteristics in a sampling frame, stratification was limited to three levels.

An additional limitation of the sampling procedure utilised is that despite an attempt to include non-members, the final sample includes only four smallholder farmers not associated with the cooperative Nicacentro. This raises the question whether the sample can therefore truly be regarded as representative; however, given the relative proportion of members to non-members, 30 to 4, this is considered by the researcher as an acceptable level of distortion.

Secondary Research

In addition to limitations deriving from choice of sampling technique, the study is also limited in terms of secondary data, due to a lack of information regarding carbon insetting – the concept is relatively new, and as such, few academic papers have been published. The idea of PES has also

not been discussed in the context of a value chain setting, and there has been little focus on ecosystem buyers – in terms of incentives shaping WTP and preferences regarding cash or in-kind compensation – but rather on service providers' willingness to accept. Private sector engagement in PES schemes is poorly discussed, and the focus is traditionally rather on societal willingness to pay. Literature on PES schemes in the context of carbon sequestration is limited, with most documented cases rather ecosystem service provision in watershed management.

Chapter 5: Potential Impact of 'Carbon Insetting' on Dual-Purpose Cattle Value Chain

5.1 Case Study Area

As outlined in the previous chapter, for the purpose of evaluating the potential impact of carbon insetting on the livestock sector and more importantly, the livelihood security and sustainability of smallholder farmers engaged in dual-purpose cattle production in Nicaragua, 40 smallholder farmers were selected from the municipalities of Muy Muy and Matiguás (further information can be found in Annex 1). More specifically, farmers were selected from four administrative districts situated within these municipalities - namely, Maizama in Muy Muy and La Bruja, Pancasán and Saiz in Matiguás.

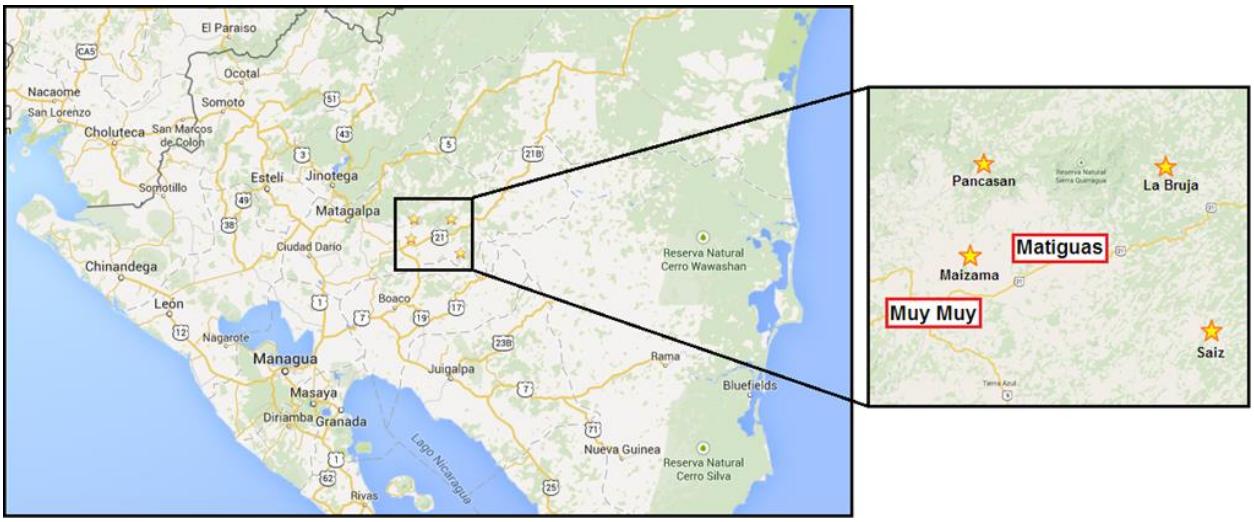


Figure 5: Map of study area, showing the location of the four administrative districts considered - Maizama, La Bruja, Saiz and Pancasán.

Figure 5 shows the exact locations of the administrative districts of Maizama, La Bruja, Saiz and Pancasan, situated along the so-called 'Vía Láctea' or 'Milky Way' which stretches from Muy Muy and Matiguás to Río Blanco and finally, to Bocana de Paiwas. (Google Maps, 2015)

Figure 6: 'La Via Lactea' – the major milk production and collection route in Nicaragua

Figure 2 shows the milk production and collection route which comprises smallholder farmers associated with the cooperative Nicacentro, who account for 219 million litres or 31.3% of the total volume of milk produced in Nicaragua annually.

5.2 Sample Demographics

Table 1 provides an overview of the demographic characteristics of the sample of smallholder farmers and their households, as well as the distribution of farmers across the administrative districts of Maizama, La Bruja, Pancasán and Saiz.

Randomly selected through stratified sampling, the sample of smallholder farmers was characterised by diversity in terms of age (ranging from 26 to 73 years old) and education levels, from primary level education (50%) to university level education (12.5%). In terms of the gender makeup, the sample reflected the fact that dual-purpose cattle production in Nicaragua is not only predominantly a male preserve, but household heads are often also male. The average household comprised five members of which two were children.

Table 1: Characteristics of smallholder dual-purpose cattle farmers in Muy Muy/Matiguas.

	Maizama	La Bruja	Pancasán	Saiz
% of sample	18%	25%	37%	20%
Age	Mean = 52 years; Range = 26-73 years			
Gender	33 males (82%); 7 females (18%)			
No. of Household Members and Children	Mean = 5 members; Range = 2-12 members Mean = 2 children; Range = 0-5* *33% of households did not have children			
Education level	No Education = 20%; Primary Education = 50%; Secondary Education = 15%; Adult Education = 2.5%; University Education = 12.5%			

5.3 Smallholder Farmers' Vulnerability to Climate Change

Thornton et al. (2009) posit that, as a demographic group, smallholder farmers engaged in livestock production are highly vulnerable to climate change. In the case of dual-purpose cattle production in Nicaragua, the smallholder farmers sampled for the purpose of this thesis were found to recognise the impacts of climate change and variability on the productivity and efficiency of their production systems, as well as on the sustainability and security of their livelihood strategy. They also appeared to be acutely aware of the need, as suggested by the FAO (2013), to adopt appropriate mitigation and adaptation strategies to conserve natural resources, and in particular, water resources.

The number of years spent by smallholder farmers in their farm homestead - which ranged from 3-60 years, with a mean of 23 years - was taken as a proxy for farmers' knowledge of and familiarity with environmental and production conditions. Irrespective of whether or not the farm homestead was their place of birth (23%), or whether they had established a homestead there at a later in life, all of the farmers sampled said that good environmental conditions for dual-purpose cattle production had influenced their decision to settle in their respective locations. 78% of farmers also said that soil conditions were good for crop and forage production.

5.3.1 Climate change and climate variability

For 22% of farmers, dual-purpose cattle production in their homestead had constituted a source of livelihood for more than 30 years, and as such, they were considered in a position to draw conclusions as regards their vulnerability to temperature and precipitation variability, and the frequency and intensity of extreme events such as drought and flooding. 97.5% of smallholder farmers said that they had noticed a difference in the climate and weather patterns impacting on their farm over a period of time from 2005-2015, as indicated by the table on the following page.

Observations regarding temperature, precipitation, heat, drought frequency, and the length of both dry and rainy seasons were evenly distributed across all districts. Distributions for wind, however, differed significantly between districts sampled (chi-square p-value = 0.036).

Table 2: Perception of climate change impact on Muy Muy and Matiguas.

	Perception of change
Temperature	Higher = 95%; Lower = 5%;
Precipitation	Higher = 37.5%; Lower = 57.5%; Constant = 5%
Wind	Higher = 20%; Lower = 45%; Constant = 35% *
Heat	97.5% higher; Constant = 2.5%
Drought frequency	Higher = 60%; Lower = 22.5%; Constant = 17.5%
Length of dry season	Shorter = 42.5%; Longer = 52.5%; Constant = 5%
Length of rainy season	Shorter = 57.5%; Longer = 32.5%; Constant = 10%

95% of smallholder farmers sampled across the districts of Maizama, La Bruja, Pancasán and Saiz said temperatures over the last decade had increased, while 97.5% said they regarded their livestock as being subject to greater heat stress. In terms of precipitation, 37.5% thought it had increased, however, the majority (57.5%) of farmers said they considered it to have decreased. 52.5% of farmers said there had been an increase in the length of the dry season, which corresponded to a decrease in the length of the rainy season noted by 57.5%.

5.3.2 Asset ownership

In terms of asset ownership, 97.5% of smallholder farmers sampled were in possession of title deeds indicating ownership of land. Ownership of other household assets - grouped into the categories of transportation, information, production, energy and luxury assets - is presented on the next page (Tables 3-8). Ownership of information assets - such as a mobile phone (90%), a radio (82.5%) and a television (82.5%) - was higher than assets in any other category.

Table 3: Ownership of transportation assets.

Motor vehicle	27.5%
Motorcycle	30%
Bicycle	10%
Animal cart	35%

Table 4: Ownership of information assets.

Mobile phone	90%
Radio	82.5%
Television	62.5%

Table 5: Ownership of production assets.

Wheel barrow	32.5%
Water pump	30%
Forage cutter	7.5%

Table 6: Ownership of energy assets.

Generator	27.5%
Solar panel	30%

Table 7: Ownership of luxury assets.

Refrigerator	40%

To differentiate between smallholder farmers and ascertain their wealth status, a simple asset index was compiled as outlined by Singh (2013). Household asset ownership and specifically, households' total number of assets, was taken as a proxy for wealth; with fixed levels of assets categorised as 'basic level', 'intermediate level' and 'high level'. As indicated in the table below, the majority of smallholder farm households belonged to the intermediate assets level category.

Table 8: Asset index of smallholder farm households sampled.

Basic level (0 assets)	2.5%
Intermediate level (1-5 assets)	70%
High level (6 or more assets)	27.5%

5.3.3 Access to markets, infrastructure and services

In terms of access to markets, infrastructure and services; 70% of farmers lived more than 10km from the nearest market and 40% had to travel more than 2hrs to buy inputs or sell meat or milk locally. Similarly, 68% of farmers had to travel more than 10km to reach the nearest veterinarian and 38% had to travel more than 2hrs in cases of animal health emergencies.

Table 9:. Distance to nearest market

Less than 1km	2.5%
1-4km	12.5%
5-9km	15%
10km or more	70%

Table 10. Distance to nearest veterinarian

1-4km	17.5%
5-9km	15%
10km or more	67.5%

In terms of access to water resources, 95% of farmers had access to a water source less than 1km away from their homestead, at less than 15 mins walking distance. Similarly, 65% of farmers had access to a road less than 1km and 80% of farmers were within 15mins walking distance from a road. Although 32.5% had to travel between 1-5km to access a road, only 10% had to travel more than 30mins.

5.3.4 Dual-purpose cattle production systems

For 90% of smallholder farmers, dual-purpose cattle production constituted their main source of income. Only 25% of farmers kept livestock other than cattle, such as pelibuey, pigs and chicken, as an additional means of generating income through sale of live animals or animal products. Farm holdings ranged in size from the smallest, at 10 manzana (mz) or 7 hectare (ha) to the largest, 500 mz (352 ha). The mean farm size was 81 manzana (57 hectares), however, as many as 47.5% of farmers had less than 50 mz (21 ha).

The dual-purpose nature of the production system in Nicaragua is evidenced by the fact that the two biggest farms in terms of production orientation - milk or meat (steer fattening) - the two biggest farms differed significantly in terms of their size. The smallholder farmer oriented towards milk production had a farm of 500 mz and a herd of 391 cattle heads, while the second farmer oriented towards meat production had 100 mz and a herd of 363 mz. The difference in production orientation was clearly illustrated by the fact that the farms had 104 cows and 66 steers, and 64 cows and 200 steers, respectively.

Smallholder farmers had a herd size ranging in size from 7 to 391 heads of cattle, with the mean herd consisting of 76 heads of cattle. Most farmers had 1 bull, 15 cows, no steers or heifers, 6 male calves for weaning and sale, and 5 female calves for weaning to replace the milking cows. The

majority of farmers had just one bull, however, 20% had 2 bulls and 12.5% of farmers had three or more bulls. The table on the following page indicates the composition of cattle herds of the farmers sampled in Muy Muy and Matiguas.

Table 11: Dual-purpose cattle herd composition.

	0	1-10	11-20	21-40	41-60	> 60
Bulls	12.5%	85%				
Cows		25%	37.5%	27.5%	2.5%	7.5%
Steers	32.5%	37.5%	47.5%	7.5%		7.5%
Heifers	17.5%	40%	22.5%	15%	5%	
Male calves	7.5%	57.5%	22.5%	7.5%	5%	
Female calves	5%	72.5%	15%	5%	2.5%	

Figure 7: Animal husbandry practices in Pancasan District (Matiguas)

Figure 8: Animal husbandry practices in Maizama District (Muy Muy)

Given the dual-purpose nature of production, smallholder farmers had mostly cross-breeds cattle - local zebu breeds crossed with brahman (good for meat production) and brown swiss, holstein, simmental and jersey (good for milk production). 12.5% of farmers said they had purebred brown swiss cattle, 5% said they had holstein cattle and 2.5% said they had simmental cattle. 15% said they had a mix of exotic crossbreds, however, the majority of farmers (65%) had so-called 'suindico' or 'pardo' cattle (local breed crossed with exotic breed).

5.3.5 Market-oriented production

Smallholder farmers produced a mean volume of milk of 120 litres per day, however, most produced 80 litres. The minimum volume produced was 20 litres, while the maximum was 600 litres. Farmers received between 9-10 cordoba (C$) or (US $0.34-0.38) for a litre of milk, with the mean price received being C$9.74 (US $0.37). 22.5% of farmers received 9.50 cordoba (US $0.36), while 45% of farmers received 10 cordoba per litre. Prices differed based on transaction costs for use of an independent or cooperative-contracted intermediary to transport milk to collection centres. The table on the following page provides an overview of milk prices received by farmers.

90% of smallholder farmers used part of the milk produced for family consumption purposes, while 85% of smallholder farmers produced meat for family consumption purposes. 43% of

farmers produced meat destined for sale at the local market, while significantly less (12.5%) produced milk for sale as fresh milk or artisan milk products.

Table 12:. Price received per litre milk in Nicaraguan Cordoba (C$) and US dollars (US$).

C$	US$	%
9.00 - 9.24	0.34 - 0.34	2.5%
9.25 - 9.49	0.35 - 0.36	7.5%
9.50 - 9.74	0.36 - 0.37	35%
9.75 - 10.00	0.37 - 0.38	50%

Figure 9: Milk collection – from farmgate to the milk collection centre, and prices offered by the Cooperative Nicacentro based on quality of raw material delivered

5.3.5 Market constraints

Smallholder farmers said that the milk price received through the cooperative Nicacentro was higher than that offered by independent intermediary milk collectors or artisan cheese makers. Many said that they still felt that their ability to secure high prices for milk and meat was constrained as a consequence of being unable to satisfy market demands for meat and milk in terms of both quality and quantity. One of the main constraints facing smallholder farmers was related to access to information regarding prices, product quality, sales opportunities and logistics.

Table 13: Smallholder farmers' access to information

Type of information	% with access
Milk prices	88%
Meat prices	53%
Milk and meat quality (expected by market)	58%

Table 14: Smallholder farmers' ease of access to information

Type of information	Easy access	Very easy access
Cattle sales	73%	27%
Interested buyers	68%	32%
Transport	73%	27%

Figure 10: Challenges associated with transport and movement during the wet season to obtain access to information, production inputs and services

In terms of meeting the product quality expectations of buyers, 80% of smallholder farmers said that they faced challenges in meeting the age, sex, weight and animal health conditions demanded or expected by buyers. Animal health was identified as most challenging by 30% of farmers,

followed by a combination of weight and health (15%), weight (13%) and age (10%). As evident by the table below, weight and health status of cattle were rated by smallholder farmers as more important characteristics for buyers than age and sex of cattle, and thus for also for smallholder farmers in the context of realising market demands.

Table 15: Smallholder farmers' perception of buyer expectations.

	Not at all important	Somewhat important	Important	Very important
Age	27%	40%	30%	3%
Sex	25%	35%	37%	3%
Weight	10%	15%	60%	15%
Animal health	13%	10%	55%	22%

5.3.6 Cooperative membership

92.5% of smallholder farmers sampled for the purpose of this thesis were members of the cooperative Nicacentro.

