The Business Case for Biodiversity and Ecosystem Services in Brazilian Agriculture
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The Business Case for Biodiversity and Ecosystem Services in Brazilian Agriculture

**Biodiversity** is fundamental to functioning agricultural systems. A large, growing body of research and practice from Brazil and around the world demonstrates that many components of biodiversity have direct, obvious relationships to agricultural productivity, whilst other components have indirect, less obvious roles in production or that generate benefits beyond the farm to wider society.

Understanding the benefits of different components of biodiversity is necessary for farmers, companies and other decision makers to manage resources and identify opportunities to maintain yields, livelihoods and supply chains. This understanding must be coupled with an appreciation of risks and opportunities linked to the reputational, financial, legal and regulatory implications, as well as the less quantifiable cultural significance of biodiversity.

Maintenance and recovery of biodiversity within and around farms guarantees those ecosystem services which underpin crop production; consequently it ensures farming viability for current and future generations, making farms ecologically and economically sustainable in the long term. Moreover, inclusion of biodiversity and its services as part of good farm management can reduce input costs and increase productivity.

In short, incorporation of biodiversity in agricultural landscapes makes them more resilient, more cost effective, more sustainable and more productive.

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Protected biodiversity guarantees the effective functioning of ecosystems and contributes to poverty reduction, food security, and human health.
Fauna & Flora International (FFI) and the Wildlife Research and Environmental Education Society (SPVS) work directly with businesses across a range of sectors to bring about change for the protection of biodiversity in all its forms, considering the intrinsic value of ecosystems and their species.

We believe that one of the most effective ways to protect biodiversity and ecosystem services is to change companies’ perception about biodiversity. In this way, we work closely with the very businesses which have the potential to lead their sectors in concrete commitments and actions for long-term and large scale positive impacts on biodiversity conservation.

We choose to work with businesses that are committed to reducing their impacts on the environment, businesses that foresee new strategic opportunities around Biodiversity and Ecosystem Services, and businesses that are positioning themselves as market leaders.

As part of the British American Tobacco Biodiversity Partnership (a corporate/NGO partnership with 8 projects in over 12 countries in 2015) Souza Cruz, FFI and SPVS started a project called “Parcerias pela Biodiversidade”, in 2011. Together we have worked to build knowledge to develop and implement cost-effective solutions to improve agricultural sustainability, biodiversity conservation and livelihoods in southern Brazil. The project is strengthening the business case for biodiversity and ecosystem services management in agriculture and encouraging widespread adoption of local good practice.

This work is aligned with environmental legislation regarding agriculture, so the project helped farmers register their farms in the Rural Environmental Registry (Cadastro Ambiental Rural) and guided them to achieve legal environmental compliance by developing Environmental Compliance Plans (PRA), as required by the Forest Code. However, the project approach involves actions related to environmental farm management that go beyond legal compliance in order to increase the benefits which can be derived from biodiversity improvement and enhanced ecosystem services.

Biodiversity and Ecosystem Services are critical for business - if it doesn’t take them seriously, business faces a number of different risks, and may fail to capitalize on opportunities.
OBJECTIVES OF THIS DOCUMENT:

• To present the work done under “Parcerias pela Biodiversidade” project, the purpose of which was to develop an economically viable approach for farmers to manage their properties in ways that help maintain and/or restore biodiversity and enhance critical ecosystem services for agricultural production.

• To enhance awareness within the Brazilian agribusiness sector about the advantages of improved biodiversity management within agricultural production.

• To engage agribusiness in the dissemination and large scale implementation of biodiversity management techniques within farms.

This document presents the following topics:

• The importance of Brazil as having immense biodiversity and as a global leader in agriculture.

• Trends in how agribusinesses are considering biodiversity and ecosystem services as an integral part of the business, and the advantages that this position provides.

• Environmental risks for Brazilian agriculture and how biodiversity can help address them

• The project “Partnerships for Biodiversity”: biodiversity as a farmer’s partner.

• Viable and feasible techniques chosen and tested by farmers to increase biodiversity and ecosystem services for agriculture and compliance with key aspects of Forest Law.

• Environmental and Economic Benefits of Biodiversity & Ecosystem Services approach: cost-benefit analysis in a landscape context (case study from southern Parana state).
Introduction

**Ecosystem Services** is an increasingly familiar term used to describe the benefits which Nature delivers to human society. In this context, “Nature” is represented by Biodiversity, which is the diversity of species and habitats at a given scale, whether it be at the genetic, species, ecosystem or landscape level. Biodiversity is the very basis for ecological processes which provide goods such as foods, fibres and medicines and services such as pollination and water flow regulation.

Biodiversity and the services it provides must be understood not only for its intrinsic and cultural value, but also as an essential ‘natural capital’. All ecosystems and natural resources in the world, and the plants and animals which inhabit these lands and seas, underpin economies, societies, and human well-being.

