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Better growth with forests - economic analysis

Tropical Forest Alliance 2020

TFA 2020

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Forward

Forests cover approximately 30 percent of the land area on our planet. Not only do they provide oxygen for the planet and a home for much of the world's wildlife, but 1.6 billion people also rely on forests for basic needs, such as good, fresh water, clothing, traditional medicine and shelter. Despite the increasing focus on sustainable land use, the deforestation rate is still high. According to WWF, approximately 46-58 thousand squares miles of forest are lost each year. It is estimated that the production of soy, beef, paper and pulp and palm oil account for about half of the world's current tropical deforestation. Scientists estimate that 12% of global greenhouse gas emissions come from deforestation.

In response to these challenges, the Tropical Forest Alliance (TFA) 2020 was created to contribute to mobilizing and coordinating actions by governments, the private sector and civil society to reduce tropical deforestation related to key agricultural commodities by 2020. The TFA is a public-private partnership in which partners take voluntary actions, individually and in combination, to reduce the tropical deforestation associated with the sourcing of commodities such as palm oil, soy, beef, paper and pulp and does so by tackling the drivers of tropical deforestation using a range of market, policy and communications approaches.

The tropical deforestation challenge is currently at a critical juncture. Whilst there has been strong commitment from many consumer goods companies and governments, many stakeholders (particularly in producer countries) perceive zero deforestation supply chain commitments to be anti-development. This perception, combined with many institutional challenges in these tropical forest rich countries, has meant that progress has been uneven and slower than otherwise would have been hoped.

One of the key underlying challenges is a lack of an unbiased fact base that explains the links between the development of sustainable land use models (linked to sustainable supply chains) and the economic and social impact for rural populations at the forest frontier. With this in mind, the TFA has asked AlphaBeta to analyse the links between sustainable land use and local economic growth, to size the investment requirements for a transition to sustainable land use models, and to provide a set of implications for the ongoing work of TFA and its partner organizations in this area. Given the short duration for this initial phase of work, the objective is not to provide a comprehensive set of conclusions on all these questions, but to frame the key issues, to identify the missing pieces of evidence, and to inform the future direction of work in this area.

Many experts in academia, government, and industry have offered invaluable guidance, suggestions, and advice. Our particular thanks to Marco Albani, Patricia Ohnmacht, Florian Reber and Anna Kopacz (TFA); Neil Scotland and Nicholas Baynham (DFID); Edit Kiss (Ecosphere Capital Partners); Craig Hanson and Helen Mountford (World Resources Institute); Juliano Assuncao (Climate Policy Initiative); Greg Fishbein (The Nature Conservancy); Nurdiana B. Darus (Indonesia Palm Oil Pledge); Murray Birt (Deutsche Bank); Mauricio Voivodic (Imaflora); Pharo Per Fredrik Ilsaas and Marianne Johnson (Ministry of the Environment, Norway); Jeff Seabright and Melissa Miners (Unilever); Paul McMahon (SLM Partners); Roland Pfeuti (RobecoSAM); and Morten Rosse (McKinsey & Company).

We are grateful for all of their input, but the final report is ours and any errors are our own.

Contents

1. Overview

A narrative has developed that suggests there is a trade-off between sustainable land use approaches and local economic growth. Given the importance of this issue for not only the global deforestation challenge, but also the prosperity of these forest-frontier communities, the absence of a strong fact base to explore this conjecture is concerning. The current debate is dominated by anecdotes rather than compelling, broad-based evidence. The challenge in conducting this analysis is that in many of these forest-frontier regions, economic data is often absent or not particularly robust. In addition, there are issues with the lack of a sufficiently long time series to understand impact or a control group to measure progress against.

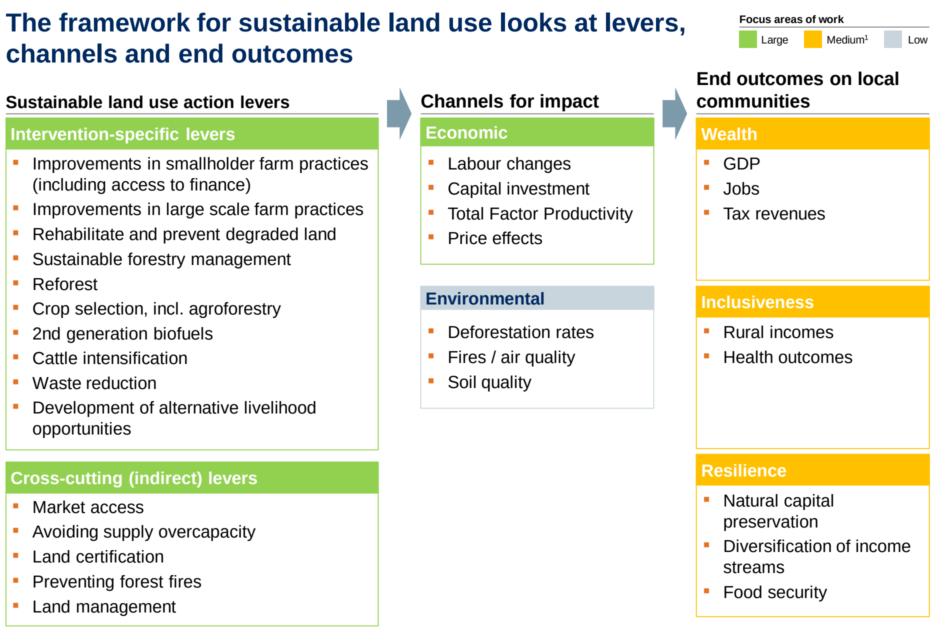
Despite the data challenges, the available evidence suggests a few key findings, including: (a) there is significant evidence of strong positive relationships between the deployment of sustainable land use models and local economic prosperity (although there are trade-offs found in some instances, particularly in the short-term); (b) the local economic impact varies significantly across the different types of levers (e.g., extremely positive for smallholder yield improvement, and generally weaker for interventions such as development of alternative livelihoods); and (c) the economic impact often depends on the specific context of interventions (i.e., it is not necessarily what you do, but how you do it that matters for impact on local growth and prosperity). For example, improvements in land tenure were only found to have a significant impact on productivity, investment and rural incomes when they were accompanied by other complimentary interventions (e.g., investments in infrastructure, extension services).

There is also a sizeable investment opportunity. Whilst there are a number of data challenges in estimating the exact investment requirements to adopt a sustainable land use approach in tropical rainforest regions, an initial estimate suggests investment needs could be roughly $160 billion annually. To put this in context, this represents about 60 percent of the current expenditure on renewable energy ($270 billion per annum). Yet to date sustainable land use approaches have relatively low visibility on the radars of investors. In many cases, there are attractive investment returns associated with these sustainable land use opportunities. In fact, past academic research has estimated that roughly 90 percent of opportunities are estimated to have returns with an IRR greater than 10 percent. Undermining this attractive investment opportunity however are a number of risks that serve to inflate hurdle rates and deter significant investment. A future agenda for TFA could include a three-prong focus of (a) helping to build the fact-base further to address the missing information on the local economic impact of sustainable land use initiatives and investment requirements; (b) working with investors, donors, multilateral organizations and local governments to help address the risks and barriers constraining investment (extending beyond the strong focus of TFA on demand-side measures for stimulating sustainable land use); and (c) engaging local policymakers and investors to help support the mind-set shift required to seize this opportunity.

2. Framework for understanding economic impacts of sustainable land use

The starting point in this analysis is to develop a framework for understanding how sustainable land use approaches can impact the local community. The framework developed includes three broad components (Exhibit 1):

EXHIBIT 1



1 Important areas but likely to be difficult to assess in rigorous fashion

SOURCE: AlphaBeta analysis

- **Sustainable land use levers.** A set of levers or actions that have the potential to create a sustainable approach to tropical rainforest management were first identified based on a review of academic literature, analysis of case studies, and interviews with various practitioners. This includes intervention-specific levers (e.g., crop selection), but also cross-cutting (indirect) levers such as land certification. The exact scope of the levers are described in further detail in the next section.
- **Channels for impact.** The channels for impact consider both economic and environmental considerations. Given that environmental considerations are already well covered in prior analysis, the focus of this research is on the economic channels. Four types of economic channels were analysed based on their contribution to overall economic growth:
    1. *Labour changes.* This refers to the change in the total number of hours worked in the local economy. Economic research shows that there is a positive correlation between improve labour productivity and employment increases. Hence by driving higher labour productivity through sustainable land practices, this could also potentially drive higher employment in agricultural areas. A further channel

could be employment in adjacent sectors. Some forest rich countries have started developing eco-tourism as part of a sustainable land use approach. The counter-argument is that sustainable land use approaches could reduce available cropland and lead to unemployment.

2. *Capital investment.* This refers to changes in investment in the local economy. Sustainable land use approaches could potentially drive this in multiple ways. First, by providing financial injections through carbon offset schemes. Second, from improvements in institutional structures which encourage a more business friendly environment. Sustainable land use models generally involve approaches to improve land certification in the local economy. This can help avoid social conflicts, and also support a better, more accountable local government. Academic evidence shows that poor political institutions, corruption, and resource wealth concentrated in the hands of a few can set the stage for deteriorating political institutions and conflict. [1] Third, sustainable land use approaches could improve the investment returns on projects and encourage more direct investment in the agriculture / forestry sector. Finally, sustainable land use approaches could open up adjacent sectors (e.g., eco-tourism) to encourage investment. The counter argument is that sustainable land use approaches could limit investment opportunities by raising costs and restricting available land.
3. *Total factor productivity (TFP).* TFP accounts for effects in total output not caused by traditionally measured inputs of labour and capital. It is often interpreted as a measure of an economy's long-term technological change or technological dynamism. It includes three important sub-components: (i) labour productivity (e.g., sustainable land use models can help improve farming practices and long-term soil health); (ii) input productivity (e.g., more sustainable approaches to agriculture can require less application of fertilizers and other inputs); and (iii) capital productivity (e.g., more efficient use of machinery and equipment). The counter argument is that TFP could be harmed by sustainable land use approaches as they require more conservative approaches to land management.
4. *Price effects.* This refers to the price effects related to sustainable land use approaches. For example, adopting sustainable land use models can enable farmers to potentially get better access to markets with higher value addition of products. There could also be potential benefits in creating better balance between global supply and demand in certain agricultural goods, which in turn could raise prices. For example, it has been argued that unsustainable palm oil practices have helped contribute to the current oversupply and low prices of palm oil.