Figure 11: Nicacentro – one of the biggest dairy cooperatives in Nicaragua

Although only 27.5% said that they felt that cooperative membership had led to an increase in their individual bargaining power, 92.5% said they felt that they were now in a position through the cooperative to negotiate with processors for a higher price for meat and milk sold. As previously

mentioned, one of the main benefits derived from cooperative membership, identified by 30% of farmers, was increased access to information.

Table 16: Benefits derived by smallholder farmers from cooperative membership

Easier to obtain a good price	70%
Easier to obtain a fixed price	30%
Easier to organise milk collection	50%
Easier to obtain credits	77.5%

The majority of cooperative-member farmers (67.5%) were present at meetings at the cooperative Nicacentro whenever they received an invitation to attend.

Table 17: Smallholder farmers' regularity of attending cooperative meeting

Never	8%
Every time if invited	67.5%
Once a month	3%
More than once a month	3%
Once a year	18.5%

Those who were not members of the cooperative, and did not therefore have the opportunity to attend meetings, instead belonged to the category of smallholder farmers (62.5%) which had access to a good social network and met on a regular basis with other households in their area, as indicated in the table below.

Table 18: Smallholder farmers' regularity of meeting with neighbours

Never	37.5%

Informally	15%
Once a week	7.5%
More than once a week	2.5%
Once a month	10%
More than once a month	27.5%

5.3.7 Climate change impact on productivity and efficiency

Noting a significant change in climate and weather patterns, 97.5% of smallholder farmers sampled said that it was more difficult today to plan production in comparison to a decade ago, and the impacts of climate variability were described by farmers as in the following table.

Table 19: Production impact of climate variability

Reduced crop yield	85%
Increased feed scarcity	65%
Increased incidence of disease	65%
Increased incidence of parasites	72.5%
Increased incidence of bacterial infection	60%
Increased production costs	82.5%
Increased input costs	92.5%

95% said that the risks associated with dual-purpose production had increased, due to increased crop yields, feed scarcity, and disease and parasite incidence. 32.5% of farmers had to purchase external feed which was not their normal habit, while 22.5% and 47.5% had to increase their expenditure (outlay) on vaccines and anti-parasitic drugs respectively which led to increased production costs for 92.5% of farmers.

Table 20: Fodder used by smallholder farmers to feed dual-purpose cattle.

Natural forages	72.5%

Improved forages (cultivated in farm)	87.5%
Forage grasses	80%
Fodder shrubs	35%
Crop residues	22.5%
Concentrate	10%
Saltlick	12.5%
Protein supplements	20%

Figure 12: Climate change has led to increased production costs, stemming from increased input costs for products such as salt lick and mineral vitamins

97.5% of smallholder farmers do not use purchased forages in their production systems, while 90% and 80% do not use concentrate or protein supplements respectively, leading to their dependence on natural forages and forages cultivated on-farm. 55% reported that they had noticed a difference in varieties of forage planted in terms of their tolerance to, and performance under, conditions of drought and high temperature. 53% of farmers said they had chosen to change the forages cultivated on their farms in the past year in response to the climate change impact observed.

The table below indicates the variety of sources of information from which 73% of farmers mentioned that they had received information regarding the cultivation of improved forages more resistant to drought and high temperatures.

Table 21: Sources of information dissemination on improved forages.

Nicacentro (cooperative)	35%
Government extension services	10%
CATIE	2.5%
Technoserve	7.5%
Private seed seller	5%
Farmer field school	2.5%
Other farmers	7.5%

Farmers said that they had received information from a variety of sources - 35% from the cooperative, and 22% from extension from the government (INTA) and from the Fund for Agricultural Development (Fondeagro) programme of the Ministry for Agriculture and Forestry (MAGFOR). They also mentioned receiving information from the Tropical Agricultural Research and Higher Education Center (CATIE), the non-profit organisation TechnoServe and from private seed sellers, through farmer field schools and from other farmers.

5.3.8 Coping strategies

Managing their production systems in an environment characterised by increasing risk due to climate change and climate variability, the majority of smallholder farmers (82.5%) described themselves as risk taking, as opposed to risk averse or risk neutral - 12.5% and 5.5% respectively. As evidenced below, farmers regarded production as the greatest risk area, however, they also identified risks associated with finances and marketing, with 57% citing access to credit as challenging compared to 22.5% who said access to information was the main constraint on production and the adoption of technologies.

Table 22: Smallholder farmers' perception of risk areas

Production risk	60%
Financial risk	45%
Market risk	40%
Technology risk	27.5%

The production risks which smallholder farmers perceived as associated with climate change are indicated in the table below. In addition to asserting a decline in milk yield compared to a decade earlier, farmers also noted an impact on calving rate, age and interval, as well as cattle body weight.

Table 23: Production risks induced by climate change

Milk yield	Decreased = 57.5%; Increased = 7.5%; Constant = 35%
Calving rate	Decreased = 17.5%; Increased = 20%; Constant = 62.5%
Calving age	Decreased = 30%; Increased = 20%; Constant = 50%
Calving interval	Decreased = 17.5%; Increased = 20%; Constant = 62.5%
Body weight	Decreased = 22.5%; Increased = 15%; Constant = 62.5%

Farmers said they had in the past year adopted a variety of coping strategies to reduce the risks associated with climate variability, with 50% reducing investment expenditures, despite 55% perceiving an incentive to continue improving their production system as outlined in the table below.

Table 24: Incentives perceived by smallholder farmers to improve production systems.

Incentive to adopt improved practices and technologies	52.5%
Incentive to expand production system	42.5%
Incentive to increase herd size	45%

Incentive to improve breeding practices	50%

Climate change was regarded by the majority of smallholder farmers as negatively impacting on productivity and efficiency of production, and 92.5% said they had used their cash savings to improve their production systems. 82.5% of farmers had looked to diversify production to overcome the impact of climate variability, for example, by adopting improved forages, or planting crops in dispersed areas to reduce yield variance.

Table 25: Coping strategies used by smallholder farmers in the last two seasons

Decided to take a loan	70%
Borrowed cash from neighbours	30%
Borrowed in-kind from neighbours	7.5%
Searched for off-farm employment	15%
Received remittances from absent household members	5%

In addition to affecting production, 67.5% of smallholder farmers said that climate variability had also impacted on household welfare and that they had had to use cash savings to improve the health and education statuses of their spouse and/or children.

70% of smallholder farmers made the decision to take a loan, with 52% looking to Nicacentro cooperative as opposed to a bank, microfinance group, NGO or a private source. The table below indicates from which source and at what interest rate, farmers obtained a loan.

Table 26: Source of loan obtained

Cooperative	52.5%
Bank	15%
Microfinance group	10%

NGO	2.5%
Private source	2.5%

97.5% of farmers said that they did not experience difficulties in obtaining a loan, and only those who sought a loan from a bank (15%) needed to pledge collateral to secure lending. More farmers (52.5%) sought a long-term loan compared to a short-term loan (17.5%), with 65% obtaining a loan in the form of cash as opposed to in-kind.

Table 27: Smallholder farmer use of loan obtained

Improve and/or maintain farm	25%
To purchase improved animals	17.5%
To purchase equipment	15%
To establish fodder	10%
To purchase feed	2.5%
To purchase female animals (for reproduction)	2.5%
Install irrigation system	2.5%
Activities unrelated to dual-purpose cattle production	10%

Figure 13: Climate change coping strategy – adoption of good agricultural practices

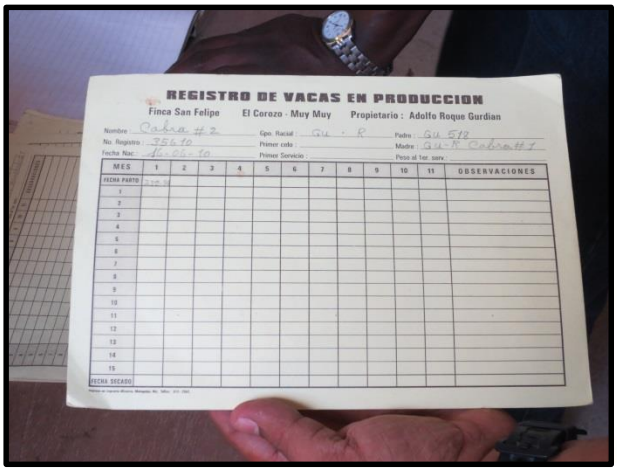
The majority of smallholder farmers used the loan obtained to improve their production systems by maintaining housing for cattle, establishing forages, installing irrigation systems, and purchasing equipment and improved animals. 10% of smallholder farmers used loans for activities unrelated to dual-purpose cattle production, such as investing in coffee production, solving legal problems associated with obtaining property documents and paying off debts.

The interest rates on loans which smallholder farmers had to pay were dependent on the source of the loan. Those who obtained a loan from Nicacentro cooperative were subject to a rate of 12% per year, compared to those obtaining from other sources, who were subject to interest rates ranging from 2-24%. Farmers who obtained a bank loan were subject to a rate of 18%.

In addition to obtaining loans, smallholder farmers also sought technological information from a range of available sources to improve their production systems, as indicated by the tables below.

Table 28: Technological information sought by smallholder farmers

Animal health	82.5%
Improved feeding	75%
Milk quality and hygiene	70%
Herd management	60%
Breeding	40%



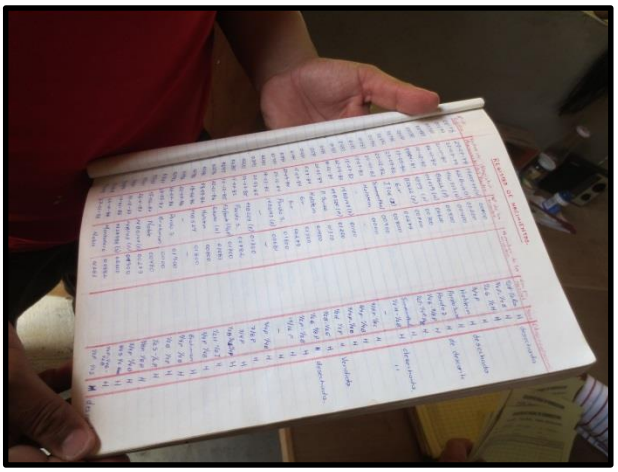


Figure 14: Few smallholder farmers keep good records for herd management and breeding

Table 29: Source of technological information

Nicacentro Cooperative	77.5%
Government extension services	42.5%
Other farmers	12.5%
NGOs	7.5%
Private veterinarian	2.5%

25% of farmers stated that they required further support, advice and information on technologies appropriate to small-scale production systems - in the areas of animal health, breeding, feeding, management and milk production (quality and hygiene). Only 7.5% said that they did not face any of the constraints in terms of putting knowledge into practice and adopting technologies to improve their production systems.

Table 30: Constraints to technology adoption

Insufficient access to credit	42.5%
Insufficient access to information	25%
Insufficient labour force	7.5%
Insufficient land size	7.5%
Insufficient fodder	5%

5.4 Meat and Milk Processors' perceptions

5.4.1 Climate Change and Climate Variability

Referred to as a 'record drought' by the World Bank on the 10th of September, 2014, Nicaragua was one of four countries in Central America which experienced a period of 40 days without rain, which threatened the food security of 100,000 households in Nicaragua's northern dry corridor and the north east region (World Bank 2015), and significantly undermined the livelihood security and sustainability of smallholder farmers engaged in dual-purpose cattle production:

> *"..this year we saw that climate change has a huge impact and is strongly affecting production, we can't have better proof that people are running at the last minute to prevent cattle dying, their crops being damaged"*
>
> - Nicaraguan Chamber of Beef Exports (CANICARNE)

The impacts of the drought were felt by the dairy and meat industry as a whole as much as by smallholder farmers. Primary production is the initial link in the chain and so the notable drop in

meat and milk production by smallholder farmers meant that the negative impact was felt throughout the dual-purpose meat and milk value chain.

Delayed rainfall events as a consequence of the El Nino phenomenon, led to a scarcity of forage which reduced the reproductive capacity of animals and consequently, adversely affected their productivity; with the impact of climate change on cattle herds and in particular, milking cows summed up in the following comment:

> *"they're skinny, low in weight and can't get pregnant, don't calve, don't produce milk because of a lack of feed and due to calorific stress caused by the heat"*
>
> - Nicaraguan Dairy Sector Chamber (CANISLAC)

Although it was not the first time that climate variability significantly impacted and affected production, it was the response not only from smallholder farmers, but also Government agencies and extension services, and Non-Government Organizations (NGOs) which many actors in the dairy and meat industry found alarming and led them to draw conclusions regarding their own vulnerability, and that of the value chain as a whole. to climate change and climate variability.

Dairy and meat industry actors stated that in the last decade, there has been a change in the climate and weather patterns in Nicaragua, specifically in terms of precipitation patterns and the length and intensity of the dry season:

> *"..before, the rains were sure to start in mid-May, now not, it starts to rain later and the rains in the previous year end earlier, so the period of drought is greater, and felt more"*
>
> - CANICARNE

The increasingly erratic nature of rainfall - in the past, the rains were perceived as ending in November or mid-December, whereas today the rains end in the first two weeks of November and there is no rain again until June - and an increase in the length of the dry season by up to 30-45

days has made it more difficult for smallholder farmers, as well as the dairy and meat industry to forecast, anticipate, plan, and implement strategies to maximize production and profit.

> *"..finally the rains arrived a month ago or so, it was a big improvement but if this rain hadn't arrived, the country would be…"*
>
> *"..and this doesn't mean that next year there won't be any effect, it is still possible that the impact of a lack of rain this year, an early winter [rainy season] starting around May, will affect the next year"*
>
> *"..we don't know what will happen next year, maybe it will lead to a decrease in production"*
>
> - CANICARNE

Dairy and meat industry actors are critical of the fact that although it is known that there will on average be 6-7 months of drought per year, in 2014, as in previous years, there was a lack of preparedness at farm-, industry- and government level in terms of coping with the erratic rainfall pattern, drought incidence and the ensuing shortage of animal feed:

> *"..as a country we improvise a lot, we don't plan, until the moment when we scramble to find a solution, this is an age old problem"* – CANICARNE

5.4 Industry Actors Role in Adapting to and Mitigating Climate Change

The meat and milk processing industry are increasingly recognising the importance of adapting to and mitigating climate change and climate variability, and the role which they can play in incentivising smallholder farmers to adopt good agricultural practices. In this context, however, they state that:

> *"..more information is required, about climate change and specific issues such as carbon sequestration – carbon capture and how it occurs?"*

However, the perception of many meat and milk processing industry actors is that:

"..there is little knowledge at the government authority level about climate change [...] [although] the government understands its role, there's much deficiency in expertise and in the Ministry of Livestock, Agriculture and Forests (MAGFOR), there is no one working specifically on the issue of climate change"

At an international level, the Nicaraguan Government, through the Ministry of Environment and Natural Resources (MARENA), has affirmed its interest in initiating and realising 'Nationally Appropriate Mitigation Actions' (NAMAs) - policies, programmes and projects to contribute to the global effort of reducing greenhouse gas emissions.

The perception of many meat and milk processing industry actors, however, is that if the NAMA concept were to create 'a more eco-competitive livestock sector through low emission and transformational production practices', Nicaragua would most likely:

"..not follow the same dynamic as Costa Rica [where the Government played an active role], would involve little intervention from Government, and more likely be a private sector initiative" - CANISLAC

According to CANICARNE, one of the key lessons learnt by the meat and milk processing industry in 2014 in the aftermath of the drought occurrence was that in responding to an extreme weather event:

"..the Government in reality cannot do things alone, it needs to be a mix of private enterprise and the Government, often there is politics involved and other interests"

One aspect of the Government's handling of the drought crisis which the meat and milk processing industry was particularly critical of was that:

"..in reality, the effect was in certain parts, not all of the country, they [the Government] say things are a catastrophe but there were zones which were very good, produced more than normal and at a national level, the effect wasn't much"

- CANISLAC

According to CANICARNE, many meat and milk processing industry actors realise that:

> *"..if there is no information we can't evaluate anything, [...] it will alarm people and lead to speculation, the product will go to the market more expensive"*

This has led to increased awareness that they, as value chain actors, have the capacity and an important role to fulfil in shaping Government response to climate change, namely:

> "*..as a production centre, we have to give information to the Government. The Government collects figures and if we point to where there is an effect, we can help to find a solution in these locations"* - CANICARNE

According to CANICARNE, following the drought occurrence there was recognition among its members, as well as members of CANISLAC, of yet another opportunity to:

> *'..engage [with Government], contribute ideas and resources to certain programmes to develop the sector"*

as well as to:

> *"..try to influence politics that are beneficial for the sector, for the country, to contribute or integrate, at the very least reduce global warming and the greenhouse effect"*

In recent years, recognising their respective roles and responsibilities, in the context of the evident Government shortcomings as regards capacity to cope with climate change and extreme weather events, both CANISLAC and CANICARNE have looked to:

> *"..work with the National Livestock Commission of Nicaragua (CONAGAN), the Central American Federation of the Beef Industry (FECESCABO) and the Central*

American Federation of the Dairy Sector (FECALAC) [...] to influence public policies at international levels to benefit primary producers and the industry"

In addition, CANISLAC and CANICARNE have maintained a close relationship with the Food and Agriculture Organization (FAO):

"..we view climate change as important, we've asked the FAO to support us in guiding MAGFOR in defining a strategy against climate change in milk and meat"

They argue that although so far discussions at national, regional and international levels have only led to:

"..a document, very little – it only deals with the future prospects and the need to adapt the livestock sector"

but that this is nevertheless, an important first step in formulating:

"..political recommendations for the Government - a national programme to outline what to do to mitigate and adapt to climate change between 2014-16, and its evolving impact at the Central American level on meat and milk production"

5.4.1 Industry Perception of smallholder farmers' capacity to adapt to and mitigate climate change

According to CANICARNE, the 4th National Agricultural Census of Nicaragua, undertaken in 2011 by the National Institute of Information and Development (INIDE), concluded that the number of cattle recorded per manzana was 0.6 heads (0.8 per hectare), signalling that production rose 'at the cost of more area' as opposed to there being 'more cattle on less area'.