Throughout the world, biodiversity is facing increasing challenges for its maintenance. Loss of habitats and ecosystems and accelerated species extinction have consequences for agriculture, such as increased costs of production and crop shortfalls, which are being felt by agricultural systems that are frequently nature-disconnected and highly dependent on inputs.

Current losses in biodiversity and ecosystem services pose a variety of risks, operationally, legally and to reputation, as these critical allies of crops are being pushed away from agriculture landscapes. Reduced economic and environmental resilience of farming landscapes that lack these ecosystem services will impact on farmer livelihoods and wider society which will, in turn, affect companies’ operations.

Fortunately, some forward-thinking companies and other institutions (such as investors) are developing or strengthening approaches which aim to bring back natural inputs and wildlife-friendly management into agriculture. There is, however, still much to learn about what actions are locally appropriate, practical for farmers, cost effective and beneficial for nature and agriculture. Moreover, considering a “no-regrets” approach, large scale actions are needed from every organisation.

As the demand for food, livestock feed, timber and biofuels grows due to increasing population and changing consumption patterns, so increasing pressure will be placed on native habitats, and on ecosystem goods and services such as water, soil and other resources. The need to adapt agriculture and agricultural supply chains to ensure adoption of more sustainable practices and land management, including the protection of public and private natural areas, becomes all the more pressing.

**Sustainable Agriculture both promotes and is enhanced by Biodiversity.**
This places a particular challenge on countries like Brazil, which has land and climatic conditions that are suited to a great performance in agriculture, but which is, at the same time, one of the most biodiverse countries on the planet. To give a dimension to this challenge, more than 80% of natural remnants of Atlantic Forest are within private rural lands, not to mention that only 12% of this biome still stands.

As such, establishing a sustainable production approach within Brazil’s agriculture which effectively includes biodiversity protection within farms and also in protected areas has unparalleled significance for both global supply chains and global ecosystem services and biodiversity.

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1 Education For Sustainable Development Information
Progressive businesses are changing the way they see Biodiversity and Ecosystem Services (BES)

Businesses in agricultural supply chains, from producers to commodity traders, manufacturers and retailers, rely on many ecosystem services throughout the value chain. Increasing, these businesses recognise the need to look at the big picture, particularly their biodiversity and ecosystem service dependencies at areas of production, in order to thrive. Conservationists are seeking opportunities to engage with agricultural companies, recognising that the private sector has a central role to play in natural resource management. Worldwide, innovative collaborations are being forged between diverse players – businesses, financial institutions, governments, intergovernmental organisations, NGOs and local communities – to meet ecosystem services challenges head-on.

Global initiatives with significant corporate engagement show how some agribusiness leaders have already incorporated biodiversity conservation and ecosystem service protection into their social responsibility policies. Movements such as the UN Global Compact and the Consumer Goods Forum, the Global Platform for Business and Biodiversity within UN Convention on Biological Diversity (CBD), as well as Brazilian initiatives, such as the Coalition on Climate, Forests, and Agriculture and the Soy Moratorium, are examples of collaborative commitments involving business to progress towards a more responsible management concerning biodiversity and of the services it provides to wider society.

The finance sector is also driving change for responsible management of biodiversity through increasingly comprehensive lending policies and criteria that better reflect the short and long-term risks of their clients not adequately managing environmental impacts and dependencies.

Accounting standards, biodiversity-related certifications, and sustainability performance indexes in stock exchange markets are also shifting towards internalising biodiversity-related costs that have been traditionally externalised and, therefore, pose potentially significant unacknowledged risks.

Many of these initiatives are, however, still at an early stage of adoption by any but the most progressive organisations and yet to be fully incorporated into company policy.

In order to respond to the upcoming demand of solutions applicable under this new framework, the “Parcerias pela Biodiversidade” project tested alternatives suitable for adoption at a large scale within Brazilian rural landscapes.
WHAT BUSINESSES ARE GETTING FROM THIS CORPORATE SHIFT?

Businesses that take a proactive approach to managing biodiversity risks and demonstrate to stakeholders that they can deliver on biodiversity targets are likely to have several competitive advantages:

- **Reputation**: Strong environmental practices can boost a business’s reputation with governments, local communities, civil society and, increasingly, with consumers. It also makes these companies to be perceived as innovative leaders by their peers, attracting business partners and employee loyalty. Reducing environmental impacts throughout the supply chain also avoids the risks of negative publicity that can undermine a company’s reputation and customer base.

- **Legal compliance**: by ensuring that the company and their supply chain fulfil environmental regulations, companies avoid compliance costs, fines and legal fees.

- **Operational sustainability**: By reducing negative impacts on the ecosystem services upon which a company’s operations depend, the medium and long-term sustainability of those operations is ensured. With such an approach, businesses can also manage their dependence on biodiversity and reduce costs for resources and services, such as freshwater, pest control, crop pollination or soil fertility.