- **End outcomes.** Whilst the economic channels are important to examine as they are more directly observable and can provide a robust evidence base for understanding causality, they are generally not the ultimate end outcome that stakeholders care about.

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[1] See for example, Paul Collier, Anke Hoeffler and Dominic Rohner, "Beyond greed and grievance: Feasibility and civil war," *Oxford Economic Papers*, volume 61, issue 1, January 2009.

For local stakeholders, it is more likely to be around wealth (e.g., jobs, GDP, tax take), inclusiveness (e.g., to what degree rural incomes improve or the health and well-being of the local population change), and to some degree resilience (i.e., is the economy likely to be well placed to withstand future economic shocks through levers such as natural capital preservation, better food security or by having a more diversified economy). For example, the number of extreme weather event has tripled since 1980, which threatens food supplies.[2] Moreover, forest ecosystem services, such as protection of soil and watersheds, and non-market goods, such as fruits, medicinal plants and fodder, are also very important to the rural poor. Research in Brazil, Indonesia and India found that ecosystem services and non-market goods accounted for between 47% and 90% of the total income of the poor.[3] There are also important gender-related issues. For example, according to the World Bank, women in forest communities derive 50% of their income from forests, whereas men derive only a third.[4] Women often lack equal rights to land ownership and other resources essential for their effective participation in forest management, and have no legal rights to compensation when deforestation takes place. These are ultimately the things that matter to stakeholders, but they can often be difficult to find a robust evidence to understand causality. As such, we focus primarily on the economic channels in this research, but also examine impacts on end outcomes where there is available evidence.

[2] *Natural catastrophes 2013: analyses, assessments*, positions, Munich Re, 2014.

[3] *The Economics of Ecosystems and Biodiversity for National and International Policy Makers*, The Economics of Ecosystems and Biodiversity (TEEB), UNEP, Nairobi, 2009.

[4] Manfre, C., and Rubin, D. *Integrating Gender into Forestry Research: A Guide for CIFOR Scientists and Programme Administrators*. CIFOR, Indonesia., Indonesia: Centre for International Forestry Research (CIFOR), 2013.

3. Examining the evidence

To test the linkages described in the above framework, a combination of academic literature review and case study analysis was conducted. The case studies were chosen based on a number of criteria, including:

- **Geographical representation.** The case studies reflect a range of different geographical contexts, including from Latin America, Asia and Africa, in order to ensure their broader applicability.
- **Availability of data and key experts.** The team sought case studies where there was good data availability, as well as a range of experts who could provide insights into the outcomes and drivers of the outcomes.
- **Relevance.** The case studies relate to one (or more) of the sustainable land use levers highlighted in Exhibit 1.
- **Demonstration of impact.** Case studies were selected where there was clear evidence of economic impact from a sustainable land use approach. This was a challenge in many instances given the limited time period for which many sustainable land use models have been implemented, but the team nonetheless sought to find case studies with some initial evidence of impact.

What did we find? Despite the data challenges, the available evidence suggests a few key findings, including:

1. There is significant evidence of strong positive relationships between the deployment of sustainable land use models and local economic prosperity. Whilst of course there are some trade-offs, particularly in the short-term,[5] the case studies indicate the potential for sustainable land use to go hand-in-hand with local prosperity in forest-rich regions.
2. The local economic impact varies significantly across the different types of levers (e.g., extremely positive for smallholder yield improvement, and weaker for interventions such as development of alternative livelihoods); and
3. The economic impact often depends on the specific context of interventions (i.e., it is not necessarily what you do, but how you do it that matters for impact on growth). For example, improvements in smallholder farming practices were often found to have a significant impact on rural incomes when they were accompanied by other complimentary interventions (e.g., investments in infrastructure enabling market access). Similarly, the case studies showed significant regional variations in economic impact of sustainable land use levers. For example, after land titling was introduced in Latin America and Asia, there were significant gains to productivity of between 50 and 100 percent, and strongly

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[5] These trade-offs can relate to either sustainable land use models having a negative impact on local growth (e.g., due to lost economic activity from reduced deforestation) or from sustainable land use levers actually leading to further deforestation (e.g., crop yield improvements raising the incentives to clear further land). See for example, Lykke E. Andersen et al., *The Dynamics of Deforestation and Economic Growth in the Brazilian Amazon*, 2002; and Rudel et al., "Agricultural intensification and changes in cultivated areas, 1970–2005." Proceedings of the National Academy of Sciences no. 106 (49): 20675-20680, 2009.

positive gains to investment and income following tenure recognition, typically titling. However, in the Africa cases, there were weak or modest gains to productivity—between zero and 10 percent gains to productivity—and in investment and income following certification (though in most cases there were still positive gains). There were several reasons identified by researchers for their differences in economic impact, including the need for coordinated public investment to unleash the benefits of land titling. When it comes to crop selection and agroforestry, the employment impact depends crucially on the choice of crops. For example, oil palm and (manual) sugarcane generate between 10 and 30 times more jobs per hectare than does large-scale mechanized grain farming.[6] The reason is that, for tree crops, the scope to substitute capital for labour is more limited than in grains.

Exhibit 2 provides an overview of the economic evidence by channel and end outcome:

EXHIBIT 2

The case studies and literature review identified initial evidence on sustainable land use economic impact

Impact: Large positive; Medium positive; Minor; Unclear; Large negative; Data gaps

Sustainable land use levers	Economic channels: Capital additions	Total Factor Productivity	Labour additions	Price effects	End outcomes: Wealth	Inclusive-ness	Resilience
Smallholder yield improvement	Medium positive	Large positive	Medium positive	Minor	Large positive	Large positive	Large positive
Large scale farm yield improvement	Medium positive	Large positive	Minor	Minor	Large positive	Minor	Large positive
Rehabilitate and prevent degraded land	Medium positive	Large positive	Medium positive	Carbon offsets (Medium positive)	Medium positive	Medium positive	Large positive
Reforest	Medium positive	Minor	Medium positive	Carbon offsets (Medium positive)	Minor	Minor	Minor
Sustainable forestry management	Medium positive	Minor	Medium positive	Carbon offsets (Medium positive)	Minor	Minor	Minor
Crop selection, including agroforestry	Minor	Large positive	Minor	Production of high value crops (Large positive)	Large positive	Large positive	Large positive
2nd generation biofuels	Data gaps	Data gaps	Data gaps	Data gaps	Data gaps	Data gaps	Data gaps
Cattle intensification	Medium positive	Large positive	Minor	Minor	Large positive	Minor	Large positive
Waste reduction	Medium positive	Large positive	Minor	Minor	Large positive	Large positive	Large positive
Market access	Medium positive	Minor	Minor	Medium positive	Minor	Minor	Minor
Alternative livelihoods	Medium positive	Minor	Minor	Minor	Minor	Minor	Minor
Avoiding supply gluts	Minor	Minor	Minor	Medium positive	Minor	Minor	Minor
Land certification	Large positive	Large positive	Minor	Minor	Large positive	Large positive	Minor
Preventing forest fires	Minor	Medium positive	Minor	Minor	Minor	Minor	Large positive
Land management	Minor	Medium positive	Minor	Medium positive	Medium positive	Minor	Minor

SOURCE: Literature and case study review; AlphaBeta analysis

Intervention specific levers

1. Smallholder farm practices

Some 1.5 billion people are dependent on smallholder farm production (defined as farms with less than two hectares of land). They are still operating at a low-income, subsistence level, and

6 *Rising Global Interest in Farmland: Can it yield sustainable and equitable benefits?* World Bank Group, 2011.

are vulnerable to ongoing environmental risk.[7] Helping these farmers to raise yields is important for not only environmental stewardship (given they account for 30 percent of cropland), but for tackling rural poverty. The scope for improvement is large. For example, smallholder Indonesian palm oil producers account for one-third of production and achieve yields that are approximately 50% lower than on large plantations.[8] Academic evidence shows there is the net potential to double current yields – more than on large-scale farms.[9] The range of levers for achieving this yield improvement include extension services, improved access to capital (to fund acquisition of necessary equipment), aggregation mechanisms (to achieve economies of scale among smallholders), and better links to markets.

A meta-study of smallholder extension services found a median rate of return of 58 percent, and the available case study evidence demonstrate the large potential impact on total factor productivity (through more capital per worker, better utilization of fertilizers, and improved farming practices), as well as labour and capital increases.[10] See Box 1 for case study examples. One of the important channels is through reducing the cost of inputs (e.g., fertilizers) by better application approaches (i.e., improved total factor productivity). Although the price of commodities has risen over the past decade, the cost of inputs has risen even quicker. Globally, the average price of urea, phosphate and diesel in real terms was around 80% higher between 2005 and 2014 compared to the two decades between 1984 and 2004.[11]

It is important to stress though that improvement in smallholder yields does not automatically lead to improved incomes. The case studies demonstrated that ensuring that the entire agriculture value chain works is necessary so that improvements in one area of the system, such as increased yields, are not constrained by a lack of connections to market or export infrastructure. In Ethiopia, for example, improvement in seed inputs, supported by good weather led to a significant increase in maize production in 2002. However, farmers could not benefit from the surplus because the country had high domestic transport costs and low purchasing power and the export infrastructure was constrained.

There is also a balancing act between yield improvement and environmental outcomes. In some cases, yield improvements have coincided with increases of land under management (in part due to incentives improving from higher productivity). For example, Rudel et al. found that between

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[7] Julian Quan, "Science review: SR25, A future for small-scale farming," Foresight Project on Global Food and Farming Futures, 2011.