"..we have done the opposite of what we should have done, we have a large area of countryside, with very little we could improve production without needing to add more land or fell trees. We could double the number, have 1.2 heads per manzana, and have twice as much production without needing additional land"

- CANICARNE

Nicaragua has a higher potential livestock stocking rate based on the carrying capacity of the land than the current national average of 0.6 cattle heads per manzana, and as such many meat and milk processing industry actors are convinced that:

> *"..[there is] a lot of scope to increase the number of cattle per manzana; to grow without needing to fell trees, but here, felling is the norm [...] the one who fells trees is the farmer, he opens up an area, sows [...] he sells the cattle, then clears more land and so it goes"* - CANICARNE

Arguing that 'logging has fostered climate change' as the 'cutting [of] trees means water from rains is not concentrated in the farm, it leaves as runoff directly to the sea', CANICARNE regards tree felling as having:

> *"..led to a win in production [given the expansion of farmland] but not productivity"*

with climate change:

> *"..impacting on yield more than anything, leading to a decrease in production per manzana, a decline in productivity and an increase in costs"* - CANICARNE

According to CANICARNE, the industry has in recent years increasingly recognised:

> *"..the consequence of climate change on production systems of smallholder farmers [...] [namely] reduced efficiency and effectiveness of the value chain*"

and in this context, has considered incentivizing farmers to:

> *"..do the opposite of what they are doing [felling trees] [...] and instead engage in reforestation'.*

Regarded as ‘most important’, reforestation is viewed by meat and milk processing industry actors as:

> *“..giving a greater value to the farm property [...] enabling production and harvesting of forest products and water [...] [which have] values in their own right, and can be commercialised”* - CANICARNE

Convinced of the idea that ‘if we reforest, we will change our climate’ and in doing so, avoid ‘the problems of climate change we saw this year’, CANISLAC and CANICARNE have looked to support CONAGAN which has:

> *“..lobbied for it [reforestation], that a percentage of agricultural and livestock farms must be reforested and by law, have a minimum of 20-30% of tree cover”*

According to CANICARNE:

> *“..as long as things are not mandatory, people will do nothing, there is indifference. There must be a law to establish minimum reforestation of farmland and other practices such as establishment of live fences [...] [which have] an immediate positive [climatic] effect”*

> *“..the Government must intervene and it needs to be strong, obliging by law so that they [farmers] cannot do this [deforestation], the Government should lead in making tree-felling illegal”*

Although smallholder farmers ‘provide a great service to society as food providers’, meat and milk processing industry actors say that ‘there is an environmental issue which needs to be reversed’, namely deforestation.
They contend that one of the main reasons for deforestation is that:

> *“..farmers are indifferent to the issue and particularly, the fact that deforestation is somehow leading to the expansion of the agricultural frontier”* - CANICARNE

This ‘indifference’ on the part of many smallholder farmers is regarded by CANICARNE as stemming from the fact that although deforestation is ‘very significant’, there is ‘much confusion’ and a notable ‘lack of awareness, how to solve it [the problem of deforestation]’ among smallholder farmers who are ‘uneducated’ and for whom engagement in dual-purpose cattle production is essentially ‘a means of survival’.

According to CANICARNE, reforestation is:

> *“..a logical thing, because cattle exposed to the sun suffer [and] forest, live fences don’t just have an effect on soil capacity for rainwater retention and runoff, they provide cattle with shade so they can perform better”*

Figure 15: Land management practices – incorporation of trees as live fences instead of dead posts; management of grazing time and intensity to prevent land degradation

Positing that ‘most farms don’t have trees and that is an error’, CANICARNE suggests that reforestation can lead to:

> *“..better utilization of fodder [...] [with] living fences and rotating plots and grazing in pastures with trees ensur[ing] shade for the animal, and better use of the pasture”*

It advocates that ‘there are a lot of practices’ which smallholder farmers can adopt which are ‘simple and cheap’, such as ‘planting little trees [...] which grow into posts’ and are comparatively less expensive than ‘purchased dead posts’.

Nevertheless, it acknowledges that there are ‘major constraints for smallholder farmers to invest in their production systems and adopt [reforestation] technologies’ and that in reality, only those:

> *“..associated [with a cooperative], who have access to technical assistance, training, education, to material requirements [...] can improve and transform their production units”* - CANICARNE

5.5 Incentives to Invest in Environmental Conservation

According to CANISLAC, climate change is ‘a cultural issue’ which stems from the extensive nature of dual-purpose cattle production in Nicaragua, and from the fact that ‘there is no awareness, no idea’ among many smallholder farmers of the extent to which it poses a threat to the productivity and efficiency of the meat and milk value chain as a whole.

There is a ‘clear’ causal relationship between expansion of the agricultural frontier and climate change, however, for smallholder farmers:

> *“..it’s a production model change to become intensive, establish cut and carry forages, have a forage cutter, know that animals don’t necessarily have to roam”*

despite the fact that it would be possible through adaptation and intensification to:

> *“..achieve greater production [...] , [and] have better management, better nutrition, more milk production (6-8 litres of milk per cows), fatter animals, more income, and increase the overall productive levels of farms [by] keeping animals in an intensive system”*

Noting that smallholder farmers often do not understand that:

> *"..environmental protection means money [...] maybe they don't understand that by protecting the environment what they are doing is increasing productivity, in primary production"*

CANISLAC states that it is time for the meat and milk processing industry actors to recognise that:

> *"..it is an issue for industry, to make production cleaner"*

and that there is a need to identify:

> *"..mechanisms or opportunities out there to give incentives to producers to promote practices that have the potential to sequester carbon and reduce GHG emissions"*

5.5.1 Smallholder Farmers

One of the obstacles for the industry, according to CANICARNE, in terms of initiating a change in production practices and a move towards sustainable intensification of production systems, is that 'there is currently no incentive' - economic or otherwise - for smallholder farmers to engage in environmental conservation activities such as 'preserving trees along a riverbank to retain water resources'.

Smallholder farmers are viewed as:

> *"..having knowledge of the mechanisms to be more efficient, more competitive [...] but [as being] in need of an economic incentive to make the necessary changes"*
>
> - Senior Executive, Milk Company

and recognising the fact that smallholder farmers only change when they have an incentive, meat and milk processing industry actors are increasingly looking to:

"..encourage them to leave traditional practices and switch [to more sustainable practices] [...] by fostering conscience and conscientiousness through a sensitization process and provision of an incentive'

- Senior Executive, Meat Company

Given the importance of good agricultural practices in the context of sustainable meat and milk production, the industry is increasingly waking up to the fact that it has the capacity and responsibility:

"..to advise farmers to improve environmental preservation [...] give seminars and courses aimed at promoting more sustainable practices in their farms, introduce farmers to systems of environmental preservation so that climate change doesn't impact on production" - Senior Executive, Milk Company

5.5.2 Meat and milk Processing Industry Actors

According to CANISLAC, the meat and milk processing industry has many reasons to work with smallholder farmers to halt the shift in the agricultural frontier associated with the development of dual-purpose cattle production systems, reverse the impact of deforestation, increase resilience against the impacts of climate change and secure adequate supply of quality raw material (milk or meat).

For the meat and milk industry, it is therefore not a question of:

"..what incentive do we have to preserve the environment?"

but rather, a question of which activities, leading to cleaner production, can:

"..generate an income and be used by a company to promote its brand, [enabling it] to say that its products belong to a category where cattle are managed better"

"..an enterprise can utilise consumer interest in environmental management [...] to receive remuneration of some form"

- Senior Executive, Meat Company

Investment in smallholder farmers is also viewed as:

> *"..an opportunity [...] to secure the loyalty of producers, who will say: I am committed to the company because they are supporting me"*

with provision of technical assistance and incentives leading to:

> *".. a strengthened value chain [...] forging close relationships to their suppliers (i.e. producers)"*

which would be a significant positive development given that, between smallholder farmers and the industry, there is often:

> *"..no confidence, no trust [...] the relationship is purely commercial - purchase and sale"*
>
> - Senior Executive, Milk Company

5.6 Investing in the Value Chain: Payments for Ecosystem Services

In Nicaragua, there has been limited experimentation with Payment for Ecosystem Service (PES) schemes, and meat and milk processing industry actors say that they:

> *"..don't have anyone who helps to support and advise on the topic - that's what we lack - support"* - CANISLAC

According to CANICARNE, the idea of PES is:

> *"..interesting, and something that is missing at the moment and that [as] people don't know about [...] there is currently no one [milk or meat company] who would do this"*

It says that, for the Government or a non-Government entity, fostering willingness to pay and accept payment of a PES among smallholder farmers and industry actors respectively, however, would simply involve:

"..extensive promotion at national level to explain the benefits of that [a PES scheme], how much money it would cost and could generate, for people to see the figures and get enthusiastic"

According to CANICARNE, a milk or meat company establishing and engaging in a PES scheme would have to:

"..be an entrepreneur with a lot of vision for initiatives [...] in Nicaragua, people may not understand much of it"

"..it's a matter of will and enthusiasm, you have to encourage people [such as smallholder farmers] who have decision-making and action-taking capacity to do things and push for what can be done [adoption of good agricultural practices]"

According to CANICARNE, a PES scheme for water conservation or reforestation should in theory be attractive for smallholder farmers as:

"..people are interested when they see dollar signs and learn they have a right to sell and earn an income for 4-7 manzana (3-5 hectares) of forest reserve, then they start to think, how much is it worth?"

In addition, it says, it would provide the perfect opportunity for meat and milk processing industry actors to:

"..bring silvopastoralism to farmers who are not accustomed to sowing in silvopastoral systems [...] [and] demonstrate that it's not necessary to cut trees to grow forages, that they can grow in the shade of the trees" - CANICARNE

Although establishment of a PES scheme, for an interested milk or meat company, would most likely mean 'investment for perhaps the first few years, generating nothing but work', CANICARNE states that in the long term:

"..[the] effort would be offset multiple times by what is achieved [...] those involved in production [would] win because they get better prices, reputation and more volume of product, [but] all of society, not just the production chain would realise economic, social, environmental and productivity benefits, as it [production] is tied to everything"

In Nicaragua, an 'Inclusive Business' project is currently being implemented by a leading dairy company, Centrolac S.A., with the support of SNV Netherlands Development Organisation and the Multilateral Investment Fund of the Inter-American Development Bank. Targeting 200 small-scale livestock farmers associated with a cooperative, the 'Cooperativa de Productores de Leche El Triunfo RL' (Cooproleche), it has to date provided technical assistance on milking best practices, productivity and quality to facilitate farmers gaining access to more stable and therefore, attractive markets where they can sell their produce at higher prices (SNV 2015).

According to CANISLAC, this project demonstrates that if a milk or meat company:

"..Would be willing to engage with smallholder farmers, it could establish a similar project [...] [and] create an excellent relationship with its value chain suppliers by providing payment for good agricultural practices"

In addition to yielding an 'improvement in quality, efficiency and productivity' of dual-purpose cattle production, establishment of a PES scheme for a milk or meat company would mean being able to:

"..generate additional value, [by] put[ting] a seal related to an attribute [such as carbon footprint reduction or environmental friendliness] which is appreciated by consumers on its products" - CANISLAC

As summed up by the Senior Executive of a meat company:

"..if there is a project which focuses and permits economic savings and also reduces the environmental impact, then it's good on all sides because it can be utilised for publicity"

Given that the 'principle limitation' preventing smallholder farmers from investing in their production systems and adopting new technologies is often limited access to credits with low interest rates, a PES scheme would likely:

> *"stimulate a change in practices, leading to greater sustainability in use and management of natural resources"*

According to CANICARNE, although for meat and milk processing companies:

> *"..it would be easier to pay [for an environmental service] in cash, because farmers have to get paid in the cooperative [so there would be less transaction and monitoring costs]"*

in particular, given that smallholder farmers typically:

> *"..ask for and want to get money at low cost, to improve infrastructure in their farms"*
>
> - Senior Executive, Meat Company

however, as summed up by CANICARNE, a PES payment would:

> *"..be better in-kind, as a company we can pay for something but we would not see an improvement in productivity, quality"*

while with in-kind payments, a farmer is:

> *"..forced to make the investment, whereas cash payments do not create any obligations, the farmer can spend on something else and not on increased productivity and on solving his problems"*

As regards the form an in-kind payment should take, CANICARNE suggests:

"..one way of thinking about and creating incentives required [...] we could deliver a bull with certain characteristics, cows to improve the genetics and specialize in meat or milk, grass seed, infrastructure to store feed for the summer, artificial insemination"

The fact that the idea of PES schemes to promote uptake of good agricultural practices by smallholder farmers has not yet been adopted by the industry, according to one milk company is due to:

"..in truth a lack of vision, given that it [environmental conservation] is an issue of looking into the future and passing on [resources] to subsequent generations"

"livestock production in Nicaragua is not environmentally friendly and instead of improving this aspect [of production], we look to improve our productivity index"

"..we are aware of what we are doing but do not look to apply [concepts such as PES] [...] we forget that there is an environmental aspect to improved productivity"

According to one meat company, a PES-style 'carbon insetting' scheme would be 'interesting' and is:

"..an issue of vision [...] being a leader and leading [smallholder farmers and other industry actors] by example"

"..if there is no interest from companies, much less from producers, there must be someone who encourages and sparks everyone to do so"

Although it would be 'a long-term investment', according to a senior executive of this meat company, 'correct management' of dual-purpose cattle production systems incentivised through a PES scheme would enable Nicaragua's meat and milk industry and smallholder farmers to 'follow its development path' in a manner which 'doesn't affect the environment'.

According to one milk company, there have been ‘very good experiences of PES in Costa Rica’, where the Government, industry and smallholder farmers have had ‘years of living with it [the concept of PES] and knowing that, and how it works’; and as such it could be an ‘initiative worth implementing’ also in the context of dual-purpose cattle production in Nicaragua. Not only would it meet the ‘business needs’ of the value chain as a whole; it would foster a stronger, more ‘permanent alliance’ between the industry and producers which is ‘vital’, given the current and future adverse implications of climate change on efficiency and productivity.

5.7 Facilitatory Actor Perceptions and Willingness to create Enabling Conditions

Perspective 1: Agricultural Extension - Government Extension Services (INTA)

According to the Nicaraguan Institute for Agricultural Technology (INTA), the impacts of climate change - drought and the El Nino phenomenon - constitute a ‘serious problem’ for smallholder farmers who are engaged in a livestock production activity which is ‘quite traditional’, extensive and underpinned by the use of pastures without trees - ‘most producers have cut down all the trees on their land’ -namely, dual-purpose cattle production.

There has been an ‘incredible advance’ in the agricultural frontier, with the area utilised for cattle production has expanded rapidly in recent years, and at the cost of deforestation extending almost into reserve areas. Although ‘much of the culpability for environmental degradation can be attributed to smallholder farmers’, INTA says that small family farmers are ‘highly unprepared’ to address and deal with climate change and variation, and for this reason urgently require assistance from the Government and private sector.