- **Access to markets**: By adherence to recognised, reputable and well audited schemes to incorporate biodiversity in robust environmental management frameworks (such as product certification), companies have access to a wider range of potential markets and customers, in addition to being able to receive a higher price for their products. These schemes can gain loyalty from both customers and suppliers.

- **Access to finance**: Given tightening lending standards, investment in company initiatives will increasingly depend upon sustainable approaches to access finance from organisations as International Finance Corporation (IFC), and other financial institutions that are signatories of initiatives adhering to the Equator Principles.

“People hold businesses directly accountable for their quality of life, and demand leadership from brands to overcome the most pressing human and planetary challenges. This is a clear signal to companies that we can’t wait for consumer demand to drive our actions: people expect businesses to take the lead.”

Ged Buffee (branding consultant for companies as Nestlé and Heinz)
Risks to agriculture in Brazil: Biodiversity as a business opportunity

There are many potential areas of risk to current and future agricultural production in Brazil related to climate, water resources, soil fertility, crop pollination and pest control. Many of these risks are a consequence of natural ecosystem loss and degradation, which leads to a decrease of ecosystem services.

On the other hand, appropriate management of biodiversity at the farm and landscape level represent effective opportunities to reduce these risks. These actions can be taken at a farm level to make a local positive impact on delivery of Ecosystem Services for agriculture, as well as within landscape-level planning and management, optimizing benefits for rural communities and the wider society.

THE WATER RESOURCES CHALLENGE: HOW CAN BIODIVERSITY ADDRESS IT?

Recent droughts in Southeast Brazil have triggered a red alert on the increasing risks of water shortage for many productive sectors, agriculture included. The shortages have exposed the inability of hard engineering-focused water supply systems to address situations of reduced rains by themselves if the “green infrastructure” is lacking.

On the other hand, the effects of floods in Southern Brazil could be reduced by conserving natural vegetation in floodplains. In order to increase watershed resilience to extreme hydrologic phenomena such as droughts or floods, the combination of man-made and natural systems is a cost-effective solution. The conservation and restoration of forests in strategic areas for hydrologic processes can effectively turn agricultural areas into more resilient landscapes to mitigate the effects of rainfall shortage or excess.

Forests and other natural ecosystems increase rainwater infiltration, providing better water storage in soils and groundwater recharge, two critical processes for reducing drought effects. Studies carried out in Brazil demonstrated that: a) springs and headwaters covered by natural forests yield 5 to 20 times more water than springs in soils covered by pastures; b) the higher the percentage of forest cover in microwatersheds, the lower will be the variation of water yield between rainy and dry seasons.

Infiltration upslope is critical to soil water recharge, providing increased moisture to downslope agricultural soils, especially in dry periods. In most of Brazil, forest cover promotes slow water supply to groundwater aquifers during the recharge process, which tends to contribute to maintaining the flow during the dry period, making it more permanent.
When it comes to water quality, river buffer strips can significantly reduce erosion and sedimentation and act as natural filters to nutrients and agrochemicals entering the streams. A survey of 27 water suppliers was conducted in 2002 by the Trust for Public Land and the American Water Works Association. They found that for every 10% increase in forest cover in the source watershed, treatment and chemical costs decreased by approximately 20%, up to about 60% forest cover. Another study conducted over 60 water treatment plants across the United States showed similar findings: decreased forest cover was significantly related to decreased water quality, while low water quality was related to higher treatment costs.

**HOW DOES BIODIVERSITY INFLUENCE SOIL HEALTH AND AVAILABILITY?**

Building soil fertility is closely tied to building soil organic matter. Relative to conventional systems, soil organic matter increases in the no-till, reduced-input, and biologically based systems. The inclusion of leguminous cover crops in rotations can increase soil aggregate stability through stronger microbial communities and increased nitrogen fixation.

The use of inoculants – bacteria which develop in symbiosis with root systems – improves nitrogen absorption from the atmosphere, reducing the need for urea inputs and increasing productivity. According to economic estimations developed by researchers of EMBRAPA (Soy Unit), for the total Brazil soy crop, the economy provided by use of biological nitrogen fixation is estimated at US$ 7 billion per year. For the total Brazilian crop of corn, wheat and rice, the economy is estimated to be approximately US$ 2 billion per year.
The control of crop pests is a commercially important service provided by natural pest predators and is a key part of integrated pest management strategies. Populations of pest predators frequently rely on intact natural habitat features close to crop sites. In Costa Rica and Jamaica, forest habitat supporting birds acting as pest predators were estimated to provide an additional economic benefit of up to $310/ha/year to coffee farmers. Ladybird beetles are a good example of the effectiveness of pest control by native animals. They are responsible for most soybean aphid control and are able to keep aphid populations below economically damaging thresholds. Without such control, soybean yields can be suppressed by 40%–60%. In the US, the economic benefit of pest control by natural predators was estimated at $239 million per year.