[8] Elsom, D. *Indonesia Country Appraisal: Opportunities for UK support to Forestry and Climate Change*. Unpublished consultancy report for DFID, 2011.

[9] *Resource revolution: Meeting the world's energy, materials, food, and water needs*, McKinsey Global Institute, November 2011.

[10] Julian M. Alston, Connie Chan-Kang, Michele C. Marra, Philip G. Pardey, TJ Wyatt, *A Meta-Analysis of Rates of Return to Agricultural R&D: Ex Pede Herculem?,* International Food Policy Research Institute, 2000

[11] *The investment case for ecological farming (white paper),* Paul McMahon, SLM Partners, January 2016.

1990 and 2005 only two of nine world regions combined land use decreases with crop yield improvements.[12]

Also, increased farming intensity could have environmental ramifications without effective management of soil quality and fertilizer application. There are good examples of how tropical rainforest rich countries have been able to manage this balance – the state of Mato Grosso in Brazil has been able to reduce deforestation of its Amazon Biome by 87 percent over 2005 and 2014, while increasing agricultural productivity and doubling its GDP. This was achieved through land-use planning and stringent monitoring and enforcement of land-use laws.[13]

Box 1. Improving smallholder farm practices (case studies)

There are a number of case studies of how tropical forest rich regions have managed to improve smallholder yields and contribute to local growth and environmental stewardship:

- **Luki Biosphere Reserve (Democratic Republic of Congo).** As part of the project, 20 ‘model’ farmers have benefitted from training, input provision (biological material as well as tools) and regular follow-up. The restitution of soil fertility, in combination with the diversification of cultures, has permitted farmers to become sedentary and cease slash-and-burn agriculture. The impact to date includes a doubling of cassava, maize, nut, and bean yields, plus a doubling of farmers’ revenues.[14]
- **ECA (Mozambique).** Many smallholder farmers in Mozambique suffer from a lack of extension services and access to critical inputs (e.g., seeds, equipment). ECA is able to offer a reliable market and fair prices by securing offtake agreements and linking farmers with high volume market players, such as SAB Miller (Cervejas de Moçambique) and Cargill. They have also supported the development of sustainable farming practices with these smallholder farmers. In 2014, the uplift in smallholder income (for 2,298 smallholder farmers) was $450 per head per year, more than doubling incomes.[15]

2. Large-scale farm practices

Large-scale farms (farms with more than two hectares of land) account for an estimated 70 percent of global land under cultivation. Whilst large-scale farms have on average double the yields of equivalent smallholder farms, academic evidence shows there is still the opportunity for

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[12] Rudel, Thomas, Laura Schneider, Maria Uriarte, Billie Lee Turner, Ruth DeFries, Deborah Lawrence, Jacqueline Geoghegan, Susanna Hecht, Amy Ickowitz, and Eric Lambin, "Agricultural intensification and changes in cultivated areas, 1970–2005." Proceedings of the National Academy of Sciences no. 106 (49): 20675-20680, 2009.

[13] *Deforestation in Mato Grosso’s Amazon Forest,* Instituto Centro de Vida, 2015.

[14] *Integrated REDD Pilot Project Around the Luki Biosphere Reserve in Mayombe Forest: Project Appraisal Report*, African Development Bank, June 2011.

[15] http://www.agdevco.com/our-investments/by-investment/ECA

a further 40 percent improvement in their yields over the next 20 years.[16] One of the key opportunities is to improve the diffusion of technologies. For example, the Brazilian Agricultural Research Corporation, known as Embrapa, has pioneered more than 9,000 technology projects to develop Brazilian agriculture, including designing a tropical strain of the soybean and other crops that can thrive in Brazil's climate and other innovations of relevance for Brazil's unique circumstances.[17] Investment in machinery to support precision farming and having basic infrastructure to support access to markets is also critical.

The academic evidence suggests that improvements in large scale farm yields can have significant impacts on investment and productivity, but weaker effects on rural incomes (which may be linked to concentrated ownership patterns in these farms).[18] In Brazil, land policy failures and large-scale programmes of subsidized credit for large farmers at negative interest rates led to mechanized rather than labour-intensive products, and the poverty impacts were somewhat limited.[19] A further caveat is that improvements in large scale farm yields are often associated with further intensification of farming and deforestation, however there are counter examples (see Box 2).

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16 *Resource revolution: Meeting the world's energy, materials, food, and water needs*, McKinsey Global Institute, November 2011.

17 Elcio Perpétuo Guimarães et al.,eds., *Agropastoral systems for the tropical savannas of Latin America*, International Center for Tropical Agriculture (CIAT) and Brazilian Agricultural Research Corporation (Embrapa), 2004.

18 Klaus Deininger (World Bank) and Derek Byerlee (IFPRI), *The Rise of Large-Scale Farms in Land-Abundant Developing Countries: Does it have a future?*, 2010.

19 *Rising Global Interest in Farmland: Can it yield sustainable and equitable benefits?* World Bank Group, 2011.

Box 2. Improving large scale farm practices (case studies)

There are a number of case studies of how tropical forest rich regions have managed to improve large scale farm yields and contribute to local growth and environmental stewardship:

- **Cerrado (Brazil).** The adaptation of soy to suit Central Brazil's growing conditions in the early 1970s was a major technological change that reshaped agriculture in the region. The combination of technological change and skilled migration increased yields and agricultural output[20] – by 2010, Brazilian production of soybeans had grown to 76 million metric tons, accounting for almost 30 percent of worldwide production. Further, the economic impact is not limited to crop production, but extends to other parts of the value chain and beyond the region. While there has been significant loss of the Cerrado ecosystem, the cause of this has been widely debated, and recent studies have found that there has been no increase in soy-related cropland in the Cerrado since 2005. Further, deforestation for overall cropland declined significantly from 2003 to 2006, and has remained low since.[21]
- **Ghana.** In 1979, the Ghana Grains Development Project was launched to develop and diffuse improved technology for maize production. Under this programme new varieties of maize were developed with higher yields and acceptable grain characteristics. In addition, research was conducted to optimize fertilizer application and plant configuration. These efforts resulted in a ~40 percent increase in maize yields from the late 1960s to the 1990s, and maize has become the most important cereal crop in the country. Again, it is difficult to measure the impact on rates of deforestation, which is the result of a combination of causes. However, it is interesting to note that as maize yields increased in the mid-1990s, the area harvested remained relatively stable. [22]

3. Rehabilitation and prevention of degraded land

Land degradation can be physical, chemical, or biological. Physical degradation refers to soil erosion and changes in the soil's structure, such as compaction or waterlogging. Chemical degradation is caused by leaching, salinization, acidification, nutrient imbalances and fertility depletion. Biological degradation refers to the loss of vegetation on rangelands, deforestation, and loss of biodiversity, which includes the loss of soil organic matter and soil microbes.[23]

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[20] *Towards Efficient Land Use in Brazil*, Climate Policy Initiative, September 2015.

[21] Marcia N. Macedo, Ruth S. DeFries, Douglas C. Morton, Claudia M. Stickler, Gillian L. Galford, and Yosio E. Shimabukuro, *Decoupling of deforestation and soy production in the southern Amazon during the late 2000s,* Proceedings of the National Academy of Sciences of the United States of America, Volume 109, 24 January 2012.

[22] Michael L. Morris, Robert Tripp, and A.A. Dankyi, *Adoption and Impact of Improved Maize Production Technology: A Case Study of the Ghana Grains Development Project,* International Maize and Wheat Improvement Center, 2009.

[23] *The investment case for ecological farming (white paper),* Paul McMahon, SLM Partners, January 2016.

The Intergovernmental Technical Panel on Soils found that 33 percent of land globally is moderately or highly degraded.[24] This leads to an estimated economic loss of $40 billion per year from the reduction in land productivity.[25] Each year about 12 million more hectares are degraded. Research indicates that, under business-as-usual, the current soils in agricultural production will yield about 30 percent less than they would otherwise by 2050.[26]

The net rates at which land degradation is occurring can be reduced either by preventing ongoing degradation through more conservational farming practices such as no-till agriculture or restoring degraded land through such practices as terracing and the replacement of topsoil. Rehabilitating the productivity of degraded cropland could offer substantial benefits to agricultural productivity.

Preventing the degradation of land would require farmers to adopt crucial practices such as no-till or low-till agriculture. This can have short-term productivity costs, but the academic evidence suggests that over the longer-term (5-10 years), yields are likely to increase and could come close to or reach conventional tillage yields. Moreover, when practiced together with residue retention and crop rotation activities in the context of conservation agriculture, there could be further improvements in land productivity.[27] In some cases rural incomes have more than doubled after implementation of land rehabilitation programmes (see Box 3). Critical to success has been the integration of local communities into the development of solutions. A further challenge has been that it typically requires large amounts of pesticides to control weeds and other pests, and often employs simple crop rotations. The next generation of no till is now being developed which addresses these concerns. This system combines no till cropping, a mix of cover crops and livestock grazing to produce crops and meat.[28]

Another opportunity to prevent land degradation is through ‘holistic planned grazing’. This involves using fencing to divide the land into smaller paddocks, grouping animals in larger numbers, and moving them frequently according to a grazing plan. The goal is for the land to receive sufficient animal impact and then enough time to recover, mimicking the behaviour of grazing animals in the wild. Holistic planned grazing can regenerate pastures, increase grass production and increase stocking rates in commercial cattle and sheep operations.[29] Case studies from Australia show producers were able to double or triple the number of cattle and the amount of beef produced after switching to holistic planned grazing.[30]

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[24] *Economics of Land Degradation Initiative*, The Intergovernmental Technical Panel on Soils, 2013.

[25] Moore, Gary. *Living with the Earth, Third Edition: Concepts in Environmental Health Science.* CRC Press, 2007.