In addition to national policies encouraging and supporting smallholder farmers in practicing sustainable management and following agroecological practices, INTA posits that there should be ‘some type of incentive’ provided to farmers who maintain an area of forest reserve on their farm or engage in environmental protection. It suggests that this:

> *“..could be monetary, perhaps in-kind, lowering of taxes or some other mechanism that producers can adopt or apply [...] if it would be possible to pay in cash, it would be great as people would much rather this, and could visualise it more”*

Alluding to the fact that 'it would be hard at the level of Government, to create a monetary mechanism', INTA highlights the 'important role' that the meat and milk industry could play in terms of taking initiative and establishing a PES scheme, despite its limited experience to date in the field of PES provision.

According to INTA, meat and milk processing industry actors would stand to gain considerably from the creation of incentives for smallholder farmers to improve their production systems, due to the fact that the industry is efficient, but primary production is inefficient:

> *"..milk and meat productivity levels are extremely low [...] 2.5-3 litres of milk per cow per day, when they should produce maybe twice that, and it takes up to 4 years to deliver an animal for slaughter"*

For smallholder farmers, engagement in a PES scheme would be a 'great opportunity' for farmers with a cash or in-kind payment for the establishment of a silvopastoral system or adoption of agroecological production practices, enabling them to transform their farms, improve production and earn additional income.

Channelled through a cooperative, a PES scheme could lead to 'greater access to for farmers to technical assistance and extension services', as well as remove one of the biggest constraints to investment in and adoption of environmentally-friendly technologies, access to credit:

> *"..credit policies do not favour producers, there's no finance for medium- and long-term loans from the conventional banking system, and many microfinance organisations offer only credit at very high interest rates"*

A PES would make the value chain 'more efficient', as it would bring together and bind different actors, reducing the possibilities to free ride, and increasing levels of trust between smallholder farmers and the meat and milk industry. An improvement in the relationships between value chain

actors would also, notably, lead to a reduction in the number of intermediaries involved in transactions, thus improving the efficiency of the chain as a whole:

> *"..the reason that producers fall into the hands of intermediaries is that, if they take animals to the slaughterhouse, they don't get paid as they should be paid, weights are not the fairest way to determine prices"*

> *"..and for milk, processors always think that producers produce bad quality milk and pay as they want based on their judgement of the quality"*

According to INTA, there would be little risk involved for smallholder farmers in engaging in a PES scheme as many already take actions to protect the environment, with agroforestry and silvopastoral practices, cultivation and utilisation of improved pastures as feed for cattle; and as such, the idea of a PES scheme, which would lead to an improvement in production systems, would be 'met with a lot of enthusiasm'.

The Nicaraguan Government is looking to restructure the livestock sector to make it more competitive, and is focusing on issues such as quality improvement, breeding and cattle traceability, and in this context, INTA says the concept of PES should be 'pushed', as it could be an important and efficient 'mechanism for technology transfer'.

Although sceptical about the sustainability of PES schemes in the long-run based on the experience in Nicaragua to date - the fact that when projects such as the end, payment is often discontinued, and as such, if approached to collaborate, it would be in a position to play a supporting or advisory role in any Government- or private sector-led PES scheme:

> *"..we are not working from a payment but rather from a technological point of view, to determine the production system efficiency effects of carbon sequestration, and developing models to recommend technologies which enhance carbon sequestration - silvopastoral systems, improved pastures, leguminous cover crops, protein banks"*

Perspective 2: Agricultural Extension - Non-Governmental Organisation (CRS)

According to Catholic Relief Services (CRS), corporate social responsibility is a concept which is 'really starting to take hold' among the private sector in Nicaragua, with one notable example being the Nicaraguan subsidiary of the international conglomerate, Mercon Coffee Group - CISA Exportadora - which has in recent years accepted 'the need to reduce waste, water consumption and carbon emissions' at its coffee processing facility in Matagalpa.

CISA Exportadora is so far the 'only large processing plant in the country that's actually measuring carbon emission', and CRS says that the idea of measuring carbon emissions and footprint reduction is still very much a case of 'chicken before the egg' as companies are not familiar with the idea. It argues that if companies would be aware of the concept of carbon insetting, however, they would 'latch on to it, embrace it'.

One of the main reasons that a greater number of companies have not adopted a 'more climate-smart approach' to production, according to CRS, is that companies in Nicaragua are primarily exporters, and there is not yet 'much demand' from 'people higher up in the chain' to reduce emissions associated with the raw agricultural commodities which they purchase, such as coffee and cocoa.

A US-based coffee roasting company which in recent years was interested in assessing and improving its 'environmental reputation' as regards operations in Nicaragua is Keurig Green Mountain, Inc. In 2013, a feasibility study was undertaken by the International Center for Tropical Agriculture (CIAT) in conjunction with CRS, FLO-Cert and Sustainable Food Lab, as a follow-up to a 2006 baseline study of the livelihood security of smallholder coffee-producing families during the so-called 'Thin Months' - a 'seasonal hunger period, when food and cash from previous harvests run short'.(Malin et al. 2013; Banerjee et al. 2013).

Although this feasibility study did not ultimately lead, as planned, to the establishment of a carbon insetting-style PES scheme involving Keurig Green Mountain and four Nicaragua coffee-producer cooperatives in San Juan del Río Coco, CRS argues that a carbon-insetting-style PES represents

‘a real opportunity, at least over the short term’ to adapt to and mitigate climate change, as it enables companies to ‘learn about where GHG emissions come from [...] [and] respond directly to the source of emissions’, through provision of a payment for adoption of by smallholder farmers of good agricultural practices, reforestation and tree planting.

Carbon insetting enables industry actors to reduce their emissions in a manner which is both environmentally and socially responsible, thus leading to an improved environmental and corporate social responsibility profile which, according to CRS, leads to companies ‘completely differentiating’ themselves from their competition:

> *“..there are so many benefits [...] if you can communicate it well, it’s very innovative - very few people are doing it [carbon insetting]”*

It facilitates companies in determining the vulnerability of the supply chain and in particular, smallholder farmers - ‘based on climate exposure and environmental degradation’ - and in taking precautionary actions to ensure supply chain adaptation to climate change and a continued secure supply of raw material, through identification and implementation of agricultural practices at farm level leading to enhanced carbon sequestration.

From its perspective as an international humanitarian agency with a poverty reduction and human development focus, CRS views carbon insetting as ‘a very practical way to respond to climate change’, given that forestry and agroforestry system practices can lead to smallholder farmers’ improved livelihood and food security, increased natural capital and a ‘new revenue stream’ associated with the PES scheme and potentially, the sale of carbon credits.

According to CRS, the aspect which fundamentally differentiates carbon insetting from carbon offsetting is that ‘it is not philanthropy’ but rather ‘about relationships’. For industry actors, carbon insetting is:

> *“..a way to really protect a supply chain over time, making it more resilient against climate change , against different kinds of shocks”*

In adopting an insetting approach to reducing GHG emissions associated with their product, and adapting to and mitigating climate change:

> *"..buyers of carbon insets are actually investing in their supply chain and in the longevity of the supply chain [...] [as opposed to] just getting commodity they can buy and sell"*

and as a consequence:

> *"..if it's an inset project, [they have] much more at stake [as regards] project outcomes"*

Another aspect which differentiates carbon insetting from offsetting is that for smallholder farmers who are 'already planting their trees, [and] not getting any incentive for it', an insetting-style PES scheme is 'something that's very easy to get involved in' unlike 'traditional offset projects'. This is due to the fact that projects are typically designed for implementation at a smaller scale, and the standards available to industry actors - such as that of the registered Scottish charity 'The Plan Vivo Foundation', namely, the '2013 Standard for Community Payments for Ecosystem Services' - have been designed specifically to:

> *"..support smallholder farmers and communities in managing their natural resources more sustainably, with a view to generating climate, livelihood and ecosystem benefits'.*
>
> (Plan Vivo 2015)

In the department of Estelí in the north of Nicaragua, a Canadian non-profit organization, Taking Root has looked to utilise reforestation 'as a tool to restore ecosystems, improve livelihoods, and tackle climate change' in implementing a so-called 'social reforestation' project. According to CRS, although not an example of carbon insetting project, the use of the Plan Vivo standard in generating carbon offsets indicates that agroforestry based projects have a 'real value' for smallholder farmers' and generate:

> *"..a lot of non-monetary benefits [...] improved soil health, water resource protection, food security, livelihood resilience, an additional source of income"*

Carbon insetting is regarded as increasing smallholder farmers' capacity for entrepreneurship and strategic alliance, as it changes the 'relationship with the buyer, [making it] more dynamic' - 'it's a new dimension to the way that they relate'; and at a fundamental level, puts smallholder farmers 'on the frontlines of innovation, in terms of what society is doing to slow the impact of climate change'.

According to CRS, carbon insetting is a type of PES designed specifically for implementation by industry actors such as the meat and milk industry in Nicaragua as it is a mechanism which 'works on the ground', with a 'local organisation, such as a cooperative [...] playing the role of capacity builder' and 'providing the assistance, receiving the funding' as opposed to the Government which 'is not very present in terms of their extension services'.

Asked to evaluate to what extent there is scope to implement carbon insetting in the context of dual-purpose cattle production, CRS says that there is potential particularly in the case of beef which is exported, and that meat and milk processing industry actors would not face difficulties in incentivizing smallholder farmers to engage in reforestation or establishment of silvopastoral systems if they provided support either cash or in-kind. Payment in-kind as opposed to cash, however, would ensure that farmers are 'spending on what they [industry actors] want to achieve' and that payment is not used for any other purpose - 'if you just give them cash, you'll not see it [lead to an investment in increasing carbon sequestration].

Convinced that carbon insetting is a type of PES scheme which 'has the potential for sustainability over time' given that buyers and sellers of the environmental service of carbon insetting - for example meat and milk processing industry actors - are 'so locked into their supply chain relationships'. CRS says that although 'very seldom directly implements [projects]', if approached, it would be willing to playing a supporting role in being an 'intermediary to set up the project to provide insurance or a guarantee to the buyer [of the environmental service]', as well as building the capacity of the selected local partner organisation - NGO or producers' cooperative.

Perspective 2: Export and Investment Promotion Organisation (CEI)

In 2012, the Nicaraguan Center for Export and Investment (CEI) launched a two-year project which centred on determining and mapping to what extent institutions in Nicaragua were choosing to engage with the topics of carbon footprinting and provision of incentives for carbon sequestration in 'practical terms, organizational terms and most importantly, business terms'.

Quickly realising in the process of its investigations that although it was not yet a widespread 'trend' among private and public sector actors, there were nevertheless a number of actors which had 'a programme, some component, some intervention related to carbon footprinting'. CEI decided to establish a public-private round table at national level on the theme with the support of The United Nations Economic Commission for Latin America and the Caribbean (CEPAL) which was also interested in the issue at a more regional level.

Public sector actors who chose to join the round table included as the Ministry of the Environment and Natural Resources (MARENA), Ministry of Development, Industry and Trade (MIFIC) and the Foundation for Technological Development in Agriculture and Forestry FUNICA. On the private sector side, the idea was to select ten companies from the agro-food sector on a 'first come-first serve' basis, with an invitation extended to all subsectors - coffee, cocoa, livestock etc. The coffee sector was selected as the first sector to respond, being 'a sector which always benefits [from public-private initiatives]' and is known for being 'highly active and innovative in adding value to coffee with different tastes and speciality products', while the cocoa sector was selected on the basis that it was viewed as having 'a lot of potential' given that it is a commodity with 'high demand, particularly in Europe'.

In the end, the project centred only on the coffee and cocoa sectors, as despite being invited to engage, the dairy and meat sectors 'incredibly, did not show up'. According to CEI, this was disappointing as the livestock sector, known for its major contribution to GHG emissions and climate change, and in this context had been working closely with MIFIC to adopt and implement good practices. From an export promotion point of view, it was also disappointing given that meat and milk are important commodities, and their export and value addition - for example, through

initiatives such as carbon footprint measuring and reduction - prioritized in the Government's national development plan.

The disinterest or apathy to take part in an initiative determining 'what sectors were doing on the theme of the environment', however, was not surprising, according to CEI, given the lack of willingness of the meat and milk sector to innovate, and its reputation as a less than environmentally-friendly primary production sector. In addition, it was not unexpected that there would be some reluctance to join the round table, given the 'behaviour of cattle farmers in this country' as regards complying with standards, improving production and efficiency at a farm level, as well as engage in environmental conservation and sustainable natural resource management.

The project resulted in a change in perception of 'carbon footprinting' from a sectoral to national level, from conceptualisation as 'just a component of social responsibility' to being seen as 'an element that should be transversal and taken into account in all fluxes and productive processes'.

According to CEI, companies in the coffee sector. for example, are now much more aware of how much GHG gasses they emit 'at each stage of processing, from farm, to drying, transport to export'; and through measurements and calculations to 'know for each kilogram of coffee exported, specifically, how much CO2 is emitted'. The study also provided an answer to the age-old question, which companies previously did not have an answer to - 'what are we exporting in the end, coffee or contamination?'

Many of the coffee and cocoa companies that joined the round-table said that they 'had no idea of carbon footprinting', and for this reason capacity building workshops were organised to define the concept is a carbon footprint, and differentiate between methodologies used to measure CO2 emissions. At a fundamental level, CEI wanted to 'awaken conscience at a national level' and change the perception of the agro-food industry, to encourage monitoring and evaluation of GHG emissions and incentivise companies to 'invest and transform their production processes'. It says it achieved this vision, as companies are now no longer 'waiting for someone to come to certify – they are convinced that it's a business strategy'.

According to CEI, companies are increasingly realising the advantages of having knowledge of carbon footprinting and the fact that there is strength in measuring emissions from an external communication point of view:

> *"..if you are already aware of your carbon footprint, your buyer will realise that you are improving practices, and aspiring to have a packaging of products that says 'certified' or 'hoping to become carbon neutral'"*

Highlighting the case of one company which is now using its knowledge in 'negotiation rounds' with foreign buyers who are 'shocked that a family company is undertaking this type of a venture [monitoring CO2 emissions]', CEI says that it expects that 'carbon footprinting' to become 'a normative, like other processes' in the future as markets such as the EU become more 'convinced that it [CO2 emissions] can be regulated'. In this context, it says, companies 'need to be educated on conceptualising the issue of climate change, [as] it could be a norm for companies in the future' and could 'help the food industry in Nicaragua to access niche markets'.

In the case of coffee and cocoa, according to CEI, Nicaragua already has a reputation for having a 'product unlike that offered by other countries [...] premium quality, certified organic', and now companies are building their environmental portfolios, by gaining 'experience in carbon footprinting', reversing the trend until recently of 'little focus [of production] in terms of environmental impact at a national level'.

One positive finding of the study was that most coffee and cocoa sector emissions were not linked to transport but rather to 'management of soil and fertilisers', which indicated that companies were already aware to a certain degree of 'what they are consuming [in energy costs]' that there was an existing level of efficiency in production related to process flows. However, it highlighted an additional benefit associated with carbon footprinting, providing an incentive to monitor and control emissions, namely, that by emitting less through regulation of fertilisers, companies could also realise gains in monetary terms given the costs associated with fertiliser use.

Despite their competitiveness in exporting raw commodities, CEI says that one of the weaknesses of companies in Nicaragua is that they do not sufficiently 'focus on internal improvement of export products [in terms of] quality, communication', and look to 'negotiate and sell to the general European market' rather than exploring niches and 'selling to a select European market' where there is 'awareness about products consumed, and [consumers] don't only think about price'. Instead, they should 'look for differentiation and competitiveness [...] improve the price, identify a loyal market'.

In the case of the meat sector, CEI notes that if companies would embrace the concept of carbon footprinting, it would be 'interesting' as the industry is well developed, has good manufacturing practices and is conscious of what is typically entailed in monitoring, evaluation and certification processes. The meat market is diversified and there is already value addition, with live cattle and special cuts for different markets in Central America, South America, North America, Asia and the EU. According to CEI, Nicaragua has 'the quality to export' even the offals and as such, 'absolutely nothing is wasted'. Nicaragua has fills its quotas for meat exports.

In comparison to meat, milk is 'another story, [as] Nicaragua does not have the necessary quality for the USA to export fresh milk and must instead export processed products – butter, yoghurt and cheese'. The industry is regarded by many as 'safe', with milk having its destination market and cheese destined primarily for El Salvador, while value-added products such as yoghurt are also mostly oriented towards Central America. Given the commercialisation at a national level - domestic demand is strong and when milk is transformed, most of the transformations are into cheese.