An estimate of the reduction in global crop production due to lost pollination services, including direct and indirect effects, is US $138.3 billion per year.

**HOW DOES BIODIVERSITY IMPROVE PEST CONTROL?**

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**HOW DOES BIODIVERSITY IMPROVE POLLINATION?**

Animal pollination of crops can be provided by both managed and wild pollinators. Benefits to grain and fruit production are provided by insects, for instance: natural and managed pollinators can increase soy productivity between 13% and 58% when compared with soy crops isolated from their influence; in cotton crops, bees and other pollinators enhanced the number of cocoons by 40% and from 35 to 40% the volume of cotton in each cocoon. Studies in coffee plantations in Brazil verified that farms near to forest fragments have 14.6% higher production, which could be related to pollination by natural pollinators, representing an extra income of US$1860.55/ha/year.

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An estimate of the reduction in global crop production due to lost pollination services, including direct and indirect effects, is US $138.3 billion per year.
Climate change is expected to alter the timing, magnitude and duration of rainfall and extreme weather events across Brazil. For South and south-eastern Brazil, the projections are:

- 1 to 4°C increase in average temperature.
- Extreme rain events which can affect crop sowing, development and harvest - Longer drought periods, which can cause water deficit in agricultural soils and shortages in water bodies used for irrigation.
- Bigger possibility of heat waves, which can affect flowering and grain ripening.

For top commodities in Brazil, the impacts can be massive and could alter the agricultural map of the region. Some crops will no longer be feasible to grow in some traditional sites. Extreme droughts and heat waves can severely threaten crop production of soybean and beans. Additionally, climate imbalance can boost populations of harmful organisms, making some plant diseases, pests and invasive species more difficult to control.
In addition to the significant role that agricultural practices play in driving or mitigating climate change, especially with regard to deforestation and loss of soil organic content, management decisions concerning biodiversity can have significant effects on the adaptive capacity of farms and agricultural systems.

A resilient landscape should contain public and private protected areas along with sustainably-managed agricultural areas, in a landscape matrix that maintains key natural processes and services. This Integrated Landscape Management increases resilience to the massive impacts which climate change is bringing to the agriculture sector.

Methods to improve sustainability of agriculture and other economic activities by using nature as an ally are known as Ecosystem Based Adaptation. Recent research done by recognised experts found that more forest cover in southeast Brazil would have minimised the effects of the extreme 2013-2014 drought.

In addition, work by organisations (including FFI) in partnership with farmers has shown yield, livelihoods and environmental benefits of implementing climate change adaptation plans, which typically include “climate smart” agricultural techniques. Thus, there are feasible ways for agriculture to adapt to climate change, wherein conservation and restoration of ecosystems are one of most cost-effective strategies.
Forests and farms in South Brazil

Brazil’s South Region is home to Araucaria forests, a peculiar and stunning ecosystem of the Atlantic Forest biome. This ecosystem is recognised for its high biodiversity and threatened species including cougars, howler monkeys, red-spectacled Amazons and the distinctive Araucaria tree.

Today, the South region is one of the country’s main agricultural centres and its farms also have an increasing responsibility of conserving its natural remnants in order to protect biodiversity and support delivery of important services and goods.

Sadly, poor planning of agricultural and forestry expansion over the past century has driven severe deforestation and degradation in southern states where most of the original ecosystems have been lost. In Paraná state, for instance, this trend has left less than 1% of the original Araucaria Forest cover with “mature” forests (large trees and naturally high biodiversity).
The Parcerias pela Biodiversidade project – one case to test how to manage farms sustainably

Through partnership between farmers, business and NGOs, we have established management approaches to maintain and restore biodiversity on rural properties. These actions enhance the supply of essential ecosystem services which support the production of agricultural commodities so important for livelihoods and to the economic output of the region.

Compliance with the Forest Code is a responsibility for every landowner, but environmental and economic gains can be far larger than costs if implementation goes beyond legal requirements and seeks to maximise opportunities whilst fulfilling these requirements.

The project demonstrates the cost-effectiveness and time-effectiveness of actions that enhance BES (Biodiversity and Ecosystem Services) to increase sustainability of the agricultural sector, indicating the economic viability and practical feasibility of a biodiversity-driven approach in farm management. The project also highlights the role agribusinesses, as major players in the food supply chain, can play in supporting farmers to adopt this approach.