[26] *Reuters*, '"Peak Soil" Threatens Future Global Food Security', 17 Jul 2015.

[27] Cameron M. Pittelkowa, Bruce A. Linquist, Mark E. Lundy, Xinqiang Liang, Kees Jan van Groenigen, Juhwan Lee, Natasja van Gestel, Johan Six, Rodney T. Ventereae and Chris van Kessel, *When does no-till yield more? A global meta-analysis,* Field Crops Research, Vol. 183, November 2015

[28] *The investment case for ecological farming (white paper),* Paul McMahon, SLM Partners, January 2016.

[29] *The investment case for ecological farming (white paper),* Paul McMahon, SLM Partners, January 2016.

[30] *Queensland Country Life*, 12 December 2013.

Box 3. Restoring degraded land and preventing degradation of land (case studies)

A number of case studies show positive long-term benefits to productivity and employment from restoring land:

- **Brazil (Mato Grosso).** The state of Mato Grosso is Brazil's top producer of soy, beef and cotton and as a result has seen one of the highest rates of deforestation and agriculture-led carbon emissions in the past decades. The state has recently launched a goal to restore 6 million hectares of degraded pastures and to put them to productive use: 3 million hectares for agriculture (primarily for soy, corn and cotton production), 2.5 million hectares for (more efficient) cattle grazing and 0.5 million hectares for conservation. Currently, some 40 percent of the land in the 93-million-hectare state is made up of unproductive pastures, far more than is used for the more lucrative crop production. The project aims to have significant economic impact – for example, it aims to support smallholders through improved land regulations and providing technical assistance.[31]
- **Kalimantan Forests and Climate Partnership (Indonesia).** The Kalimantan Forests and Climate Partnership (KFCP) is one of the largest REDD+ (Reducing Emissions from Deforestation and forest Degradation) demonstration activities in Indonesia. Its activities extend over 120,000 hectares of the Indonesian province of Central Kalimantan, within an area referred to as the Ex-Mega Rice Project (EMRP) which covers approximately 1.4 million ha of depleted or degraded peatlands. KFCP sought to work with communities and to provide short-term income-generating benefits to communities through trialling Payments for Environmental Services (PES) for community efforts that contributed to peatland rehabilitation and medium-term benefits through a livelihoods programme. The PES has amounted to approximately one fifth of the income necessary to cover monthly household expenses, but with wide variations across households. The programme evaluation described the cash payments as "a welcome infusion, but not a windfall." [32] Some of the longer terms benefits of the development of alternative livelihood programmes however may deliver significantly more economic value, albeit it is too early for the exact impact to be known. For example, projections suggest that those villagers learning to develop rubber clones, annual additional income per household may reach Rp 150 million per year (US$11,000).
- **Shinyanga (Tanzania).** Prior to 1985, the region had been degraded of its Acacia and Miombo woodlands (as part of tsetse fly eradication and cash crop based agricultural expansion). By 2004, more than 300,000 ha of woodland had been restored across the 833 villages of the region with an economic value of US$14 per person per month

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[31] *Mato Grosso Brasil: COP 21*, November 2015.

[32] Dr. Lenard Milich, Djamilah, and Dr. Ali Said, *KFCP Socio-economic study*, Indonesia-Australia Forest Carbon Partnership, 2014.

– almost double the average level of rural consumption in Tanzania.[33] There were a number of interconnecting economic and social benefits from the programme. Trees and catchment conservation improved water quality restored woodlands provided fodder for oxen at the critical end of dry season times; revenues from the sale of tree products, such as honey and poles, helped pay for children's schooling; the multiplicity of tree goods (fuel, building timber, fruits, gum, medicines, fodder) and services (water catchment, erosion reduction, cultural) spread the risk of crop failure and enhanced resilience by diversifying the economy and diets; and there were clear benefits to women as the time taken to collect fuelwood, fruits and wild foods was dramatically reduced. Underlying the success was an integration of local villages into the development of the approach (using a 'bottom up' approach) and respect for local institutions.

- **Juma Sustainable Development Reserve (Brazil).** At the current rate of deforestation, about one-third of the forest in Brazil's Amazonas will have been lost by 2050, releasing 3.5 billion tonnes of carbon dioxide. Bolsa Floresta in Amazonas (the country's largest state, nearly 98 percent covered by rainforest), has developed the Juma Sustainable Development Reserve, an area of 600,000 hectares (1.2 million acres) bordered by two highways. The project aims to avoid the degradation of 366,000 hectares of rainforest and the emission of 210 MtCO2e into the atmosphere by 2050. Under the project, local forest communities are rewarded for committing to avoid clearing primary forest and avoid burning vegetation. Funding is distributed at four levels:
    - *Individual families:* payment of around USD 25 per month transferred through a debit card issued to the wife (based on regular inspections to ensure that trees are being maintained)
    - *Family associations:* cash grant averaging USD 500 per month per association plus in-kind equipment (such as Internet connections)
    - *Social programmes:* grants of approximately USD 70,000 per year for each reserve, directed towards social activities, such as education or health, and designed to complement existing state and local government programmes
    - *Sustainable income generation:* equivalent to USD 70,000 per year for each reserve to support income-generating activities based on sustainable land and resource use

4. Reforestation

This involves increasing the natural carbon sink by enlarging the forest cover with suitable, economically viable tree species, such as native species that can yield timber and non-timber products as well as fast-growing species such as acacias. The business case for this is mainly around carbon offsets. However, there are opportunities to broaden impact by planting a temporary timber plantation, which could then be gradually transformed into conservation or protection forest. In addition, the reforestation can support development of adjacent sectors, such as eco-tourism (see Box 4).

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[33] Edmund Barrow, *300,000 Hectares Restored in Shinyanga, Tanzania — but what did it really take to achieve this restoration?,* SAPIENS, Volume 7, 2014.

Box 4. Reforestation (case studies)

A number of case studies show positive long-term benefits to investment and employment from reforestation:

- **Indonesia (Central Kalimantan).** Sebangau National Park in Central Kalimantan covers an area of 569,700 hectares and has tremendous biodiversity. In 2006, the Indonesian Institute of Sciences (LIPI) found 808 herbal plant species, 116 bird species, and 35 species of mammals, including 6,000 to 9,000 orangutans, sun bears, and clouded leopards. WWF Indonesia and Garuda Airlines are cooperating in a reforestation programme, covering an area of 250 hectares with 100,000 trees. The World Wildlife Fund for Nature Indonesia has begun developing the concept of community-based ecotourism in Sebangau National Park, based on ensuring the conservation of the area, whilst ensuring the economic participation of the local people.

5. Sustainable forestry management

Non-sustainable extraction of timber can result in significant deforestation, particularly in tropical rainforests. Opportunities exist to minimize the total biomass removed during the harvesting activities, which is typically many multiples of the timber extracted for commercially purposes. This includes trees felled to open roads and skidding trails for harvesting operations and to provide materials for bridges as well as trees damaged during the cutting and removal of commercial timber. Levers include enforcing more sustainable forest management practices in dry land areas (e.g., by hiring more people to enforce reduced impact logging and to overlook and verify enrichment planting), providing technical support to farmers and loggers, improving forest governance, and educating consumers in key international markets. Ensuring that local communities are fully integrated into the management, monitoring, and enforcement of local forests is critical and needs to be accompanied by appropriate incentives that reward individuals and communities for promoting the sustainable use of forests. Due to variability in study methodologies and context, synthesis of evidence on economic impact is difficult.[34] However, the case studies demonstrate how these approaches can lead to significant benefits to investment and income, more than offsetting the short-term loss from producing less (Box 5).

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34 Diana E Bowler, Lisette M Buyung-Ali, John R Healey, Julia PG Jones, Teri M Knight, Andrew S Pullin, *Does community forest management provide global environmental benefits and improve local welfare?,* Frontiers in Ecology and the Environment, volume 10, issue 1, 26 September 2011.

Box 5. Sustainable forestry management (case studies)

A number of case studies show positive benefits to long-term productivity and income generation from more sustainable forestry management:

- **Sabah (Malaysia).** The Sabah State Government has given its priority to Sustainable Forest Management (SFM) practices. Economic impact analysis was conducted based on four scenarios arising from SFM practices: a reduction by 24% in harvested area; and increase by 49% in external cost of timber harvesting; an increase by 47% in the cost of internalisation of the externalities; and a 20% gain in market access. The results showed that whilst the equilibrium quantity of timber had decreased, this welfare loss on the timber industry was offset by price gains and improved market access.[35]
- **Heart of Borneo (Borneo).** The Heart of Borneo project is a partnership between Brunei Darussalam, Indonesia, and Malaysia to conserve 220,000 square kilometres of rainforest – almost one-third of the island – through a network of protected areas and sustainably-managed forests. The economic analysis of this project found a number of potential economic benefits, including a decrease in future costs to businesses, households and government; increased future revenue from biodiversity-based and green industries; higher crop yields and lower domestic energy consumption; and supporting a transformation to a more equitable economy. By 2030, every dollar invested in these green initiatives is estimated to have a payback of $4.2.[36]

6. Crop selection, including agroforestry

Agroforestry is the integration of trees with cropping or livestock systems. Trees can be grown for timber, fruit, nuts, forage or a combination of products. A variety of crops or grasses can be inter-planted in the alleys between trees, with enough space to allow conventional machines to operate. In livestock systems, the trees can also act as a source of forage for animals. As a result, agroforestry (and crop selection), have the opportunity to raise yields and incomes, whilst also reducing the need for further deforestation. For example, a study in Thailand found that the cultivation of cabbage and carnations reduced pressure on local forests as these crops required less land than traditional crops.[37] In Brazil, agroforestry techniques have been used in producing palm oil, along with cassava, maize, legumes or fruit trees.

Agroforestry has an economic impact primarily through the productivity and price effect channels. Productivity can be higher than in monocultures because of resource complementarity. For

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[35] Rahim, AS Abdul et al. "Market and welfare economic impacts of sustainable forestry management practices – An empirical analysis of timber market in Sabah, Malaysia". *Journal of Tropical Forest Science* 24.4 (2012): 440–454.