Nicaragua does not currently have trade agreements for yoghurt or milk, does not take advantage of its quota for butter, and only meets its quota for cheese. It is essentially a sector which 'has potential but is not innovative, and needs to be developed at an organizational level, at a value generation level and above all in terms of commercial links. For this reason, CEI posits that:

> *"..the milk sector would take longer to empower through the methodology [of carbon footprinting] and more would have to be invested in training, capacity*

building and knowledge diffusion to raise awareness of the topic within the sector. It would be more feasible with meat"

Nevertheless, it says that given that Nicaragua is 'affected by climate change issues, [and that] if there is a drought, what is the sector most affected? Livestock' - CEI suggests that meat and companies should try to merge environmental and market issues, and therefore explore the concept of carbon footprinting as a means of growing and diversifying to sell in more lucrative niche markets, 'not only in the traditional markets'. It argues that a 'proactive approach' to adapting to climate change which involves reducing GHG emissions will not only lead to the improved cost-effectiveness of the meat and milk value chain, but will also enable actors to explore 'new market opportunities' and 'diversify supply offered' enabling them to sustain exports against a backdrop of uncertainty stemming from climate change.

For CEI, the motivation to establish a project focused on the promotion of carbon footprinting was underpinned by its desire to 'develop the country's image' to make Nicaragua more than 'just a dot on a map', rather an interesting country of origin for buyers of raw commodities, with the ability to 'innovate to compete in large markets'. In addition, the project was designed to foster greater vertical integration in value chains, as regards environmental conscientiousness which required extensive round-table discussions, capacity building workshops and information dissemination, given that:

"..companies in Nicaragua [...] don't do anything which implies a monetary change, if they are not sure that they will see an improvement [...] they will do absolutely nothing which leads them to encounter risk"

As an institution, CEI plays a facilitatory role -which it could also fulfil in the context of a carbon insetting-style PES scheme - in helping companies to 'get to know the market', providing commercial information as regards to what extent something such as carbon footprinting is 'demanded by the market', and facilitating companies in adapting their business strategies to ensure 'product suitability for the international market'. Many companies, it states, have 'outdated strategic plans' and fail to realise that

> *"..the weakest link in almost all agro-food value chains [in Nicaragua] is commercialisation – knowing how to sell, what prices to sell at, and having knowledge of issues that require consideration [such as carbon footprinting]"*

Establishing new commercial contacts and realising market diversification, it argues, requires greater integration of environmental and market issues such as GHG emissions and carbon footprinting, and an effort on the part of companies to work more closely with or even be directly involved in the production and natural resource management activities of producer cooperatives.

As such, in addition to companies, CEI looks to 'reach smallholder farmers with new innovative proposals' such as carbon insetting, which it believes not only allows farmers to develop, but will benefit the company with whom they work and the value chain within which they engage, as well as the sector as a whole.

Chapter 6: Carbon Insetting - Willingness to Pay (WTP) and Accept (WTA)

6.1 A Carbon Credits Industry Perspective

Perspective 1: Carbon Standards Certification Organization - FLO-Cert

According to FLO-Cert - the certification body of the Fair Trade Movement - agro-food industry actors are 'quite aware that climate change is happening' and that it is 'very much affecting' their supply chains at a global level - hypothetically speaking, in the case of coffee, from the 'coffee producer cooperative, the coffee exporter, the coffee importer to the coffee roaster'.

Facing a climate change-induced 'problem in sourcing [raw commodities]', agro-food industry actors are increasingly recognising that:

> *"..to really make a change [...] they need to invest in their own supply chains and their own producers, to help them fight [climate change]"*

as opposed to simply contributing towards climate change adaptation and mitigation by reducing GHG emissions and the 'carbon footprint of their company in Europe or the USA'.

At the same time, however, agro-food industry actors are progressively realising that synergies exist between enhancing smallholder farmers' capacity to adapt to and mitigate climate change, reducing their carbon footprint, improving the overall resilience of the value chain to climate change. As a consequence, FLO-Cert posits, many agro-food industry actors are now starting to explore the extent to which innovative payment for ecosystem service mechanisms - such as 'carbon insetting' - can incentivize adoption by farmers of good agricultural practices and sustainable natural resource management, and concurrently, ensure continued access to raw commodities.

According to FLO-Cert, for agro-food industry actors, the difference between 'carbon insetting' and the more widely-known financial mechanism 'carbon offsetting' is that in the case of insetting, 'you don't invest somewhere you don't really care about'; but as a company rather look to incentivize smallholder farmers in your own chain to engage in practices leading to carbon

sequestration which have carbon credit generation potential, based on the premise that there is a 'need to secure [product] supply and the chain is under stress'.

For agro-food industry actors who engage in carbon insetting with the objective of obtaining carbon credits, certification constitutes a high additional cost and as a consequence, some companies - those working in short supply chains, with a limited number of smallholder farmers and where a high level of confidence exists between value chain actors - are choosing to:

> *"trust the fact that if you plant trees and these are professionally managed, there will be a certain amount of trees equating to a certain amount of carbon sequestered"*

The majority of agro-food actors, however, engage in carbon insetting with the idea of obtaining certified carbon credits, as their intention is to reduce or neutralize their GHG emissions output, and to use insetting activities for corporate social responsibility (CSR) purposes as - 'it's a nice thing to communicate' that a company is investing in its producers.

Although the certification process is not difficult to realise, it hinges primarily on the ability to indicate additionality of carbon sequestered, which is easily proven as:

> *"..the reason smallholder farmers don't do it [mitigate climate change without provision of an incentive] is because they can't do it"*

most agro-food industry actors choose to undertake feasibility studies to determine to what extent 'it is worth it or not' to look for certification - and if the answer is yes, against which available carbon standard - using the following criteria:

> *"..how much [sequestration is required], which methodology [should be utilised], how much would it cost, how much credit would be generated?"*

Paving the way for agro-food industry actors to ‘put a label on their product’ - complementing rather than competing with existing labels such as ‘Fair Trade’ and ‘Organic’ - carbon credit certification, FLO-Cert posits, communicates product environmental awareness, serves to strengthen consumer confidence, and as such, crucially, ensures value chain sustainability.

Perspective 2: GHG Emissions Reduction Project Developer - South Pole Carbon

According to South Pole Carbon - a leading premium emission reduction project developer - which specializes in developing ‘innovative climate action solutions’ for corporate sector actors to help them reach sustainability targets, including carbon insetting which it regards as:

> *“..on the cutting edge in terms of climate change impact [...] [but] still somewhat of a niche product”*

Carbon insetting is adopted exclusively in the context of the voluntary carbon credit market, with by corporate sector actors choosing carbon insetting over ‘a regular offsetting solution’ doing so based on their recognition of its strength as a product ‘indicating thought leadership’, therefore enabling companies to differentiate themselves from competitors.

For corporate sector actors, one of the key differences between carbon insetting and carbon offsetting is the fact that carbon sequestration and credit generation takes place ‘along a value chain’. There is a ‘link to the operations of a company's supply chain’, with the ‘majority or a significant part of the carbon credits generated by a project, bought by the same company’, and only remaining credits are traded as carbon offsets on the regular voluntary carbon market.

As opposed to seeking to ‘just establish a project with [their] supplier farmers’, corporate sector actors who choose to engage in carbon insetting are not so much interested in the carbon certificate itself, but rather in:

> *“..the core benefits of the certificate [...] which matter to business, [such as] improved agriculture, cleaner water, improved health of smallholder farmers”*

At a fundamental level, in comparison to offset credits, inset credits are not just a commodity; and for this reason, South Pole Carbon posits, corporate sector actors choose not to 'buy it [the credit] elsewhere [outside their own supply chain]' despite the fact that to do so might perhaps be more straightforward or cost-effective.

For corporate sector actors, certification in the context of compliance with the standards of the voluntary carbon market is 'less expensive and complex' than in the context of the regulatory carbon market. This is due to the fact that to comply, for example, with the Kyoto Protocol's Clean Development Mechanism (CDM), corporate sector actors need to ensure that they purchase credits certified according to so-called 'best standards', such as the ever-popular Gold Standard - widely regarded as underpinned by 'best practice methodology' and therefore, a 'high quality carbon credit label'.

An alternative certification option to that offered by the Gold Standard Foundation, according to South Pole Carbon, however, which has 'positioned itself as the leading standard in insetting' is the 2013 Plan Vivo Standard or Community Payments for Ecosystem Services (PES). Although a slightly 'lower profile standard', due to its relative new arrival to the market, the Plan Vivo Standard is 'well suited to insetting' given that its flexibility and the fact that it was specifically designed for adoption in the case of smallholder- and community-based projects.

One of the reasons why carbon insetting appeals to certain corporate sector actors is that there are 'considerably synergies between carbon projects and business [in terms of aims and desired outcomes]'. By establishing a carbon insetting reforestation or agroforestry project, for example, a corporate sector actor can augment farm income and by 'linking a project to actual business' can reduce the 'risk of interrupted business' stemming from smallholder farmers' financial instability and exacerbated climate-change-induced 'supply problems'.

According to South Pole Carbon, carbon insetting projects have the capacity to:

> *"..increase smallholder farmers' livelihood security, improve their health, [and] even improve their education [...] help them to adopt improved agricultural practices and [as such] adapt to climate change"*

They typically require a 'lengthy' period of time for implementation and to induce change in the behaviour and practices of smallholder farmers, however, and this is one reason, South Pole Carbon states, that it 'doesn't always work for farmers', who choose to engage but then 'after a couple of years, chop down all the trees'.

South Pole Carbon contends that one of the most important elements in establishing a carbon insetting project is 'finding a good partner on the ground to make it happen'. Unlike carbon offsetting projects, insetting projects require a corporate sector actor and their designated project developer to 'work with a certain pre-selected cooperative' which is already involved in the value chain, and as such it is not possible to 'pick the best partner cooperative in the country'.

Given that project design and implementation involves 'a lot of underground rooting' - monitoring activities and collection of data to be sent to the project developer to facilitate delivery of credits to the buyer based on emissions outcomes - institutional support at all levels, from producer cooperative to local government, is regarded as 'crucial'. In particular, the cooperative must be 'willing and able to engage in the project' as it has an important role to play in terms of 'capacity building, technology transfer and effecting behavioural change'.

In many cases, the risk perceived by corporate sector actors is not related specifically to the carbon insetting mechanism but rather to the technology promoted by a project, which in the case of projects developed by South Pole Carbon ranges from cook stoves to water purification, reforestation and agroforestry. To date, 'household-based projects' - cook stove and water purification projects - have proven most successful, leading some potential corporate sector clients to pose the valid question - 'what exactly is the link to my business?'.

Nevertheless, South Pole Carbon says that the concept of carbon insetting has been welcomed by corporate sector actors looking to find innovative solutions to climate change. Highlighting one of its flagship projects, its collaboration with the 'Oserian Flower Farm' situated near Lake Naivasha, Kenya - 'the largest and most technically advanced fair-trade certified flower farm in the country, which consistently produces year round quality flower products' - it points to the fact that cook stove technology can be an attractive and a revenue-generating investment option for the corporate sector.

The carbon insetting project which has received perhaps the most widespread acclaim, however, is the South Pole Carbon-designed project which saw Coop - Switzerland's second largest retail and wholesale company - and the World Wildlife Fund (WWF) team up to 'offset […] or compensate emissions from goods that Coop imports by plane [...] within its supply chain '. The first project to be implemented in the context of a supply chain by South Pole Carbon, its success led to the development of further projects:

> *"..WWF promoted the concept quite heavily for us [...] they liked the concept and also approached several other potential, other cooperative partners of theirs with the concept"*

Still ongoing, the project has proven 'that the concept works', however, perhaps more importantly, it has also 'indicated where the concept of insetting needs to be improved' to make it more appealing to the corporate sector and more attractive to smallholder farmers.

In the case of reforestation and agroforestry projects, in particular, South Pole Carbon notes, processes of implementation and certification are 'very challenging' due to the fact that smallholder farmers must firstly be 'convinced to plant trees [...] which is not so easy'. In addition to its technical feasibility, a project must namely be evaluated based on the extent to which there is scope for 'enough win-win' to incentivize both corporate sector actor and the smallholder farmers with whom they work.

According to South Pole Carbon, a 'crucial lever in the business model' of carbon insetting is the provision of means of subsidised inputs as opposed to cash handouts, which serves to reduce costs for the private sector as they can negotiate, distribute and provide payment in-kind and it also increases project sustainability as farmers are 'committed [...] and have to pay'.

Stating that carbon insetting does not 'fundamentally change the relationships within a value chain' - as it is simply as if a smallholder farmer produces 'an additional product', in this case a carbon credit - South Pole Carbon posits that it is nevertheless a mechanism which can leads to empowerment and 'increases capacity for entrepreneurship' where a project is correctly designed and implemented. In addition, it suggests, even if the individual farmer does not benefit directly in terms of becoming more empowered, 'it's often the cooperative' which improves its position viz-a-viz other value chain actors and gains more clout to negotiate on behalf of its members.

Asked to what extent carbon insetting 'could work for something like livestock' in Nicaragua, South Pole Carbon says that 'it could definitely work' as there is much scope - given the fact that 'quality is still lacking' - to increase efficiency of transport and production activities, and input and technology use. For a project to be successful, in addition to 'interest from not only retailers, but also manufacturers' in the concept, South Pole Carbon notes, ultimately all that is required is commitment towards the realisation of CSR and environmental sustainability goals by:

> *"..a medium-sized company who's CEO really would like to do something in the context of CSR and improve supply chain sustainability via climate change [adaptation and mitigation activities]"*

6.2 An Agro-food Industry Perspective

Perspective 1: Coffee Company - Source Climate Change Coffee

The 'only conservation-led coffee company', Source Climate Change Coffee aims to 'protect the world's forests', by incentivising smallholder farmers to:

> *"..plant trees in ecological hotspots [namely, La Sierra Cloud Forest, Mexico and Mount Elgon Cloud Forest, Uganda]'*

and at the same time, incentivising end-consumers to:

> *"..make direct payments for ecosystem services for every bag or tin [of coffee] sold, through reforestation carbon credits"*

Trading in carbon neutral single origin, gourmet coffee, it was founded as a start-up company to showcase the 'carbon insetting' concept, after attempts in vain by Source Sustainable - an 'ethical trading services' company providing consultancy and advisory services on the topic of 'sustainable and ethical sourcing' - to convince tea and coffee companies that carbon insetting could be a means to 'tap into new market opportunities, ensure long-term survival of products and gain competitive advantage'.

An assessment of incentives underpinning 36 international projects established to protect forests, had led Source Sustainable to conclude that companies could address climate change-induced impacts on their supply chain by 'using the supply chain for forestation'. In proposing the idea to its clients, however, it found that companies 'had a very difficult time understanding it [carbon insetting]', which led it to recognise that the only way to advance and promote the concept was to lead by example, and demonstrate first-hand the benefits of engaging in carbon insetting.

In 2013, a decision was taken by the director of Source Sustainable to establish Source Climate Change Coffee in a bid to create 'a really successful product' and in doing so derive a 'story' which would 'communicate well' and get 'businesses interested' in carbon insetting.

According to Source Climate Change Coffee, despite the fact that 'it's still very, very early days', its establishment has led to growing interest in the concept of carbon insetting among companies who 'like the message'. Realising the 'need to engage with their supply chain to address climate change', companies are now considering reforestation and sustainable land management as a means of 'replenishing supply chains', recognising that:

> *"..we can't continue to take from them without putting something back. Because we'll exhaust everything, we'll exhaust the water, we'll exhaust the soil, we'll exhaust all of the green resources and not put anything back"*

Positing that, if all companies engaged in carbon insetting, 'it would ‘address greenhouse gas emissions in agriculture’; Source Climate Change Coffee says that the main issue is that:

> *“..the moment you start talking to companies about the assessment [of carbon footprint] and developing a carbon project”*

Carbon insetting is perceived as a ‘very expensive’ business venture, a view which is justified given that:

> *“..you need to get it [the project] approved, you need to make sure that the economic mechanism works and that the money is going to go where it needs to go. And then you need to verify it. All of that is a costly process”*

> *“..it can cost anything between 40.000 and 150.000 [British] pounds. And that’s just for one site”*

> *“..to create one product sometimes, you might be sourcing from 100 different sites - if you price that at 40.000, you’ve got a lot of money to be spending”*

Establishing a carbon insetting project typically ‘takes a long time’ - from the preparation phase to the implementation phase where ‘you contract smallholder farmers’ and ‘explain to them what you’re doing [reforestation or afforestation]’. For this reason, and the fact that implementation ‘needs a lot of collaboration [...] and money’, Source Climate Change Coffee suggests that:

> *“..companies [...] [should look to] work hand in hand with development organisations that have experience in the field, to develop joint projects”*

According to Source Climate Change Coffee, carbon insetting is ‘truly innovative, [and] forward-looking [...] there’s a real argument behind it’ and although it is currently ‘very niche’, has the potential to ‘become a widely adopted mitigation and adaptation strategy’.