<table>
<thead>
<tr>
<th>INTERVENTION</th>
<th>ECOSYSTEM SERVICE</th>
<th>IMPACT</th>
<th>BENEFIT FOR AGRICULTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riparian forests restoration</td>
<td>Sediment and nutrient retention</td>
<td>Smaller loss of fertile soil / Better water quality</td>
<td>Soil conservation / lower treatment cost</td>
</tr>
<tr>
<td>Pollinator management</td>
<td>Pollination</td>
<td>Increased fruits and seeds productivity</td>
<td>Bigger crop production in same area</td>
</tr>
<tr>
<td>Nitrogen-fixing bacteria in seeds</td>
<td>Atmospheric Nitrogen absorption</td>
<td>Bigger growth and production</td>
<td>Bigger crop production/ less input use</td>
</tr>
<tr>
<td>Forest enrichment</td>
<td>Pest control/Pollination</td>
<td>Bigger biodiversity, enhancing ecological processes</td>
<td>Bigger crop production/ less agrochemicals use</td>
</tr>
<tr>
<td>Control of exotic invasive species</td>
<td>Maintenance of local biodiversity</td>
<td>Maintenance of ecological processes</td>
<td>Bigger crop production/ less agrochemicals use</td>
</tr>
</tbody>
</table>

Table 1: List of BES management techniques tested in “Parcerias pela Biodiversidade” project
The project has calculated the full costs of implementing these interventions as tested in partnership with farmers in south Paraná State. Monitoring of interventions has proved the success of these actions and detailed modelling demonstrates the potential economic returns. The project provides practical, tested and financially viable solutions for managing land and natural resources that benefit biodiversity and improve the long-term sustainability of farming. It also highlights potential for opportunities to leverage additional support to manage biodiversity on farms.

Ultimately, the project aims to provide practical solutions to support farmers and agribusinesses to manage healthy ecosystems, maximising the “natural capital” on farms for productive, biodiversity-rich landscapes. The partnership is actively communicating with companies and cooperatives that source a range of agricultural commodities to increase application of the BES farming approach. Across Brazil’s South Region, the project had worked to engage and inform the agribusiness sector, government institutions and other stakeholders to drive sustainable management of Brazil’s threatened landscapes.

**ACTIVITIES PROMOTED UNDER BIODIVERSITY AND ECOSYSTEM SERVICES MANAGEMENT**

- **Forest restoration being implemented in riparian areas with native species**
- **Polinator management through the use of native flowering plants**
- **Sowing of seeds inoculated with nitrogen fixing bacteria**
- **Control of exotic invasive species through girdling**

Photos: SPVS
How much does it cost to implement BES good practice on farms?

In order for BES management practices to be accepted by agribusinesses and farmers, the economic suitability of the required investment must be well understood. The BES interventions must not only be effective and feasible to implement, but also need to be relatively inexpensive in order to justify return on investment. The Biodiversity Partnership project has calculated a range of costs for some proven BES management techniques by testing them on farms in the municipality of Paula Freitas, south Paraná.

Table 2 shows the range of costs of the BES interventions implemented in the project (financial values as of November, 2015):

<table>
<thead>
<tr>
<th>BES INTERVENTIONS</th>
<th>COST (R$)</th>
<th>COST (US$)*</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fencing of water courses</strong></td>
<td>750 – 1.130</td>
<td>198 – 297</td>
<td>100 meters</td>
</tr>
<tr>
<td><strong>Forest restoration in riparian zone</strong></td>
<td>4.890 – 7.330</td>
<td>1.235 – 1.930</td>
<td>Hectare</td>
</tr>
<tr>
<td><strong>Enrichment of degraded forest</strong></td>
<td>140 – 210</td>
<td>37 – 55</td>
<td>100 seedlings/Ha</td>
</tr>
<tr>
<td><strong>Use of inoculants in crops</strong></td>
<td>43 – 65</td>
<td>11 – 17</td>
<td>Hectare</td>
</tr>
<tr>
<td><strong>Pollinator management</strong></td>
<td>124 – 186</td>
<td>33 – 49</td>
<td>10 seedlings of forage plants</td>
</tr>
<tr>
<td><strong>Invasive alien species management</strong></td>
<td>45 – 67</td>
<td>12 – 18</td>
<td>Hectare</td>
</tr>
</tbody>
</table>

*considering exchange rate of USD 1 = R$ 3.8 as it was in 04th November 2015

Table 2: Costs of implementation of BES interventions on 17 properties including labour and materials costs.
It is noteworthy that these values vary from farm to farm according the cost of available materials, logistics, environmental conditions, local costs of manpower, etc. Forest restoration costs are very dependent on the previous land use (compacted soil by cattle would need additional ground tillage, for instance); the range on costs of forest enrichment is due to the varying prices of species not easily found in nurseries; cost of invasive species control vary according the species and density of infestation.

The outcomes of this work demonstrate that, with small adaptation to local conditions, the costs of BES interventions, which are often perceived to be too high, can be dramatically reduced. For instance, our tested tree-planting restoration techniques, which include labour costs for planting, maintenance (weeding) for 2 years and local seedling prices, are much cheaper (on average R$6,107/ha) than average costs indicated in contemporary literature (approximately R$9,800 for reforestation method, in 2012)\textsuperscript{21}. This can, in part, be explained by not using fertilizers, herbicides and pesticides, and by implementation being carried-out by farmers (although the equivalent working time cost of a hired rural worker was included in the calculations). This low-input technique has not compromised the results, as attested by the high rates of seedlings survival after two years of planting (more than 90%).