[36] *Heart of Borneo: Investing in nature for a green economy*, Synthesis report, May 2012.

[37] Waranoot Tungittiplakorn and Philip Dearden, "Biodiversity conservation and cash crop development in northern Thailand", *Biodiversity and Conservation,* volume 11, issue 11, November 2002.

example, European research shows that agroforestry can boost output by up to 40%.[38] In addition, better crop selection can lead to price increases of up to 50 percent. In Indonesia for example, McKinsey Global Institute estimated that shifting the mix toward high-value crops could increase revenue by US$45 billion in 2030.[39]

The employment impact of agroforestry and crop selection depends crucially on the choice of crops. For example, oil palm and (manual) sugarcane generate between 10 and 30 times more jobs per hectare than does large-scale mechanized grain farming.[40] The reason is that, for tree crops, the scope to substitute capital for labour is more limited than in grains.

Box 6. Crop selection (case studies)

A number of case studies show positive benefits to long-term productivity and income generation from crop selection and agroforestry techniques:

- **Mato Grosso do Sul (Brazil).** Between 2005 and 2012, substantial private investment in the sugarcane business brought large-scale changes as land use moved from low productivity pastures to high productivity crops. Land for sugarcane increased by more than 3 times, and the number of sugarcane mills grew from 8 to 22. GDP in the region increased significantly from higher agriculture productivity, greater access to capital, and downstream investments in processing.[41] A study of the industry in Mato Grosso do Sul found that 4 years after the building of a sugarcane mill, a typical municipality would see a doubling of GDP, a 29 percent increase in employment and a 30 percent increase in wages.[42]

7. 2nd generation biofuels

Second generation biofuels, also known as advanced biofuels, are fuels that can be manufactured from various types of biomass (i.e., any source of organic carbon that is renewed rapidly as part of the carbon cycle). The savings opportunity from a substantial shift away from fossil-based fuels and chemicals towards bio-based-products is hard to quantify because key technologies such as ligno-cellulosic (LC) are still at an early stage of moving into industrial scale application with falling costs. However, one estimate put the global opportunity at $10 billion in

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[38] *The investment case for ecological farming (white paper),* Paul McMahon, SLM Partners, January 2016.

[39] *The archipelago economy: Unleashing Indonesia's potential*, McKinsey Global Institute, September 2012.

[40] *Rising Global Interest in Farmland: Can it yield sustainable and equitable benefits?* World Bank Group, 2011.

[41] *Towards Efficient Land Use in Brazil*, Climate Policy Initiative, September 2015.

[42] Juliano Assunção, Breno Pietracci, Priscila Souza, *Fuelling Development: Sugarcane Expansion Impacts in Brazil,* August 2015.

2030.[43] Unfortunately, given the nascent nature of this technology (production capacity of the first commercial plants remains small), the economic impact of 2nd generation biofuels has yet to be established.[44]

8. Cattle stock intensification

Around 70% of the grains used by developed countries are fed to animals. Livestock consume an estimated one-third or more of the world's cereal grain, with 40% of such feed going to ruminants (cud-chewing), mainly cattle.[45] There are opportunities to improve productivity and reduce the impact of this cattle on forests, through breeding of genetically suited cattle, control of transmissible diseases, adopting smart supplements (the productivity of ruminant animals can often be boosted with supplements, some of which encourage microbes in the rumen to grow quickly and to provide better nutrition), and selection of marginal areas (e.g., mountainsides or low-lying wet grasslands) for grazing.[46] Experts suggest that there is an opportunity for a 15-20% feed efficiency improvement through feed additives and improved practice (based on expert interviews).[47] There is also the potential to triple productivity (see Box 7).

Academic evidence also suggests that cattle stock intensification does lead to reduced deforestation. For example, between 1996 and 2006, the productivity of cattle grew by 57.5% in the average Amazon municipality and this was associated with reduced deforestation.[48]

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43 *Accelerating Green Growth Through Public-Private Partnerships*, 3GF, June 2012.

44 Joern Huenteler, Laura Diaz Anadon, Henry Lee, Nidhi Santen, *Commercializing second-generation biofuels,* Harvard Kennedy School, November 2014

45 *Food and Agriculture Organization of the United Nations World Agriculture: Towards 2015/2030*, FAO, 2002.

46 Eisler et al., *Agriculture: Steps to sustainable livestock*, Nature, 5 March, 2014.

47 *Resource revolution: Meeting the world's energy, materials, food, and water needs*, McKinsey Global Institute, November 2011.

48 Petterson Molina Vale, *The conservation versus production trade-off: does livestock intensification increase deforestation? Evidence from the Brazilian Amazon*, Grantham Research Institute on Climate Change and the Environment, Working Paper No.174, December 2014.

Box 7. Sustainable cattle intensification (case studies)

A number of case studies show positive benefits to long-term productivity and income generation from crop selection and agroforestry techniques:

- **Para (Brazil).** The cattle sector is an important part of Brazil and Pará's economy, but also a leading driver of deforestation - almost 85% of all deforested areas are now pastures. Over the past decade, deforestation rates have slowed by over 70% from historical levels in Brazil and Pará, but largely from halting the expansion of ranching and other agriculture. Analysis by TNC suggests that cattle processed in Pará could increase 50% by 2030 with no new deforestation, and allow for the restoration of over 40,000 ha of forest, protection of over 200,000 ha, and reduced emissions of a billion tons CO_2e. Investment in intensification is estimated to have the potential to increase productivity by more than 3x, with real ROIs of 10-15% over 12 years. Key challenges must be overcome, however, including helping ranchers access credit and technical assistance.[49]

9. Waste reduction

Between 20 and 30 percent of food is wasted somewhere along the value chain, even before allowing for food waste at the point of consumption (Exhibit 3). In developed countries, the vast majority of waste occurs in processing, packaging, and distribution. In developing countries, poor storage facilities and insufficient infrastructure mean that a significant share of food is wasted after harvest. Because postharvest waste in developing countries is twice as large as waste in developed economies, the opportunity in developing economies is relatively big. Developing regions could also invest in additional opportunities in processing, packaging, and distribution. By doing so, these regions could reap considerable rewards on food security because they tend to be home to more net food importers than exporters. As in the building sector, new IT applications may make it possible to track inefficiencies across the supply chain, enabling much better resource monitoring and management.

Reducing food waste will also have significant benefits in cutting the amount of water used in agriculture by avoiding irrigation and reducing energy consumption. Because of the energy consumed throughout the length of the supply chain, reducing food waste at the later stages of that chain can save three times the energy of cutting waste at the postharvest stage (although reducing postharvest and supply-chain waste would have more benefits for food security). Being able to monitor the percentage of food waste in each value chain would be useful for supporting a drive to reduce it.

There are a number of economic and social benefits associated with reducing food waste. These include reducing the likelihood that small-holders become net food buyers; increasing the return on investment of time spent farming and the total time needed to work in fields; and raising

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49 Green growth and sustainable cattle intensification in Para, The Nature Conservancy, December 1, 2015.

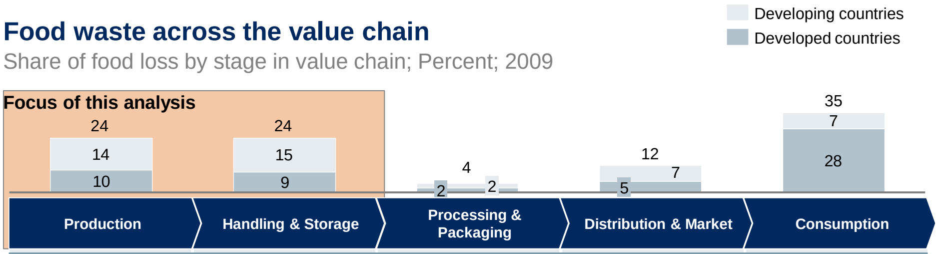
overall productivity levels (and income).[50] Pilot efforts in Benin, Cape Verde, India, and Rwanda have documented reductions of food loss by more than 60 percent during field trials of a variety of low-cost storage techniques and handling practices.[51] Of those available techniques, 81 percent were found to be able to increase the incomes of smallholders by more than 30 percent (See Box 8).

Whilst the potential benefits are impressive, the analysis of past research also highlighted a number of caveats. Even once the necessary investment is in place, case studies have shown that farmers must change their behaviour to capture the opportunity in full. For example, one major issue in adoption of using metal silos in some African countries has been the fact that most farmers wanted to keep the grain stored in the safety of their own homes, in case of theft.

EXHIBIT 3

Food waste across the value chain

Share of food loss by stage in value chain; Percent; 2009



	Production	Handling & Storage	Processing & Packaging	Distribution & Market	Consumption
Definition	During or immediately after harvesting on the farm	After produce leaves the farm for handling, storage, and transport	During industrial or domestic processing and/or packaging	During distribution to markets, including losses at wholesale and retail markets	Losses in the home or business of the consumer, including restaurants / caterers
Includes	Fruits bruised during picking or threshing	Edible food eaten by pests	Milk spilled during pasteurization and processing (e.g., cheese)	Edible produce sorted out due to quality	Edible products sorted out due to quality
	Crops sorted out post-harvest for not meeting quality standards	Edible produce degraded by fungus or disease	Edible fruit or grains sorted out as not suitable for processing	Edible products expired before being purchased	Food purchased but not eaten
	Crops left behind in-fields due to poor mechanical harvesting or sharp drops in prices	Livestock death during transport to slaughter or not accepted for slaughter	Livestock trimming during slaughtering and industrial processing	Edible products spilled or damaged in market	Food cooked but not eaten
	Fish discarded during fishing operations	Fish that are spilled or degraded after landing	Fish spilled or damaged during canning / smoking		

SOURCE: World Resources Institute

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50 *Reducing food loss and waste*, World Resources Institute, June 2013.