Positing that retailers are facing:

> *"..a time [...] where it has become increasingly important to communicate to their customers what they're doing in terms of sustainability [...] because customers want to know [whether or not] there's an environmental impact"*

and where:

> *"..if a supermarket competes on price alone, it's lost. It's finished. The supply chain's at risk [and] it has no competitive edge"*

Source Climate Change Coffee notes that retailers need to:

> *"..develop strategies to communicate with their suppliers [...] [and therefore also] intermediary buyers [who] are the only ones that link the consumer to the environment [...] [and are] able to tell consumers what's happening"*

By 'investing in [...] and changing the nature of the supply chain' through carbon insetting, companies can 'develop relationships' characterised by 'longevity' and 'stability', as well as 'total transparency' upstream as well as downstream - companies can therefore increase their 'competitive advantage', realise 'massive cost savings' and most importantly, in an era of 'being more innovative' out of necessity, strengthen companies' corporate social responsibility and environmental sustainability profiles.

According to Source Climate Change Coffee, due to the fact that:

> *"..if a company has invested attention and care and put effort into making something happen with its suppliers, it will not walk away that easily'*

carbon insetting will change how companies view smallholder farmers as it will:

> *"..inherently increase their bargaining power and strategic alliances and entrepreneurship"*

Smallholder farmers ‘know instinctively what’s happening’ as regards climate change and its impact on agricultural production, and at a fundamental level, carbon insetting will allow smallholder farmers to ‘develop a dialogue’ around ‘what they’re doing’ to mitigate and adapt to climate change, which is significant given that ‘a lot of farmers initially don’t have this dialogue’.

Important in terms of strengthening and reinforcing the relationship between companies and smallholder farmers as interdependent supply chain actors working collaboratively towards a common goal - namely, environmental conservation and sustainable land management - for companies, it is:

> *“..a very difficult dialogue to have with smallholder farmers [...] to explain climate change services [ecosystem services], explain what the trees do, and how it’s helping your community and how it’s helping the world’s environment”*

Although smallholder farmers ‘work the land, day in day out’, they nevertheless need to ‘learn about it [the benefits of environmental conservation and sustainable land management]’, however, Source Climate Change Coffee notes that when ‘they understand it [...] they explain it in beautiful terms’ and through this dialogue, essentially ‘become environmental stewards [...] almost environmental conservationists’.

According to Source Climate Change Coffee, companies should - as part of the dialogue process with smallholder farmers - look to dispel ‘the common misconception’ as regards the impact of PES schemes - and therefore, of carbon insetting - on farmers’ income, as ‘they’re not going to get rich from it’. At a fundamental level, companies should explain to farmers that:

> *“..the only thing this carbon is going to give to you [...] [is] an incentive to keep the trees and hardwood standing”*

Given that smallholder farmers 'don't appropriate something that is not theirs' and that in the case of 'a lot of reforestation projects [...] within two years, the trees have disappeared' due to the fact that 'nobody took care of them', Source Climate Change Coffee suggests that it is important to:

> *"..incentivise a farmer to plant trees on their land, so that they see the benefits [...] the tree remains standing and it grows, they can get extra crops, they get extra wood for construction"*

It suggests that if smallholder farmers notice the 'benefits' in terms of environmental impact - 'wildlife coming back to the area, more birds, some of the streams flowing again' - and the impact in terms of 'good crops, good yields', they will:

> *"..start thinking of their farm as worth managing, as a business venture as opposed to just a piece of land"*

and as consequence:

> *"..start to become much more innovative and better [producers] in general"*

A 'common misconception' among smallholder farmers, according to Source Climate Change Coffee, is that they 'have to do lots of [additional] work on their farm' to participate in a PES scheme. As opposed to needing to drastically change their production practices, however, it says that farmers can more or less 'do exactly as they did before' and at a fundamental level, need only to 'look after the trees' for which 'they're getting paid a tiny amount of money' and for which 'they receive support from agricultural organisations'. In essence, it notes, for smallholder farmers engagement in carbon insetting is therefore relatively straightforward as:

> *"..it doesn't involve a lot of time [...] they're working on the farm anyway. It's just that they have to manage it [the farm] differently"*

Reflecting on its own experience, Source Climate Change Coffee admits that for companies, in contrast to smallholder farmers, venturing into the field of carbon insetting is 'not an easy process'

and is something which took ‘a lot of effort’ - from convincing intermediary actors in the value chain to ‘get on board with the idea’, to clearing up ‘confusion about what carbon was’.

For this reason, it says, it is important that companies look to identify and work with ‘very good reforestation partners’ as carbon insetting typically ‘takes time and requires [significant] effort and resources’. As a company, Source Climate Change Coffee notes, ‘you need to count on the support’ of the project developer, implementing organisations such as local NGOs who have a presence on the ground and therefore ‘understand what you need’; as well as identify a good ‘cooperative structure to feed into’ as:

> *“..you need people to be able to accompany you, help you through the process of setting up the project, facilitate your need for information and for a transparent supply chain and to be enthused by it [the carbon insetting concept]”*

As important as it is to identify a network of capable partners to implement a carbon insetting project, Source Climate Change Coffee posits, it is just as paramount to have a high quality product which can ‘catch the imagination of retailers out there’. A company will not be in a position to capitalize on the benefits of carbon insetting, unless it is in a position to sell its product, as ultimately, in terms of developing a market for carbon footprint-reduced products or carbon neutral products:

> *“..it doesn’t matter what farmers are doing and what a product does, if the quality is bad. It has to be a good product [...] [to] really make it happen”*

Having earned widespread praise and admiration for having successfully ventured into and promoted the concept of carbon insetting, Source Climate Change Coffee states that in implementing a carbon insetting project:

> *“..it’s better [for a company] to take it easy and not get carried away with a million and what things, because otherwise you lose the focus that you need”*

Today supplying 30 small retail outlets across the UK with carbon neutral coffee products, it says that the key for companies is to:

"start small, consolidate what you do, and then get to the next stage [...] everything needs investment and communication"

As regards the timeframe required for a carbon insetting project to take off and deliver returns, it notes that:

"..you need somebody to be working on it [carbon insetting] full time and a lot of resources. So either you go to the investment industry and tap and get investors in, or you build it [a carbon insetting project] up progressively through careful planning"

In many ways, Source Climate Change Coffee's success can be attributed to its innovative marketing strategy in 'selling the idea of carbon offset or carbon footprint reduction, in terms of improving [smallholder farmers'] livelihoods'. Taking cognisance of the fact that 'you can't talk about carbon as carbon, as it doesn't mean anything to anybody', the company has instead chosen to focus on and talk about:

"..how to protect forests which form clouds and generate rain [...] [as] it's simple, but otherwise people don't know what carbon is"

In order to 'appeal to normal consumers', Source Climate Change Coffee's packages and tins of single origin organic speciality coffee are branded as 'brimming with environmental, social and ecological benefits' and in the case of the coffee from Mount Elgon Cloud Forest in Uganda, as 'support[ing] some 300 coffee farmers in a reforestation project'. Although 'there's no such thing' as a 'reforestation credit', by referring to it as such, the company has managed to successfully communicate to its customers 'that it's a carbon credit linked to tree planting', thereby 'breaking it down', making it 'more tangible', and therefore, a less abstract concept.

Underscoring the fact that that '20% of global GHG emissions come from the continued misuse of the world's forests', Source Climate Change Coffee says that carbon insetting can enable a company to transform its marketing strategy and make it more innovative. For the purposes of informing consumers of 'smallholder farmers' on-going conservation efforts at the cloud forest of

origin', the company has included a 'carbon credit tracking number which if entered in an internet search engine is linked to the market registry where the credit is held on the rear of all tin and bags'.

Source Climate Change Coffee notes that this, in particular, highlights the role that consumers can play in incentivizing smallholder farmers to engage in 'reforestation and conservation activities'; and the fact that for every coffee product sold - at a cost of an extra pound per bag or per tin - 7kg of carbon dioxide is offset through 'reforestation carbon credits' generated within the supply chain by smallholder farmers planting trees.

Carbon insetting is 'about creative thinking and innovation in supply chains' and in this context, 'there's no point in making sustainability a very expensive thing, because it shouldn't be more expensive [than conventional products]'. Despite 'real pressure [...] from the people that sell the product', Source Climate Change Coffee has steadfastly looked to ensure that its coffee products fall into 'the same price range' as conventional coffee products, thus 'making them available to consumers so that they can afford it [sustainability]'. It contends, companies should make a product 'attractive enough to influence [buying habits]', as opposed to making it 'very niche and very expensive' to the extent that 'nobody is going to want it' - the product and at a fundamental level, carbon insetting, as a climate change adaptation and mitigation strategy.

Source Climate Change Coffee is optimistic, however, that as regulations are increasingly introduced forcing companies 'to reduce carbon emissions on a national level' are reinforced, and wider society 'starts to understand what it is happening around climate change, around carbon and why resources are being depleted'; more and more companies will 'want to engage in sustainability [...] and do something cutting edge'. In this context, it posits, realising that if they can 'get the other end of the chain to say: yeah, we're interested if you set the project up, we'll buy it [the product and concept]', companies will realise the benefits of, and therefore 'start becoming very interested' in carbon insetting.

Perspective 2: Cocoa Company - Chocolats Halba

A self-styled 'pioneer in the area of sustainability in the chocolate sector', Chocolats Halba has engaged in carbon insetting through its cocoa supply chain. By analysing, reducing and compensating GHG emissions and 'offsetting all remaining corporate emissions in its own value chain', the Swiss premium manufacturer of chocolate specialities for retail and industry - a division of Coop, Switzerland's second largest wholesale and retail company - has succeeded in achieving its carbon reduction goals and in doing so, also realised its goal of climate-neutral chocolate production as illustrated in the diagram below.

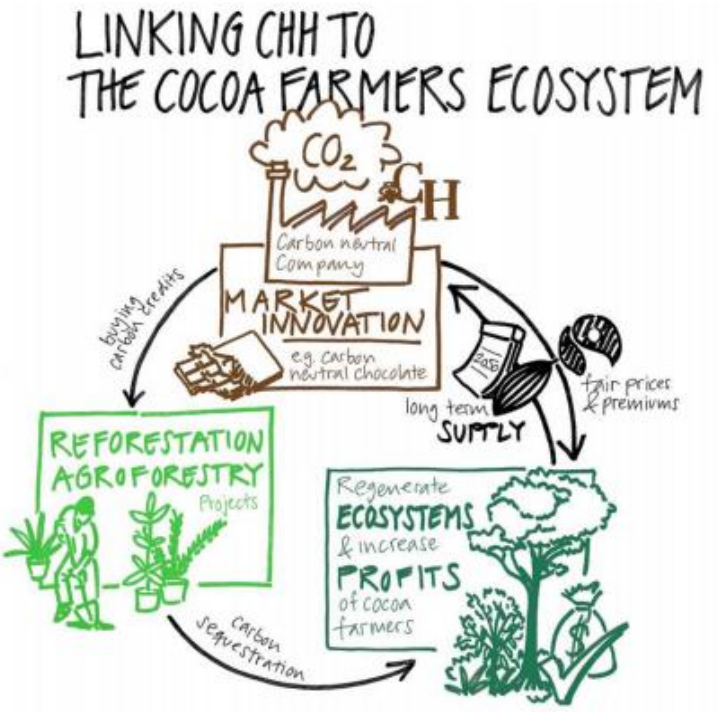


Figure 16: Chocolats Halba's conceptualisation of carbon insetting in its value chain

adapted from 'Linking a chocolate factory to the ecosystem of cocoa farmers', a presentation by Christoph Inauen of Chocolats Halba during the Furth Session: 'Value Chain Enhancement' of the Second BioTrade Congress "Integrating REDD+ into BioTrade Strategies" in Geneva, Switzerland on the 12th December, 2013(Inauen, 2013).

According to Chocolats Halba, engagement in carbon insetting:

> *"..actually makes a lot of sense [...] it's not something [an offsetting project] very far away, we offset the emissions within the ecosystem of our company [...] so we*

can influence the ecosystem that produces the raw materials we need to produce chocolates"

Although it trades directly with the cooperatives from which it procures cocoa, its carbon insetting engagement activities and 'all that is carbon-related, or carbon insetting-related' are managed by Pur Projet - a French organization which 'assists companies in incorporating climate issues into their raison d'être and businesses, through regeneration and preservation of ecosystems' (Pur Projet 2015).

Charged with developing the project strategy (agroforestry, reforestation or forest conservation) on behalf of Chocolats Halba, Pur Projet undertakes 'the whole carbon certification process', monitors project impact and most importantly, oversees the purchase and sale of carbon credits from two cooperatives in the chocolate company's supply chain - namely, Cocoa Acopagro Agricultural Cooperative (ACOPAGRO) in Peru and the Association of Producers of Organic Cacao Agroforestry Systems in Olancho (APROSACAO) in Honduras.

Chocolats Halba sources cocoa from Ghana, Honduras and Peru, however, until very recently, it only procured carbon credits from its agroforestry project in Peru, as its reforestation project in Ghana was too small, and the reforestation/agroforestry project in Honduras had not yet been certified to generate carbon credits. In 2014, the Honduras project was also certified by Gold Standard, with credits - generated by smallholder farmers 'mixing cocoa with ordinary trees in agroforestry systems' and planting hardwood trees - approved for emissions trading purposes.

As part of its agreement with Pur Projet, Chocolats Halba has signed a contract to purchase carbon credits equivalent to 30,000 tonnes of carbon from smallholder farmers involved in its project in Honduras, at a cost of 20 euros per tonne - of which 15 euro goes to the cooperative. Although this price includes the cost of project development, it is nevertheless regarded as a 'high' given that that:

"..30,000 tonnes is not so much, [and] one tonne of carbon credits at the moment costs around 8-10 euros [...] which means that a big part per tonne goes for project development"

To keep costs low, Chocolats Halba has shared the costs of carbon credit certification with other small investors in the case of Peru, and in the case of Honduras with its 'mother company' - the Swiss retail company, Coop. The company says that high costs are also the reason that it is not currently, or in the foreseeable future, looking to obtain credits from its reforestation project in Ghana, as although smallholder farmers 'really like the project', it is 'too small to justify the certification costs'.

Prior to its engagement in carbon insetting, any carbon reduction goals which Chocolats Halba had built into its supply chain were mainly related to its production facility and had 'nothing to do with any insetting/offsetting strategy', instead being 'only about carbon reduction'. Having achieved the goal of 'reducing carbon emissions by thirty percent [...] within the last couple of years', the company says that it did not view carbon insetting as an extension of its carbon reduction goals, but rather its motivation to engage was to realise its aspiration of becoming a producer of carbon neutral chocolate products.

Faced with the option of either engaging in carbon insetting or offsetting, Chocolats Halba decided to go for the latter 'strategy' as although both would involve the purchase of carbon credits:

"..offsetting for us means just buying carbon credits from a project somewhere in the world, where we have no contact with [...] [while] if you do it within your supply chain, we can have a better understanding and a closer relationship with our farmers"

Carbon insetting projects enable a company to 'link its own economic activities to its own economic ecosystem', in other words, to the economic situation of the smallholder farmers from which it sources its raw material. By establishing a project, investing in capacity to 'produce in an

agroforestry system' and purchasing carbon credits, Chocolats Halba says it has provided farmers with an additional source of income to the cocoa which it purchases from them. This is significant, it says, given that 'in cocoa the daily income of farmers is very low' and so, through sale of carbon credits 'in the long run, they can increase their income a lot'.

For companies, Chocolats Halba posits, carbon insetting can facilitate value creation in terms of its brand and boost its 'credibility and sustainability of [its] corporate social responsibility activities' leading to an improved image:

> *"..if you tell consumers we do offsetting of carbon, but we do it with the farmers, I think that's such a different story [to carbon offsetting outside the value chain]"*

According to Chocolats Halba, 'carbon insetting leads to a win-win outcome' as it:

> *"..creates a better alliance and a better understanding [...] and [fosters] a long-term relationship - a better relationship of trust - between farmers and us [companies]"*

This relationship in turn is the 'important base' for:

> *"..a lot of social, economic, environmental and productivity benefits for farmers', but also 'social and economic benefits' for us [companies]"*

To measure the impact on smallholder farmers, Chocolats Halba in conjunction with Pur Projet is in the process of 'setting up a measurement system' made up of '140 different things that we measure every year', which will better indicate 'the impact on the farmers on different levels [...] in economic, ecological and social terms' of its carbon insetting projects in Peru and Honduras.