\textsuperscript{21} Brancalion et al, 2012Finding the money for tropical forest restoration Unasylva 239, Vol. 63, 2012/1
Do the benefits overcome the costs of BES management?

Simple biodiversity management techniques, such as the forest restoration techniques tested in this project, can improve multiple ecosystem services, providing several opportunities for economic gains and cost reduction. It is important that projects devoted to ecosystem services improvement assess the quantification of economic benefits compared with associated costs. Regarding this need of a clear Cost vs Benefit analysis, the “Parcerias pela Biodiversidade” project has developed economic estimates of benefits, both for the farms, the surrounding communities and wider society which depend on the health of these ecosystems to obtain services such as clean and constant water supply, erosion reduction, pollination and pest control, among others.

We used a software model, known as InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs), developed by the Natural Capital Project http://www.naturalcapitalproject.org) to map and value ecosystem services. The models produced sound estimates of economic benefits derived from the improvement of ecosystem services provided by BES management interventions in a landscape approach.

We have modelled a virtual restoration intervention for the whole watershed in which the trial farms are located. For this analysis, we produced several hypothetical land use maps of different scenarios of riparian forest restoration. Here we present the comparison between three scenarios current, 10 m width and 30 m width* riparian buffers for the whole project watershed (Jararaca river basin, Paula Freitas-PR):

- Current land use;
- 10 m width riparian buffers on all streams;
- 30 m width riparian buffers on all streams

The InVEST models for Carbon, Crop Pollination, Sediment Retention and Water Purification were able to spatially prioritise areas for ecosystem services improvement and to estimate the economic gains between the pre-project land-use scenario and each of the two restoration scenarios (10 and 30 meters wide buffers).

In this analysis, the indicators of economic benefits from ecosystem services (ES) were:

- **Sediment and nutrient retention:** drinking water treatment cost savings
- **Soil conservation:** avoided recovery costs of agricultural soil.
• **Carbon sequestration**: potential value of carbon credits (using current average value of Verified Carbon Standards-VCS).

• **Crop pollination**: increased crop productivity provided by more efficient pollination from native insects and other animals.

Comparing the estimated economic outcomes from biodiversity and ecosystem services improvement with the associated costs for its implementation in the same landscape, we were able to demonstrate a significant return on investment as illustrated in the following tables.

Considering:

• **full recovery of ecosystem services**, produced by restoration of all riparian buffers, considering a 10m wide strip, (71 ha to be restored) or a 30m wide strip, (352 ha to be restored)

• **restoration costs in 10-meter scenario**: USD 115,490 / R$ 438,860 (71.2 ha x R$ 6,107/ha), and in 30-meter scenario: USD 565,170 / R$ 2,147,650 (352 ha x R$ 6,107/ha),

The estimated revenues derived from reduced costs of soil recovery, water treatment and dredging, and additional incomes from selling carbon credits, would represent total gains of more than US$ 509 thousand * (R$ 1.9 million) per year, being USD 421

*considering exchange rate of USD 1 = R$ 3.8 as it was in 04th November 2015

**PICTURE 1: MAP DETAIL OF THE SCENARIOS MODELLED FOR ECOSYSTEM SERVICES ESTIMATION.**
thousand as costs reduction and USD 88 thousand as income increase, in the scenario which considers a 30-meter width restoration; in the 10-meter restoration scenario the total gains would be USD 177 thousand per year (USD 155 thousand in cost reduction and USD 22 thousand as improved incomes). In both cases the gains are perpetual, as these areas will be providing endlessly these benefits, if fully protected. In a 7-year cost-benefit analysis, the 30-meter scenario indicates a potential net income 2.5 times bigger than the 10-meter scenario by the seventh year. It is a demonstration that BES management “beyond the Forest Code” is worth undertaking, as the returns in terms of ecosystem services delivery is much bigger than simply doing the minimum necessary according environmental legislation.