51 Kitinoja, L. *Identification of appropriate postharvest technologies for improving market access and incomes for small horticultural farmers in Sub-Saharan Africa and South Asia. Part 2: Postharvest Loss Assessments.* World Food Logistic Organization, 2010.

Box 8. Reducing food waste in the value chain (case studies)

Economic impacts of food waste management:

- **Rwanda / Ghana / Benin / India.** These four countries were selected for an FAO study of the current level of postharvest food waste and the testing of potential interventions for their cost effectiveness and impact. Postharvest losses were high across all four countries, particularly for certain categories – for example, Bening Ghana had a loss rate of 25 percent for tomatoes; India had a 14 percent loss rate for eggplant; and Rwanda had a 15 percent loss rate for bananas. More than 50 potential postharvest interventions were identified and field trials were conducted on 19 of these interventions. This resulted in the identification of eight categories of specific interventions that were found to reduce losses, maintain quality and/or increase market value while being easy to use on a trial basis, low cost and readily available or easy to construct using local materials. These technologies were submitted to cost/benefit analyses and 81 percent met the criteria of being able to increase incomes for smallholder famers and direct marketers by 30% or more.

10. Development of alternative livelihood opportunities

This relates to the development of alternative economic opportunities in forest-rich regions that can support (and indeed take advantage of) sustainability. A particular example is eco-tourism. Whilst in theory eco-tourism should be a great economic opportunity to maintain forests, these programmes often face challenges, including tourism contributing to biodiversity loss, interference with local communities, and the failure of many projects to reach meaningful scale (in part due to the competitive nature of the industry and the lack of supporting infrastructure such as accessibility via major airline routes).[52] Baun Bango in Central Kalimantan for example has only had 50 visitors since 2010. In some instances, the challenges related to the failure to properly train staff on the principles of eco-tourism. Other opportunities seem to have had more impact (see Box 9).

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52 Astrid J. Øvstetun and Janet Cochrane, *The role of conservation agencies in ecotourism: a case study from Central Kalimantan in Indonesia*, Working Paper, 2013.

Box 9. Development of alternative livelihood opportunities (case studies)

Case studies demonstrate that there are viable alternative livelihood opportunities in many forest-rich regions that can marry significant economic impact with environmental stewardship:

- **Goma (Democratic Republic of Congo).** The project in Virunga Park (Goma) in the DRC focuses on substituting wood-based coal by biomass briquettes. The biomass briquettes are made of grasses, leaves, agricultural residue, sawdust, and recycled paper, allowing for a complete substitution of fuelwood. This has led to the creation of over 1,200 jobs to date.
- **Ibi Batéké project (Democratic Republic of Congo).** The Ibi Batéké Carbon Sink Plantation (IBCSP) project in the Democratic Republic of Congo is an afforestation and clean energy project. It will convert a natural grassy savanna, disturbed by man-initiated fires, into an abundant and sustainable fuelwood supply for charcoal production.[53] Over 200 jobs have been created to date.
- **Kalimantan Forests and Climate Partnership (Indonesia).** As part of the Kalimantan Forests and Climate Partnership (KFCP) REDD+ demonstration project, local villagers were given support to develop a range of alternative livelihood opportunities, including agroforestry, rubber clones, and *beje* (traditional fishponds open to the river). Whilst the alternative livelihood programmes were found to offer significant long-term potential for income generation (up to USD 11,000 per household in some cases), a review of the project highlighted the need to bridge longer-term livelihoods opportunities with short-term income generating opportunities. For example, training people in producing slabs of higher quality rubber to gain the producers higher income offered large long-term potential, but the new rubber plantations take years to yield and were further delayed due to the time needed to produce quality slabs vis-à-vis faster processing methods.[54]

Cross-cutting (indirect) levers

Beyond the direct levers of achieving sustainable land use analysed above, there are also some broader, indirect cross-cutting levers which are potential positive externalities associated with sustainable land use.

1) Market access

This relates to improved market access through certification of sustainable products, and/or being able to achieve a price premium through the production of sustainably sourced products. According to Nielsen's Global Health and Wellness Survey – a survey of 30,000 consumers in 60 countries – young people are much more interested in sustainably-sourced food and willing to pay a premium for it. Among consumers under age 20, 41 percent said they would willingly pay a

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53 http://www.forestcarbonportal.com/project/ibi-bateke-sink-plantation-project

54 Dr. Lenard Milich, Djamilah, and Dr. Ali Said, *KFCP Socio-economic study*, Indonesia-Australia Forest Carbon Partnership, 2014.

premium for sustainable products, compared to 21 percent of Baby Boomers (aged 50 to mid-60s).[55] The UK already applies a procurement policy that requires central government departments to buy "legal and sustainable" timber, and has set out public and private sector commitments to purchase 100% of palm oil from credibly certified sources by 2015.[56] These policies can create significant opportunities for sustainability-compliant producer countries. There is tremendous opportunity for future growth in sustainable products. For instance, the market for FSC-certified forest products alone is expected to quadruple over the next five years to more than USD 200 billion.[57] Analysis of reduced impact logging approaches in Sabah found that market access improved by 20 percent.[58]

Market access benefits appear to greatly depend on whether there is the local enabling environment to take advantage of them. For example, organic and Fairtrade certification were associated with better post-harvest practices and higher prices in Brazil nut production in Brazil, Bolivia and Peru, while Forest Stewardship Council (FSC) certification was related to improved pre-harvest planning. However, the benefits varied significantly across countries. Certification was viewed most positively in Bolivia, where producers gleaned financial and social benefits, moderately in Peru, and least positively in Brazil, where benefits were lower or non-existent.[59] The reason for the differences in economic outcomes was related to the extent of partnerships with cooperatives, donors, government, and non-governmental organizations.

2) Avoiding supply gluts

Palm oil prices have recently been weighed down, in part through record inventory levels. Understanding the degree to which the oversupply of palm and other agricultural products (linked to unsustainable practices) has contributed to recent low prices is difficult given the multitude of intermingled drivers (e.g., weather impacts, prices of competing vegetable oils, demand in emerging markets, government promotion of biofuels). However, it is noteworthy that supply in Indonesia and Malaysia (which account for roughly 85 percent of global production) has increased at record levels since 2005 (at a CAGR of 7 percent). This is the fastest growth rate amongst major agricultural commodities, and there are some links in terms of the extent of price declines. While there is no constant correlation between supply and price, an inverse relationship can be seen when comparing historical stock and prices of palm oil for Malaysia and Indonesia. The build-up of palm oil inventories over the course of 2015 resulted in the depression of prices in

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55 USA Today, 9 Jan 2015.

56 https://www.gov.uk/government/publications/sustainable-production-of-palm-oil-uk-statement

57 *Innovative markets and market-like instruments for ecosystem services – The matrix*, Ecosystem Marketplace, 2013.

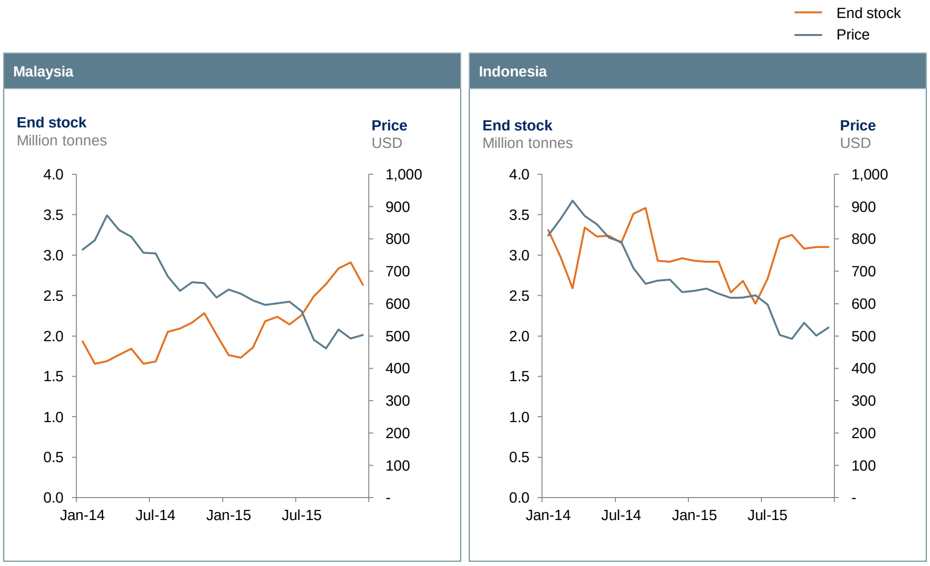
58 Rahim, AS Abdul et al. "Market and welfare economic impacts of sustainable forestry management practices – An empirical analysis of timber market in Sabah, Malaysia". *Journal of Tropical Forest Science* 24.4 (2012): 440–454.

59 Duchelle et al., "Is Certification Associated with Better Forest Management and Socioeconomic Benefits? A Comparative Analysis of Three Certification Schemes Applied to Brazil Nuts in Western Amazonia", Society & Natural Resources: An International Journal, Volume 27, Issue 2, 2014.

both countries (see Exhibit 4). Moreover, there is evidence of a price ceiling for palm oil linked to soy prices. Soybean and palm oil dominate the marketplace and account for roughly 63 percent of the total world production of edible oils. Soybean oil and palm oil are considered “substitute goods” because food processors often switch between the two ingredients as the prices fluctuate. As such, there is potentially a ceiling for palm oil linked to soybean prices, however this may be weakened by the fact that palm oil typically has significantly lower operating costs (particularly around seeds and need for less machinery) and hence is more competitive at the same price level as soy.