In the case of Honduras, in particular, the project appears to have had a 'big impact on the livelihood security and food security' of smallholder farmers, due to the fact that cocoa production in an agroforestry system:

"..makes the whole ecosystem a lot more productive [...] in many ways, more diversified and [therefore] ecologically stable"

Prior to the initiation of the carbon insetting project in Honduras, smallholder farmers were vulnerable to climate change, had 'very few cattle and very degraded land' and therefore, produced very little. Essentially a project 'started from scratch', Chocolats Halba's motivation to establish a 'new area of cocoa production in the eastern part of the country' and on smallholder incentivize farmers to cultivate cocoa in an agroforestry system followed the irreversible, destructive impact in 1998 of Hurricane Mitch on existing cocoa fields.

To date, the company's commitment to 'developing a high-quality fair and organic cocoa pipeline in Honduras' has had a profound impact, with smallholder farmers benefitting from being able to obtain an additional source of income from different fruits and in the long run, from the sale of teak trees. For Chocolats Halba, however, more significant than this 'diversification of income' is the fact that the project has helped to adapt the ecosystem on which farmers depend for cocoa production to climate change, and that as a result, farmers are in a better position to mitigate the impacts of climate change.

According to Chocolats Halba, the project implemented on the ground by Swiss NGO Helvetas and the APROSACAO cooperative, has 'strengthened their [farmers'] capacity for entrepreneurship' as well as for 'strategic alliance and formation', with farmers now 'more involved in the cooperative' than in the past, benefitting from the group sale of cocoa and as a result, 'improved bargaining power', and no longer needing to turn to the formal banking system for credit.

Through its project, Chocolats Halba distributes seedlings for free to smallholder farmers who receive payment firstly if they plant the seedlings, and thereafter:

"..they get the money for the ecosystem service that they provide [...] if the tree is still there after 6 months, after 12 months, after 3 years"

In this set-up, the cooperative plays an important role in project implementation:

> *"..producing the seedlings or the trees, providing technical assistance and capacity building for farmers with the money from the carbon credits"*

Although suggesting that smallholder farmers often need 'both in-kind support and direct cash', Chocolats Halba does not look to influence the cooperative in terms of how it spends money received, saying 'cooperatives can decide what they offer with their money'. It does, however, look to support the cooperative in other ways, for example by also encouraging the companies with which it works or to whom it sells, to engage in the purchase of carbon certificates, as cooperatives:

> *"..really depend on somebody that can pre-finance carbon credits [...] it's a lot of investment - very difficult [for a cooperative] to pay 200,000 or 300.000 dollars for the certification and to have that [debt] for a couple of years until you get the certificate that then starts selling on its own"*

Chocolats Halba does not develop its own carbon projects - 'we're a chocolate company [...] so we will always have Pur Projet as the project developer' - and is therefore considerably insulated from the influences of the 'institutional context'. It maintains, however, that there can be 'a big difference' in terms of project outcomes based on the 'institutional setup', referring to Honduras, for example, where 'it's much harder to appropriate land' than in Peru, which complicates the project implementation, and specifically, the tree monitoring and certification process.

According to Chocolats Halba, the relationship and level of trust which exists between cooperative and the company incentivising a carbon insetting project is important:

> *"..in the Peruvian value chain there is an intermediary, but we have direct links with the cooperative ACOPAGRO. We know them well and have visited since 2000.*

We know they are well able to bring an innovation [such as carbon insetting] to the market"

The success of a carbon insetting project also depends on those further along a value chain and according to Chocolats Halba, although few clients are interested in 'investing in tree planting'; the company has identified 'quite a few clients that are into carbon neutral labelling', which it says is a concept that is:

"..easier to communicate [...] the buyer has no clue about tree planting, [...] [but] you can just present a carbon neutral label which the buyer thinks is 'cool'"

Chocolats Halba utilises 'a private signet from Pur Projet' on its chocolate products, which it says is contingent on 'presenting a plan on how you're going to reduce your carbon footprint' and therefore signals commitment to do so to retailers selling brand products. The label has been well-received by 'Business2Business' clients, who 'like the concept [of carbon insetting]' and the company credits its innovative marketing strategy - in being one of the first manufacturers to present chocolate bearing the label 'carbon-neutral product' - as having enabled it to 'save around 50 million Swiss francs [41.6 million euro]' in the last five years.

Chocolats Halba's sales have increased since it started to sell carbon neutral products in 2010 and in 2012, 23% of all products (12 million products) sold were labelled 'carbon neutral'. Although, the company admits that, despite growing environmental awareness among consumers, it says that this most likely due to the fact that for end consumers the price difference 'is not big money [...] a dark chocolate more or less costs half a cent more and the final milk chocolate around 1 cent more', rather than that the end consumer 'really gets the concept' which it deems 'too abstract'.

Contending that reduced carbon footprint is therefore 'not really THE sales argument', Chocolats Halba says that the carbon neutral is 'not in competition' with other labels such as organic and fair trade, and that 'on the contrary [...] they are very complementary'. For this reason, it says, 'more and more companies' starting to subscribe to what was once seen as '[a lot of] hot air' - the idea of 'linking an economic activity to its supply chains and working with the supply chain to make it

more sustainable'. At a fundamental level, there is increasing recognition among companies that carbon insetting is an important and investment-worthy 'business strategy for the future'.

Chapter 7: Discussion

The objective of this thesis is to evaluate the extent to which 'carbon insetting' can serve as an innovative climate change mitigation and adaptation strategy, enabling actors throughout the dual-purpose cattle value chain in Nicaragua to realise ‘quadruple-win’ outcomes (social, economic, environmental and productivity benefits).

Assessing the willingness to pay (WTP) and accept (WTA) payment for ecosystem service provision, the thesis evaluates whether it is feasible through a PES mechanism such as carbon insetting - where there is an explicit aim to generate social, economic, and environmental and productivity benefits - to positively contribute to the improved livelihood security and sustainability of smallholder farmers engaged in dual-purpose cattle production in Nicaragua.

7.1 Importance of dual-purpose cattle production for Nicaragua

As evident from the literature review and the results of this study, dual-purpose cattle production is of economic, social and cultural significance for Nicaragua - at a national and societal level and in the context of this thesis, notably, at an individual smallholder farmer level.

A source of livelihood for more than 136,000 smallholder farm households across the country, dual-purpose cattle production is the most important livestock production activities in Nicaragua, with almost half of the land under agricultural production at a national level utilised for extensive grazing of cattle on permanent pasture (Holmann, 2014; Schütz et al., 2004).

The results of this study indicate that it is precisely due to this extensive nature of dual-purpose cattle production - and the fact that natural forages in combination with improved grasses are utilised as fodder, as opposed to concentrate feeds - that Nicaragua, with a comparative advantage in terms of production costs, is highly competitive in export markets for both beef and dairy products. This is similar to the conclusions of studies undertaken by Holmann (2014) and Schütz et al. (2004).

According to senior executives of the Nicaraguan Chamber of Beef Exports (CANICARNE) and the Nicaraguan Dairy Sector Chamber (CANISLAC), the volume and value of export milk and meat products has risen substantially in recent years. Representing a fifth of Nicaragua's total exports, meat and dairy products now generate more than one billion US dollars per year in revenues.

The trend in growth of Nicaraguan dairy and beef exports is forecast to continue into the next decade and in this context, the Government - recognising the opportunity to generate tax revenues and foreign exchange - has looked to attract and incentivize outside investors to enter the market, including two large regional dairy players; namely, the Mexican dairy group Lala and the Costa Rican cooperative Dos Pinos (Holmann, 2014).

The results of this study indicate, however, that for the Government, the importance of dual-purpose cattle production stems, at a fundamental level, equally from the fact that it underpins Nicaragua's macro-, and microeconomic well-being. As an agricultural production activity, it contributes to a third of overall GDP and critically accounts for a fifth of employment at a national level, if the value chain as a whole is taken into consideration.

Meat and Milk Processing Industry

For the meat and milk processing industry, it is very lucrative to engage in exportation of dairy products (milk powder, evaporated milk, fluid milk and cheese) to countries such as El Salvador, Guatemala and Venezuela; and in the case of beef, to Venezuela and the USA (Holmann,2014). This study confirms that this is the case, with CANICARNE and CANISLAC asserting that four-fifths of meat and milk products produced in Nicaragua is destined for the export market.

Viewing themselves as on a par with industry in competitor countries in terms of complying with sanitation, health and safety regulations, meat and milk processing industry actors are interested in tapping into new strategic markets such as the European Union; and as this study indicates, in exploring the potential feasibility of niche markets - ranging from organic to fair trade and even carbon-neutral - for meat and milk products.

In the meat and milk value chain, processing industry actors are price setters as opposed to price takers. They capture and retain a much higher share compared to smallholder farmers of final prices, which are already discriminatory given that they are based on subjective judgement of the quality of raw material delivered - in the case of milk through the cooling network to the milk plant; and in the case of beef, by smallholder farmers or through intermediary actors responsible for transport of live animals to the slaughterhouse.

Smallholder Farmers

According to Holmann (2014) dual-purpose cattle production is an attractive form of production for smallholder farmers. This study indicates that for those who choose to produce meat and milk, it is their main livelihood strategy and source of income and a source of community prestige. Production is of traditional cultural value, practiced on farm homesteads inherited from forefathers. The way of life provides regular opportunities for smallholder farmers to meet with their neighbouring farmers, contributing significantly therefore to their social capital and capacity to cope in times of need, drawing on community support for financial help or resources following shocks and stresses.

Cattle are an important household asset with considerable liquidity, with dual purpose cattle production involving lower levels of risk than specialization in either dairy or beef production. Smallholder farmers who engage in dual-purpose cattle production and sell to the formal meat and milk processing industry, receive a higher price than those who produce milk, artisan dairy products or meat for sale in the local market. For this reason, the majority of smallholder farmers prefer to produce meat and milk for sale to the formal meat and dairy industry, and for family nutrition and consumption purposes only - despite the seasonality of prices and the price fluctuations stemming from variable market supply and demand.

The results of this study showed that although the extent to which smallholder dual-purpose cattle farmers have bargaining power and have limited capacity to assertively participate in the meat and milk value chain, the farmers did not face difficulties in organising sale of cattle - whether normal or distress sale. Indeed, many farmers had in recent seasons sold cattle to improve the health and education status of their households.

The decision of smallholder farmers to engage in dual-purpose cattle production was also shown by this study to be influenced by the presence of good environmental and soil conditions for cattle, crop and forage production. Equally important, however, was the fact that cattle farmers are a somewhat privileged social group. The results of this study indicate that they are subject to less scrutiny from Government as regards adherence to environmental regulations, and in many cases their traditional 'mentality' as regards production practices leading to widespread deforestation, land degradation and the shift in the agricultural frontier has, until recently, been wholly accepted.

It is only now that industry and Government are looking to foster conscientiousness among farmers and incentivise adoption of more sustainable production practices.

7.2 Constraints to Dual-Purpose Cattle Production

The dual-purpose value chain (meat and milk) is characterised by an inefficiency which stems from the production practices of smallholder farmers, and extends all along the value chain to intermediaries and ultimately, the meat and milk processing industry.

Smallholder Farmers

This study identified a number of factors which result in low productivity and efficiency of production - ranging from smallholder farmers' inadequate practices in terms of breeding, herd management, hygiene (in milking), transport (delivery of meat and milk to processing facilities); to lack of access to credit, information (market, quality, prices) and services (animal health, extension, artificial insemination).

This study confirmed the finding that smallholder farmers obtain just 4 litres per cow per day, on average, through a native and improved forages-based diet (Holmann, 2014), due to seasonal shortages of forage and water. It also indicated, however, that unpreparedness to deal with extreme climate events (e.g. the 'record' drought of 2014) - leading to exacerbated animal nutrition problems - was a factor equally contributing to the inefficiency of dual-purpose production as a production system.

Regarded by the FAO (2013) as a traditional production system, dual-purpose production generates less monetary (income per acre) and non-monetary benefits (resilience to environmental shocks and degradation of resources) compared to more diversified production systems such as silvopastoral systems. The extensive nature of production means that farmers do not realise the potential livestock stocking rate based on the carrying capacity of the land, and so do not utilise the land productively. On the contrary, smallholder farmers fell trees to clear land to extend their farms and establish new production areas - in the process, contributing to deforestation, land degradation and the widely condemned agricultural frontier shift in Nicaragua.

For smallholder farmers, there is currently no incentive to sustainably manage their farmland and cattle herds as returns on investments are not attractive - the output-input ratio is low, with low prices received for milk and meat produced. As indicated by this study, most farmers do not perceive an incentive to adopt improved practices and technologies; expand their production system or the size of their herd; or improve breeding practices.

Despite the importance of breeding practices in the context of realising higher prices associated with improved quality of meat and milk products, most smallholder farmers fail to maintain herd books, implement organised breeding schemes to reduce the risk of inbreeding and maintain genetic quality, and fundamentally, fail to undertake genomic evaluation of cattle or select according to traits (pedigree, reproduction, milk production, calving interval).

This has led CANICARNE and CANISLAC to suggest that in the long-run, there will be an erosion of genetic quality of the national herd - an issue which is further compounded by the fact that some smallholder farmers engage in illegal cross-border trade of young calves, steers and occasionally cows. Viewing it as ‘good business’, they argue, farmers fail to understand the long-term repercussions in terms of undermined ‘sustainability’ of the national herd and dual-purpose production as a system.

In addition to the high cost of artificial insemination, which smallholder farmers cite as one of the biggest constraints to realising improved breeding, the results of this study suggest that there is no

incentive to buy new breeding stock as farmers tend to keep calves for long periods of time (up to 4 years) before bringing them to slaughter. In addition to increasing production costs related to feeding and animal health, maintaining calves for long periods of time reduces the space available for new animals and increases labour costs.

Most farmers say that they face difficulties in satisfying the age, sex, weight and animal health requirements which they perceive as demanded by the industry. A key finding of this study, however, is that the reason for this is that a major disconnect exists between what farmers perceive as product requirements and the standards which the process industry in reality expects farmers to meet. In the context of beef production, for example, farmers do not regard age of slaughter as an important characteristic, despite the fact that it is regarded by industry as one of the main factors influencing quality.

As stated by Holmann (2014), the low and fluctuating prices which farmers receive for meat and milk are a consequence of the seasonal nature of production, and balance between market supply and demand. In addition to supporting this finding, the results of this study suggest that low prices are also due to the subjective quality assessment by meat and milk processing industry actors.

Characterised by low levels of trust, knowledge sharing and coordination, the institutional arrangements which govern relationships between farmers and the meat and milk industry are weak. Many farmers complain that the production practices of a small number of farmers (i.e. milk adulteration, poor hygiene) have resulted in low prices and unfair industry bias against all farmers.

Meat and Milk Industry

Livestock growth is private sector-driven in Nicaragua, with technology adoption promoted by cooperatives and large dairy plants as opposed to Government extension services (Holmann, 2014). As indicated by this study, however, smallholder farmers nevertheless still lack adequate access to information, extension and animal health services as well as access to credit provided at low interest rates.

Industrial capacity to process meat and milk has increased significantly in Nicaragua in recent years, driven in the case of milk by the establishment of collection centres and an efficient cooling network, and in the case of beef by strengthening of slaughterhouse efficiency and improvements in the transport network (Holmann, 2014). This study highlights, however, that there are still considerable issues to be addressed in improving the cost-efficiency of processing activities - many industry actors assert that they operate at levels below plant capacity and that meat and milk processing unit costs are high, resulting from inadequate quality and quantity of raw material from smallholders farmers.

Low productivity in the primary production link of the value chain, has led some industry actors to call for a move away from dual-purpose cattle production towards specialization by farmers in either meat or milk production, as a means of improving the quality of raw material received. Despite the fact that the facilities utilised by processing industry actors meet international sanitary and phytosanitary standards**,** the quality of raw material is too low to enable industry manufacture milk, dairy and meat products which would allow access to high value export markets (e.g. European Union).

Another barrier currently hampering the industry is that there is no operating system in place to ensure traceability of animals and products. This situation is expected to change in the near future, however, as the Government has initiated a process to establish a cattle traceability system at national level in advance of signing a free-trade agreement with the EU which will provide a new export market opportunity generating higher revenues than current trade with the USA (Holmann, 2014).

Aside from this positive initiative, the meat and milk processing industry asserts that the Government is not providing sufficient support, as regards assisting the industry develop and advance the primary production sector. The response in the aftermath of the recent 'record' drought in 2014 serves to highlight the fact that the biggest constraint to productivity is not necessarily seasonality of forages production which creates scarcity and unreliable supply of raw material, but rather the unpreparedness and failure on the part of smallholder farmers, the value chain as a whole,

as well as actors outside the value chain - both public and private sectors - to respond in time to the crisis situation. In the end, both smallholder farmer and industry suffered unnecessary losses.