*considering exchange rate of USD 1 = R$ 3.8 as it was in 04th November 2015

<table>
<thead>
<tr>
<th></th>
<th>EROSION (TON/yr)</th>
<th>SEDIMENT DELIVERY (TON/yr)</th>
<th>SOIL RECOVERY COSTS (USD/yr)*</th>
<th>WATER TREATMENT COSTS (USD/yr)</th>
<th>DREDGING COSTS (USD/yr)</th>
<th>TOTAL COSTS (USD/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Current</strong></td>
<td>234,064.9</td>
<td>17,040.9</td>
<td>554,364</td>
<td>3,290,837</td>
<td>147,987</td>
<td>3,993,188</td>
</tr>
<tr>
<td><strong>Restoring 10 m buffer</strong></td>
<td>221,072.7</td>
<td>15,005.8</td>
<td>523,593</td>
<td>3,184,407</td>
<td>130,314</td>
<td>3,838,315</td>
</tr>
<tr>
<td><strong>Reduction (absolute values)</strong></td>
<td>12,992.2</td>
<td>2,035.1</td>
<td>30,771</td>
<td>106,429</td>
<td>17,673</td>
<td>154,874</td>
</tr>
<tr>
<td><strong>Restoring 30 m buffer</strong></td>
<td>198,913.1</td>
<td>11,937.5</td>
<td>471,110</td>
<td>2,997,610</td>
<td>103,668</td>
<td>3,572,388</td>
</tr>
<tr>
<td><strong>Reduction (absolute values)</strong></td>
<td>35,151.8</td>
<td>5,103.4</td>
<td>83,254</td>
<td>293,227</td>
<td>44,319</td>
<td>420,800</td>
</tr>
</tbody>
</table>

Table 3 – Costs reduction derived from restoration in APP, related to sediment retention and soil conservation, ecosystem services. It encompasses in-farm (soil recovery) and out-farm costs (water treatment and dredging).

<table>
<thead>
<tr>
<th></th>
<th>AVERAGE SOY CROP PRODUCTIVITY (KG/HA/YEAR)</th>
<th>CROP INCOME (USD/yr)*</th>
<th>CARBON CREDITS INCOME (USD/yr)</th>
<th>TOTAL INCOME (USD/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Current</strong></td>
<td>3000.0</td>
<td>4,796,970</td>
<td>0</td>
<td>4,796,970</td>
</tr>
<tr>
<td><strong>10 m buffer</strong></td>
<td>3011.4</td>
<td>4,815,257</td>
<td>3,782</td>
<td>4,819,039</td>
</tr>
<tr>
<td><strong>Increase</strong></td>
<td>11.4</td>
<td>18,287</td>
<td>3,782</td>
<td>22,069</td>
</tr>
<tr>
<td><strong>Restoring 30 m buffer</strong></td>
<td>3043.9</td>
<td>4,867,193</td>
<td>18,508</td>
<td>4,885,702</td>
</tr>
<tr>
<td><strong>Increase</strong></td>
<td>43.9</td>
<td>70,223</td>
<td>18,508</td>
<td>88,732</td>
</tr>
</tbody>
</table>

Table 4 – In-farm economic gains derived from restoration in APP, related to crop productivity and carbon sequestration (in restored areas)
It is important to keep in mind that this analysis shows potential economic and social benefits both for farmers, when it comes to cost reduction and production increase, but also indicates benefits for wider society, as it presents gains related to protection and recovery of critical ecosystem services that positively impacts millions of people living in both rural communities and in cities.

As farmers manage natural processes in agricultural landscapes which supply cities or industry with clean water, for instance, financial mechanisms can be established to ensure the beneficiaries pay to support such efforts. Mechanisms of Payment for Ecosystem Services (PES or PSA in Portuguese), where and when the enabling conditions are present, can be an effective framework for encouraging farmers in this transition towards a more sustainable agriculture, where biodiversity is an inseparable ally.

*considering exchange rate of USD 1 = R$ 3.8 as it was in 04th November 2015

<table>
<thead>
<tr>
<th>RESTORATION (10 M ALONG STREAMS)</th>
<th>YEAR 1</th>
<th>YEAR 2</th>
<th>YEAR 3</th>
<th>YEAR 4</th>
<th>YEAR 5</th>
<th>YEAR 6</th>
<th>YEAR 7</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restored area (ha)</td>
<td>72</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>72</td>
</tr>
<tr>
<td>Investment (USD)</td>
<td>88,407</td>
<td>26,852</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>115,490</td>
</tr>
<tr>
<td>Outcome (USD)</td>
<td>0</td>
<td>44,236</td>
<td>88,471</td>
<td>132,707</td>
<td>176,943</td>
<td>176,943</td>
<td>176,943</td>
<td>796,242</td>
</tr>
<tr>
<td>Balance (USD)</td>
<td>-88,638</td>
<td>17,384</td>
<td>88,471</td>
<td>132,707</td>
<td>176,943</td>
<td>176,943</td>
<td>176,943</td>
<td>680,752</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RESTORATION (30 M ALONG STREAMS)</th>
<th>YEAR 1</th>
<th>YEAR 2</th>
<th>YEAR 3</th>
<th>YEAR 4</th>
<th>YEAR 5</th>
<th>YEAR 6</th>
<th>YEAR 7</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restored area (ha)</td>
<td>352</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>352</td>
</tr>
<tr>
<td>Investment (USD)</td>
<td>433,767</td>
<td>131,404</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>565,171</td>
</tr>
<tr>
<td>Outcome (USD)</td>
<td>0</td>
<td>127,383</td>
<td>254,766</td>
<td>382,149</td>
<td>509,532</td>
<td>509,532</td>
<td>509,532</td>
<td>2,292,893</td>
</tr>
<tr>
<td>Balance (USD)</td>
<td>-433,767</td>
<td>-4,021</td>
<td>254,766</td>
<td>382,149</td>
<td>509,532</td>
<td>509,532</td>
<td>509,532</td>
<td>1,727,722</td>
</tr>
</tbody>
</table>