EXHIBIT 4

Supply and price of palm oil in Malaysia and Indonesia



SOURCE: Malaysia Palm Oil Board; Oil World

3) Land certification

Land tenure has long been viewed as a central element of development efforts as it affects productivity through at least three channels, namely (i) the likelihood of investments; (ii) the scope for transferring land to more productive users and take up non-agricultural employment; and (iii) the ability to use land as collateral for credit. The positive impacts of more secure land tenure on investment and land values in rural areas have been demonstrated in China, Thailand, Latin America, Eastern Europe and Africa.[60]

However a systematic review using studies that were based on randomized control trials (i.e., randomized samples of farming households in an area that had received a treatment, which was,

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[60] K. Deininger, D.A. Ali, and T. Alemu, *Impacts of land certification on tenure security, investment, and land market participation: evidence from Ethiopia*, Land Econ., 87 (2), 2011.

for example, land-rights certification, in comparison to a community where the researchers controlled all other factors apart from the fact that the community had not received land-rights certification) showed that the impact on productivity, investment, access to credit and incomes differed significantly by geography.[61] In the Latin American and Asia cases, after certification or titling, there were significant gains to productivity of between 50 and 100 percent, and strong positive gains to investment and income following tenure recognition, typically titling. However, in the Africa cases, there were weak or modest gains to productivity—between zero and 10 percent gains to productivity—and in investment and income following certification (though in most cases there were still positive gains). Another important finding was there was no or weak discernible credit effects anywhere. The researchers identified a few explanations for the results. First, customary tenure systems in Africa already provide access to land as a social right by virtue of one's membership in the community (and hence less upside from formal tenure initiatives), low wealth levels in Africa may constrain their ability to take advantage of land security, and the need for coordinated public investments to unleash the benefits (e.g., affordable access to farming inputs and markets, and investment in roads, cooperatives, and farmer training). A good example of the benefits of a coordinated approach comes from Asia. Thailand and Vietnam have clarified property rights and used public investment to provide smallholders with access to technology. This led to a significant expansion of rice exports from these countries—and subsequently exports of other commodities with higher value added—and had a major impact on poverty reduction.[62]

In addition, there is some evidence that it can have broader benefits in terms of social development – the land registration process may provide the solution to previous conflicts, and thus lead to greater cohesion within the community. A recent attempt at measuring conflict-related agricultural output losses for all developing countries showed that they are extensive: for the 28 years from 1970 to 1997, estimated losses amount to almost $121 billion at 1995 prices, or an average of $4.3 billion per year.[63] According to data collected by the Consortium for Agrarian Reform (Konsorsium Pembaruan Agraria), there were 369 cases of agrarian-related conflict in 2013 in Indonesia, an 86% increase from 2012. In 2013, 21 people were killed, 30 were shot, 130 were persecuted, and 239 were detained.[64] In Indonesia it is estimated that some commercial palm oil producers leave as much as 20 percent of their concession areas unused due to conflict concerns. Moreover, greater tenure security could reduce suspicion towards local governments (where citizens fear displacement or eviction by the government) and outsiders, improving overall

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61 Steven Lawry, Cyrus Samii, Ruth Hall, Aaron Leopold, Donna Hornby, and Farai Mtero, *The Impact of Land Property Rights Interventions on Investment and Agricultural Productivity in Developing Countries: a Systematic Review*, Campbell Systematic Reviews, 2014.

62 *Rising Global Interest in Farmland: Can it yield sustainable and equitable benefits?* World Bank Group, 2011.

63 *Agricultural Development and the Cost of Conflict*, UNEP, 2006.

64 http://www.mongabay.co.id/2013/12/22/konflik-agraria-2013-meningkat-21-warga-tewas-30-tertembak/

relationships. However, there are also instances to the contrary where poor execution of land registration has led to negative impacts on farmers and increased social tensions.[65]

4) Preventing forest fires

Forest fires not only have a major impact on the environment, they also significantly impact the local economy. For example, based on its own calculations, the Indonesian government estimates that the cost of mitigating the recent haze crisis this year could range from 300 trillion to 475 trillion rupiah (approximately $47 billion). This effectively means less fiscal resources that could be devoted to areas that could have higher capital and labour productivity, such as infrastructure, education or health.

Major progress could be achieved by prohibiting fire as a tool for land preparation, providing appropriate and practical equipment (and, if appropriate, financial incentives) for manual land clearing, developing appropriate early-warning systems based on fire risk status and field-based fire detection, strengthening fire brigades, ensuring strong enforcement and large penalties for rule violations, and building public awareness of the economic and social costs of forest fires in the province.

Past plans for combating fires, such as the 2006 Palangka Raya Declaration on Forest and Land Fires (which produced an action plan focusing on building awareness, developing local knowledge in land preparation, developing early warning systems, and introducing a reward system for villages that are fire free) highlight the need for inclusion of local communities from a very early stage with ongoing interactions, appropriate financial resourcing and funding mechanisms, clear responsibilities, and strong leadership to ensure impact.[66]

5) Land management

A landscape management approach involves partnerships to manage agricultural production and ecosystem protection across a connected area of land at scale, as opposed to approaches that primarily involve a range of business, smallholder farmer and government actors managing smaller dispersed patches of land more independently. There are significant opportunities to reduce deforestation through a more efficient and sustainable land management approach – for example by using already degraded land rather than forested land for new agricultural cultivation – and by limiting or stopping agricultural expansion into deep peatlands.

Ensuring effective land allocation is extremely challenging given the cross-jurisdictional nature of land tenure and spatial planning issues. Increased collaboration among different levels of government is critical to improving spatial planning and must be supported by detailed technical analyses, which can provide an accurate assessment of current land allocation and assess the potential economic benefits of using different land types for different activities. This information then needs to be consolidated into a single land titling system to register deeds and map areas, supported by strong community engagement.

Whilst challenging to implement, there is a large potential upside. For example, Unilever is currently piloting a land management approach in Sei Mangkei (in North Sumatra, Indonesia) that will support production of a palm kernel fractionation facility. In North Sumatra, there is an

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65 Steven Lawry, Cyrus Samii, Ruth Hall, Aaron Leopold, Donna Hornby, and Farai Mtero, *The Impact of Land Property Rights Interventions on Investment and Agricultural Productivity in Developing Countries: a Systematic Review*, Campbell Systematic Reviews, 2014.

66 Master Plan for Rehabilitation and Revitalization of the EMRP Area – Technical Report 1: Forest and Land Fire Management in the Ex-Mega Rice Project Area.

estimated 1.1 million hectares of degraded land inside the forest estate that has potential to be used more productively – either through rezoning to enable agricultural production, or rehabilitation and protection.[67] Isolating the economic impact of land management approaches is often challenging as they are often coupled with land certification interventions or efforts to improve smallholder farming practices. An example of this is the ejido forests in Mexico – in the mid-1980s decision-making power over the land was transferred to local communities or 'ejidos'. Each ejido conducts an integrated land use planning exercise annually, clearly demarcating land for different uses. The ejidos also cooperate to provide technical assistance and develop a combined market strategy, which has resulted in higher prices and a larger range of crops sold. This has the combined effect of increasing income flows to the ejidos while ensuring the sustainability of forest harvesting.[68]

[67] *Achieving a high-productivity, sustainable palm oil sector in Indonesia: a landscape management approach*, Climate Policy Initiative, IDH and Unilever, July 2015.

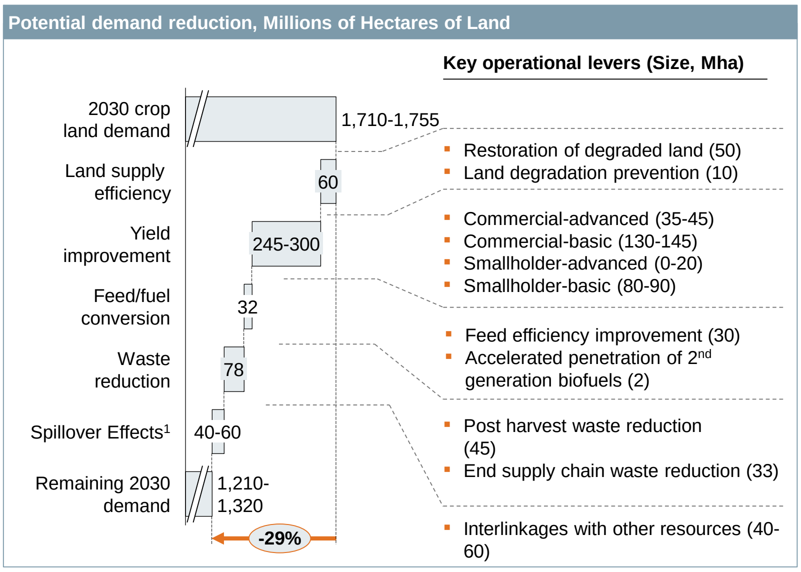
[68] E M Richards, *The forest ejidos of south-east Mexico: A case study of participatory natural forest management,* Rural Development Forestry Network, Network Paper 13c, Summer 1992.

4. Sizing the benefits and the investment opportunity

What is the size of the potential benefits from adopting these sustainable land use initiatives and how much would it cost? Sizing the potential economic benefits in a holistic fashion is difficult, given the multitude of inter-connecting factors. However, there are estimates on the potential scale of environmental benefits from adopting these sustainable land use initiatives. From a top-down perspective, McKinsey Global Institute estimated that by implementing a range of land productivity levers (including smallholder efficiency, food waste and restoring degraded land), it would be possible to reduce the 'business-as-usual' requirements on land demand in 2030 by around 20 percent, or in other words, requiring no new net additions of land (Exhibit 5).[69] This rough approximation of potential was used as one of the inputs to inform the size of the opportunity from each lever and the associated investment requirements.

EXHIBIT 5

Based on global analysis, McKinsey Global Institute identified land productivity levers that could reduce land demand by 30% by 2030



1 Represent the net savings in use of a given resource from improvements in productivity of other natural resources
SOURCE: McKinsey Global Institute

From a bottom-up perspective, there a range of country studies in tropical forest rich countries. For example, McKinsey & Company found that eliminating deforestation in Brazil by 2030 could account for over 70 percent of the entire carbon abatement opportunities in the country.[70]

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69 *Resource revolution: Meeting the world's energy, materials, food, and water needs*, McKinsey Global Institute, November 2011.