In the context of increasing resilience to the emerging constraint of climate change, industry actors have called for further measures to support smallholder farmers in overcoming challenges faced in production, emphasising that improved access to information, extension services and credit could also facilitate farmers in realising increased productivity and cost-efficiency of production.

The results of this study indicate that the meat and milk processors are starting to recognise that their business could benefit from deepening the relationship with smallholder farmers beyond the current commercial interface. This supports the findings of Holmann (2014) who states that levels of trust or confidence between actors in the dual-purpose value chain are low due to the fact that there are many intermediaries in the chain that increase transaction costs and reduce overall efficiency and quality of raw material received.

Meat and milk processing industry actors argue that Government should address the "hidden" link in the milk value chain in Nicaragua - 'Cuajadaras' and 'Queserillas' (micro and small dairy processors) who compete with formal sector actors - with the aim of improving processing facilities and practices. As described by Holmann (2014), these small artisan cheese factories and intermediaries pay a low price for fresh milk, do not demand high quality raw material and in many cases, do not currently adhere to regulations regarding quality and production standards.

Although the milk cooling network has improved quality, this study indicates that a thriving market still exists for 'dirty milk' for use in the manufacture of artisanal dairy products for local and export markets. According to CANISLAC, Nicaragua lacks infrastructure such as laboratories where quality can be tested for quality characteristics (e.g. fat content) and for adulteration or contamination. If such facilities would be established, it argues, it would provide a justification for industry to reward smallholder farmers with higher prices in return for adopting of good primary production practices, as industry would be in a position to access more lucrative markets.

This study indicates that one key area which the meat and milk industry views as a major source of inefficiency is the illegal cross-border trade of cattle. The "hidden" link in the beef value chain enables smallholder farmers and intermediaries to circumvent payment of taxes, which makes it an attractive outlet for maximising profits in sale. Smallholder farmers are offered high prices and sales are quick, which formal industry actors argue leads to unfair competition and undermines value chain productivity and efficiency.

7.3 Impact of Climate Change on Dual-Purpose Cattle Production

As noted by Thornton et al. (2009), although the impact of climate variability on livestock production systems is subject to intense debate, it is generally agreed that an increase in temperature of between 1.8 and 4 degrees Celsius, in addition to changed precipitation patterns, tends to lead to reduced water availability, undermined crop productivity and increased disease incidence and severity among livestock.

In Nicaragua, the extent to which climate change threatens to undermine the efficiency and productivity of dual-purpose production is increasingly being recognised. Indeed, as the results of this study indicate, actors along the dual-purpose value chain view themselves as affected in recent years by the phenomenon of climate change.

In a promising omen for climate change adaptation and mitigation, both smallholder farmers and meat and milk processing industry actors were in agreement that the climate was changing, but more importantly, that a value chain level response to climate change was required to halt the current and expected "ripple effect" in terms of impact along the value chain, from the smallholder farmer production level to the meat and milk processing industry level.

As described by the World Bank, in 2014, smallholder farmers located in large areas of Nicaragua were impacted by a 'record' drought, with delayed rainfall events as a consequence of the El Nino phenomenon leading to scarcity of forages for feeding, reduced reproductive capacity and consequently, a decline in productivity of dual-purpose cattle. In addition to undermining the livelihood security and sustainability of smallholder farmers engaged in dual-purpose cattle

production, the drought led to reduced efficiency and productivity of the processing industry and dual-purpose (meat and milk) value chain as a whole.

In terms of the impact of climate change on the primary production sector, this study indicates that the majority of smallholder farmers perceived an increase in temperature, more variability or unpredictability in precipitation patterns (shorter period of rainfall but with increased intensity), and an increase in heat (conceptualised in terms of hotter conditions leading to heat stress in cattle). Farmers also reported a reduction in wind (important in the context of cooling following heat stress), more frequent drought occurrences, and an increase in the length of the dry season and concurrently, a decrease in the length of the rainy season.

Smallholder farmers' perception of climate change closely mirrored the predictions of the IPCC and the World Bank (2008), indicating that they were acutely aware of climate change - an increase in temperature, a decrease in precipitation and a decrease in cloud cover (related to perception of increased 'heat'). They noted an impact of climate change on the productivity and efficiency of the production systems, supporting the finding of Thornton et al. (2009) that livestock farmers most affected by climate variability are those in climate-sensitive areas where production grassland-based and highly dependent on good climatic conditions - in particular, precipitation events.

Referring to their reliance on natural forages and improved grasses for dual-purpose cattle production smallholder described themselves as highly vulnerable to climate variability, with temperature and precipitation changes and increased occurrence of drought events leading to a shortage of animal feed (6-7 months per year) and water shortages. In addition to increased feed scarcity and incidence of disease, parasites and bacterial infection, they summed up the impact of climate variability, at a fundamental level, as increased production costs associated with animal health (e.g. vaccines and anti-parasitic drugs) and input costs (e.g. external feed).

The results of this study indicate that smallholder farmers perceived an impact of climate variability on forages planted and the performance of their cattle herd similar to the findings of Thornton et al. (2009) who note that an increase in temperature leads, in the case of forages, to

reduced digestibility, rates of degradation and nutrient availability; in the case of cattle performance, to heat stress and adversely impacted metabolism resulting in reduced productivity, physical activity, feed intake, production potential (regardless of feed intake) and a deficit in energy leading to a decrease in fertility, fitness and longevity; and in the case of disease transmission, higher rates of infection by disease vectors.

One of the key findings of this study is that against a backdrop of increased difficulty in planning production resulting from climate change and climate variability, the majority of smallholder farmers recognised that they had no choice but to accept the increased risk associated with dual-purpose production. Relating a decline in milk yield this in particular to reduced availability of forages, many smallholder farmers used cash savings or took a loan to improve their production systems (e.g. by purchasing equipment and improved animals, establishing improved housing for cattle, installing irrigation systems) and diversifying production (e.g. by adopting improved forages and planting in dispersed areas to reduce yield variance).

This study indicates that smallholder farmers are aware of climate change. In doing so, it highlights the fact that farmers' concerns regarding the impact of climate variability on production should be given due consideration by actors participating in, and external to the dual-purpose value chain; and at a fundamental level, suggests that - given their desire sustain and strengthen their livelihoods - smallholder farmers can and should be mobilised as part of any strategy at value chain level, to adapt to and mitigate the impacts of climate change.

In this context, however, it highlights the need to increase access to extension services - providing support, advice and information to smallholder farmers on technologies appropriate to small-scale production systems in relation to animal health, breeding, feeding, management and milk production (quality and hygiene) - and access to credit with low interest rates, cited by farmers as the biggest constraint to putting knowledge into practice and to the adoption of climate-smart technologies with the capacity to improve the resilience of dual-purpose cattle production systems.

From the point of view of the meat and milk processing industry, climate change is a constraint which exacerbates the existing inefficiency and productivity bottlenecks in the value chain -

stemming from the traditional extensive production practices of smallholder farmers - and adversely impacts on the quality and quantity of raw material received.

Although the Nicaraguan Government has affirmed its interest in initiating and realising 'Nationally Appropriate Mitigation Actions' (NAMAs) - policies, programmes and projects to contribute to the global effort of reducing greenhouse gas emissions - there is scepticism among meat and milk processing industry actors of public sector capacity to create 'a more eco-competitive livestock sector through low emission and transformational production practices' and in the process, positively impact on the resilience and therefore productivity of dual purpose cattle production. According to CANISLAC and CARNICARNE, the manner in which the Government dealt with and responded to the plight of smallholder farmers during and in the aftermath of the 'record drought' of 2014, underscored the fact that if an intervention was initiated to reduce the impact of climate change on the dual-purpose value chain - and specifically, on primary production - it would undoubtedly require participation and input from the private sector in Nicaragua to be successful.

7.4 Feasibility of Carbon Insetting based on WTP/WTA payment for ES

A new innovative payment for ecosystem services (PES) mechanism, carbon insetting involves a conditional voluntary transaction between a buyer and a provider for the ecosystem service of carbon sequestration, with a direct or in-kind payment made on the basis of a clearly defined land use leading to either an reduction in GHG emissions or an increase in carbon sequestered.

In contrast to other PES mechanisms such as carbon offsetting, this transaction takes place within, as opposed to outside the confines of a value chain; meaning that carbon insetting conceptually responds to many of the criticisms leveraged at traditional PES mechanisms which are widely regarded as having attempted but ultimately failed, to internalize the positive externalities and public value associated with preserving intact ecosystems and acknowledging the life-supporting and life-enhancing functions of the environment that are critical to human well-being.

Unlike traditional PES mechanisms such as carbon offsetting, the value of carbon insetting lies precisely in the fact that it is grounded in the context of a supply chain. As such, it explicitly

responds to the needs of the buyers and sellers of the ecosystem service of carbon sequestration - in the case of this study, the meat and milk processing industry and smallholder farmers engaged in dual-purpose cattle production in Nicaragua.

The results of this study indicate that, given the current situation in which smallholder farmers and the processing industry find themselves - in the aftermath of a 'record' drought event in 2014 - although interaction in a value chain is often by its nature complex, both smallholder farmers and processing industry actors, facing increasingly uncertain and complex production conditions, would be open to giving consideration to engagement in a carbon insetting project.

This arises from their inherent shared interest to improve the productivity and efficiency, as well as resilience to climate change, of the dual-purpose cattle value chain as a whole. Indirectly and directly facilitating interaction and dialogue between actors with competing and complementing interests and motivations, carbon insetting would at a fundamental level enable the experience, efforts, knowledge and resources of different actors - ranging from smallholder farmers, research and development organisations, to the private sector - to be leveraged to generate win-win solutions for all actors participant in the dual-purpose value chain (Malin et al., 2009; Banjeree, 2013).

By initiating a carbon insetting project, the processing industry could transform environmental conservation into an attractive proposition, incentivising smallholder farmers through a compensatory payment to adopt climate-smart and good agricultural practices. Leading to an arrestment or reversal of environmental degradation, deforestation and a shift in the agricultural frontier, it would also resolve key issues related to quality and quantity of raw material delivered to the cooling network and slaughterhouses.

For smallholder farmers engaged in dual-purpose cattle production in Nicaragua - for whom, in many cases, it is the only source of income - participation in a carbon insetting project would enable them to realise direct and tangible economic benefits. Providing an income higher than that earned through alternative land use, it would also enhance farmers' access to improved technologies, better production conditions and to technical assistance, credit and resource inputs (Porras et al., 2011). This is significant given that, historically, PES mechanisms were not intended

to result in the improved livelihood security and sustainability of resource-poor smallholder farmers (Tacconi et al., 2009).

Carbon insetting, however, as a mechanism is explicitly 'pro-poor', and recognises the fact that there is the nexus relationship between environmental conservation, degradation and poverty. Smallholder farmers often deplete and degrade natural resources at rates incompatible with long term sustainability due to their reliance on these finite resources to supplement their income and sustain their livelihoods (Dasgupta et al., 2003). As indicated by the results of this study, in the context of Nicaragua, engagement by smallholder farmers in environmental stewardship, conservation and protection would also be indisputably linked to and contingent on provision of an economic incentive - either a direct or in-kind payment.

Although, as indicated by the results of this study, the current relationship between smallholder farmers and processing industry actors is characterised by mutual distrust and established solely on commercial considerations; through market or quasi-market bargaining - in the context of carbon insetting - the processing industry and smallholder farmers could be in a position to overcome collective action problems, mistrust and inertia. At a fundamental level, it would provide a platform for action-taking and decision-making which is socially optimal and sustainable, as opposed to rational behaviour which would otherwise dictate that individuals or entities act in a manner which is self-interest maximizing.

Indeed, the key aspect differentiating carbon insetting from traditional PES mechanisms and the reason that it is advocated as a new innovative climate change mitigation and adaptation strategy is that - assuming that value chain actors are willing to provide and accept payment for ecosystem service provision - it has the capacity to generate quadruple-win outcomes (social, economic, environmental and productivity benefits) as opposed to only realising double dividends (social and environmental benefits).

As indicated by the results of this study, most smallholder farmers would be willing to participate in a carbon insetting project and accept payment (WTA), despite their experience of PES schemes to date. As outlined by Van Hecken & Bastiaensen (2010) in previous cases where PES schemes

were implemented in Nicaragua, smallholder farmers did not receive adequate compensation for the opportunity costs of non-conservation alternative land uses. Their WTA stems, however, from their own awareness of the increasingly significant adverse impact of climate change on the productivity and efficiency of their production systems; as well as an appreciation of the fact that reduction in the level of degraded pasture and increased density of trees in pastures, fodder banks and live fences can increase resilience and therefore the sustainability of their chosen livelihood strategy.

As stated by Mulder et al. (2004), PES mechanisms are attractive to the private sector market when conservation or sustainable use of resources leads to a return on investment (business profit) or if it is philanthropically attractive. The results of this study suggest that in the case of the dual-purpose cattle value chain, processing industry actors' motivation to engage in carbon insetting would be partly of a philanthropic nature, but primarily as a consequence of their recognition of the gains which could potentially be realised as regards reducing the costs and environmental risks associated with procuring raw material and securing improved quality and quantity in an era of climate variability.

As evidenced by the experiences of Chocolats Halba and Source Climate Change Coffee in Honduras and Mexico respectively, engagement by meat and milk processing industry actors in Nicaragua in carbon insetting in the short term, would improve value chain relationships and fundamentally improve their corporate social and environmental responsibility profiles. In the long-term, carbon insetting could provide an opportunity to realise value addition and market differentiation, with 'green branding' of products as carbon neutral or low-carbon, enabling lucrative niche markets for environmentally and socially sustainable export products to be exploited.

In addition to the WTP and WTA payment for ecosystem service provision of initiator and participant actors, the feasibility of a carbon insetting project is contingent on the willingness of facilitatory actors external to the value chain to create enabling conditions. The insights provided by the carbon insetting experiences of Chocolats Halba and Source Climate Change Coffee confirm that the degree to which a PES is socially embedded in terms of its design and implementation, is a critical factor determining its feasibility and thus ultimately, its success as

regards enabling theoretical win-win outcomes to be realised. Institutional and political economy issues cannot be overlooked and facilitatory actors must be willing to fulfil their respective roles (Bulte et al., 2008; Jack et al., 2008; Muradian et al., 2010; Porras et al., 2011).

At a fundamental level, the feasibility of a PES scheme is dependent on the extent to which it is constrained or supported by institutions - ranging from research and development organisations, to public and private sector organisations - who have an important role to play as regards shaping perceptions, values and social norms to enable actors with divergent objectives to overcome their collective action problem and the stalemate which stems from their inclination to pursue respective individual non-cooperative strategies. The results of this study indicate that, in the context of the dual-purpose cattle value chain in Nicaragua, there is sufficient willingness at facilitatory actor level to ensure successful implementation and outcome of a carbon insetting project, should the feasibility of initiating a carbon insetting project be explored in the context of adapting to and mitigating the current and future impacts of climate change.

Chapter 8: Conclusions

This study shows that it is feasible to implement a PES mechanism which is explicitly designed to generate 'quadruple-win' benefits for the buyers and providers of an ecosystem service, such as carbon sequestration. Although there is potential, successful PES scheme outcome is inherently contingent on the ecosystem service buyers' willingness to pay, as well as the underpinning motive to realise social, economic, and environmental and productivity gains through investment in ecosystem service provision.

Grounded in the context of a value chain, carbon insetting provides a platform for value chain actors – often regarded as having divergent and indeed, even conflicting interests – to collaborate in adapting to and mitigating climate change. A phenomenon most significantly impacting on those responsible for primary production – namely, smallholder farmers – the 'ripple effect' of climate change extends to undermine the business interests of all actors participating in an agro-food value chain.

Facilitating agro-food processing industry actors such as those engaged in the dual-purpose cattle value chain in Nicaragua, to interact with smallholder farmers - who are willing to accept payment, given that they equally recognise the social, economic, environmental and productivity benefits which can be gain from providing the ecosystem service of carbon sequestration – carbon insetting consolidates climate change mitigation and adaptation efforts across a value chain.

In doing so, it adds value to the value chain as a whole – improving commercial relationships which exist between actors, facilitating access to new markets, paving the way for products to be certified as low-carbon or carbon neutral, enhancing the traceability and quality of products and ultimately generating profits which can be shared and reinvested to improve the livelihood security and sustainability of smallholder farmers engaged in dual-purpose cattle production.

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