Tables 5 and 6 – Economic balance between investments in restoration and economic outcomes derived from ecosystem services improvement, regarding 10 meter and 30 meter restoration scenarios (considering a) 2 years of maintenance and b) 4 years for full ecosystem services delivery by restored areas)
Additional economic opportunities

Of course, the value that ecosystem services provide for agriculture and the quality of life it gives to communities by itself justifies the adoption of these simple, efficient, and cost-effective techniques by farmers and agribusinesses. In addition, complementary sources of income related to biodiversity are available for farmers and companies.

In sites where natural resources management is allowed (such as legal reserves), the restored or conserved area can itself be a direct source of income for farmers, as is possible by planting native fruit tree species and other native plants which provide fibre, leaves and seeds. Another promising business is seedling production for forest restoration, since the restoration obligations are knocking on the door of Brazilian farmers.

The conservation of natural areas in rural properties have been seen lately as a business opportunity, since “surplus” natural areas (areas of natural vegetation additional to minimum requirements of Legal Reserves (Reserva Legal) and Permanent Preservation Areas (APPs)) can be negotiated with other farmers who need to offset Legal Reserve deficit. Other emerging financial mechanisms that bring new potential advantages are the Payment for Ecosystem Services (PES) approaches for those who are conserving or restoring natural areas within farms.
This relatively new economy, often linked to carbon storage or water resource provision, has been proven to generate income to support farmers and landowners to make land-use decisions that benefit society and biodiversity.

An example of successful initiatives regarding promotion of enabling conditions and strengthening of PES schemes is the “Produtor de Água” federal program, coordinated by the National Water Agency (Agência Nacional de Águas – ANA). According to data presented by ANA in March 2015, about 45,000 hectares have received interventions promoted by 38 projects under this program, within watersheds totalling 400,000 hectares and which supply a total population of 35 million people. Over R$ 50 million have been invested in these projects, wherein a significate portion has been destined to cash payments to farmers, not to mention that most of resources were invested in the form of improvements within farms (soil conservation, forest restoration, fencing, water troughs, etc).
Farmers perception on biodiversity benefits for agriculture

The adoption of the approach presented in this document is strongly dependent of farmers’ perception of direct benefits to their properties and crops. By applying questionnaires to the farmers involved in the trials, the project was able to identify their receptivity to the BES approach, the motivations for adopting these techniques and the main challenges they faced to engage with it. It has brought many valuable learned lessons, which main are:

• Farmers expressed that the regulatory scenario (such as the Forest Code) was the main motivation for engagement at the beginning of project, but after a couple of years developing trial tests in their farms, they were convinced that reduced biodiversity could also be an operational risk for farming, increasing costs and vulnerability;

• The farmers demonstrated awareness about dependence of crop production from ecosystem services.

• At the end of the trial period, the great majority of farmers declared they can already monitor the success of the interventions and perceive returns from their implementation.

• They generally also stated that acceptance is strongly influenced by incentives of any sort, which act as catalysts for adoption of new farm management techniques, before benefits from BES management becomes more evident.

• Main drivers for ensuring successful implementation are compatibility with farm calendar and farmer routine, and low implementation costs.
The change of farmer’s perception about BES and its benefits to agriculture is a key element to guarantee committed engagement and lasting outcomes under any BES management scheme. In order to promote this change and also to improve BES management planning, knowledge of the reality and routine of farms is crucial and this is only possible when good communication and trust is built between companies, cooperatives and farmers. The involvement of agricultural extension staff in this process is an effective way to disseminate concepts and techniques to large numbers of farmers, since these staff appreciate the day-to-day reality of farming.

Naturally this change of perception leads to a change of farmer behaviour and incorporation of the BES approach in farm management. For agribusiness, this new farming approach can be understood as an asset, adding value within supply chains and effectively contributing to company sustainability goals. It also improves relationships between agribusinesses and farmers, reduces risks in the most important link of supply chains and guarantees good practices which can open access of products to demanding markets.
Conclusion

This document is devoted to persons or organizations which can make a positive change towards an evolving agriculture that fully integrates biodiversity into farm management, whilst benefitting from this partnership with nature in environmental, economic and social ways. Incorporating Biodiversity and Ecosystem Services (BES) into farming can make farms more resilient, more efficient, more beautiful and more sustainable (ecologically and economically).

We are working on dissemination of the BES farming concept which is intrinsically attached to agricultural sustainability. Farmers, cooperatives and companies must be seen as partners of biodiversity conservation and their engagement in farm management wherein biodiversity and its ecosystem services play a critical role is an effective way to demonstrate commitment.
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