70 *Pathways to a low carbon economy for Brazil*, McKinsey & Company, 2009.

Similarly, in the DRC, opportunities were identified which could avoid 13 million hectares of deforestation and 23 million hectares of land degradation by 2030.[71]

The investment opportunity associated with sustainable land use approaches was broken down into two broad components:[72]

1. **Investment opportunities potentially amenable to private sector participation.** For the sustainable land use levers described earlier, we sought to understand the investment requirements. Past academic evidence has shown that the majority of these levers are 'potentially' attractive to private sector investors, albeit once certain key risks are mitigated (something we discuss in further detail later).
2. **Enabling investments.** These are the incremental costs that are critical to the overall success of the sustainable land use strategy, but are not solely related to any one specific intervention, and may be difficult to encourage private sector participation. These include:
   - *Basic institutional readiness:* costs associated with establishing the basic institutional structures needed to support sustainable land use, such as training government officials.
   - *Land use policy:* the incremental costs associated with developing regulatory responses to support sustainable land use and opportunities for sustainable livelihoods (e.g., developing a spatial plan and land certification).
   - *Community engagement:* the incremental costs associated with developing and implementing the processes for engaging with local communities.
   - *Infrastructure:* the incremental costs responsible for developing the technology and systems infrastructure or soft infrastructure (e.g., market information, fire brigades, education, health) and hard infrastructure (e.g., electricity, roads) to support sustainable land use and sustainable livelihoods.

Based on this analysis, we found that up to $167 billion investment is needed annually to 2030, of which 96 percent (equivalent to roughly $161 billion) is potentially amenable to private sector participation (Exhibit 6).[73] The remaining $6 billion will likely require some form of government, donor or multilateral support for initiatives such as spatial planning and land tenure support. To put this in context, the size of the total investment opportunity is 60 percent of the size of the current expenditure on renewable energies ($270 billion per annum).

How did this figure compare to other estimates? Finding benchmarks with the exact scope as being used here is difficult, but based on available data, the estimates appear broadly consistent with previous analyses of investment requirements. McKinsey Global Institute estimated that $310 billion is currently invested annually in the land sector, and this could rise to

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[71] *The Democratic Republic of Congo's REDD+ Potential, Ministry of Environment*, Nature Conservation and Tourism, December 2009.

[72] See the appendix for further details on the methodology for the investment sizing.

[73] We stress the phase "potentially" as the amenability to private sector participation depends crucially on the risk-return profile which is very context specific.

up to $435 billion through the adoption of various land and food productivity levers (beyond "business-as-usual" improvements).[74] The higher number in their analysis can be attributed to their focus on all agricultural land (not just tropical forest areas), as well as their focus on 'downstream' levers such as food waste in the supply chain. A more recent study by Credit Suisse and McKinsey has estimated that $300 to $400 billion per year is needed to preserve healthy ecosystems on land and in the oceans. Again, the broader scope of resources considered and the global nature of that work can explain much of the differences.[75] The Food and Agriculture Organization of the United Nations estimates an annual investment requirement of $210 billion up to 2050 for crop and livestock production in developing countries.[76] Whilst this amount is more than is estimated here, this is likely due to differences in base year, country coverage and the range of levers considered.

There are a number of caveats with this analysis, which imply that these estimates should be positioned as "directional" estimates. First, the cost estimates are based on case studies and whilst efforts have been made to allow for geographical variations, the particular costs in a given context could vary significantly from those used in the analysis. Second, the analysis does not distinguish between total and incremental investment opportunities from adopting sustainable land use initiatives. For example, in the case of large-scale farm yields, the investment sizing is based on estimated costs for mechanizing farms, but not the cost of adopting a sustainable versus a "business-as-usual" approach. Third, we have made assumptions on the size of the opportunity that could be potentially realised with each lever. This is based on past academic literature,[77] but there could be significant variation in investment requirements depending on assumptions made in this area. In the appendix we have included all of the underlying assumptions used in this analysis and our hope is that it can provide a foundation for others to build upon with more granular estimates.

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[74] *Resource revolution: Meeting the world's energy, materials, food, and water needs*, McKinsey Global Institute, November 2011.

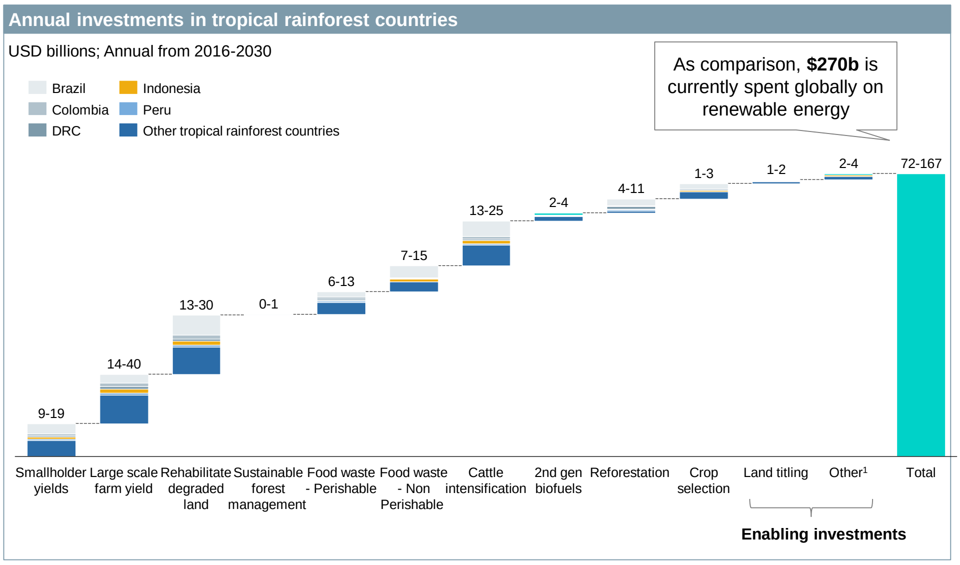
[75] *Conservation Finance From Niche to Mainstream: The Building of an Institutional Asset Class*, Credit Suisse and the McKinsey Center for Business and Environment, January 2016.

[76] Josef Schmidhuber, Jelle Bruinsma and Gerold Boedeker, *Capital Requirements for agriculture in developing countries to 2050,* Food and Agriculture Organization of the United Nations, 2009.

[77] See for example, *Resource revolution: Meeting the world's energy, materials, food, and water needs*, McKinsey Global Institute, November 2011.

EXHIBIT 6

For the sustainable land use levers, there is an annual investment opportunity of around $160b



1 Others includes spatial planning, training of government officials, community engagement and soft infrastructure.
SOURCE: McKinsey Global Institute; FAO; TNC; Investment case studies; AlphaBeta analysis

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Some of the areas have particularly high investment requirements. For example, implementing a cold supply chain in developing countries requires significant investment. A cold storage system with a capacity of 30,000 tonnes could have an annualized cost in China of more than $100 million.[78] Similarly, capital required for 2G biofuel plants is significant; the International Energy Agency has estimated that the investment cost for a commercial-scale 2G biofuel plant is up to 10 times more than that of a 1G biofuel plant.[79]

At a country-level, the largest investment opportunities are in Brazil, given its large share of agricultural land among tropical rainforest countries. But there are also large commercial opportunities in countries such as the Democratic Republic of the Congo (DRC) and Indonesia. In Indonesia for example, agriculture revenue could potentially more than triple by 2030 to reach $450 billion through a range of sustainable land use levers.[80]

How do these investment requirements compare to current investment in the area? Whilst getting exact numbers is difficult, it is useful to compare the investment requirements to the assets under management of investment funds created to invest in ecological and regenerative

78 *Resource revolution: Meeting the world's energy, materials, food, and water needs*, McKinsey Global Institute, November 2011.

79 *Sustainable Production of Second-Generation Biofuels,* International Energy Agency, February 2010

80 *The archipelago economy: Unleashing Indonesia's potential*, McKinsey Global Institute, September 2012.

agriculture and food systems. Currently these funds have just over USD 500 million in assets under management.[81] Even if we consider broader agricultural funds, the capital base of the 31 leading funds amounts to just under USD 4 billion.[82] Whilst large, this is less than 3 percent of the annual investment requirements.

Furthermore, the investment opportunity in sustainable land use has potentially very attractive returns for private investors. From a private-sector investor perspective, McKinsey Global Institute has estimated that 72 percent of opportunities (which have a high overlap with those we consider in our analysis) have returns greater than 10 percent.[83] After adjusting for subsidies and carbon (at a price of $30 per tonne), all of the land opportunities have returns greater than 10 percent (Exhibit 7).

Based on investor interviews and a review of investment returns in this area, some particular sustainable land use opportunities were found to have particularly large returns. These include improving commercial farm yields, cattle intensification, postharvest non-perishable food waste, prevention of land degradation and restoring moderately degraded land. For example, planting palm oil on degraded, deforested land in Indonesia (rather than clearing virgin forest) for example, could generate an internal rate of return of 14-16%.[84] Cattle intensification also has high potential returns – in Para in Brazil, the returns from sustainable cattle intensification are estimated to be 10-15% over 12 years.[85]

This returns data is consistent with what private sector investors have been able to achieve through sustainability land use investments. The average range of net IRRs for forestry funds was 10-13 percent.[86] Some have performed even better. For example, Quadris Environmental Forestry Fund invests directly in Floresteca SA, the world’s largest teak plantation company, based in Brazil. The three year performance average across the eight funds has been in the region of 16%.

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81 *The investment case for ecological farming (white paper),* Paul McMahon, SLM Partners, January 2016.

82 *Agricultural investment funds for developing countries*, FAO, 2010.

83 *Resource revolution: Meeting the world’s energy, materials, food, and water needs*, McKinsey Global Institute, November 2011.

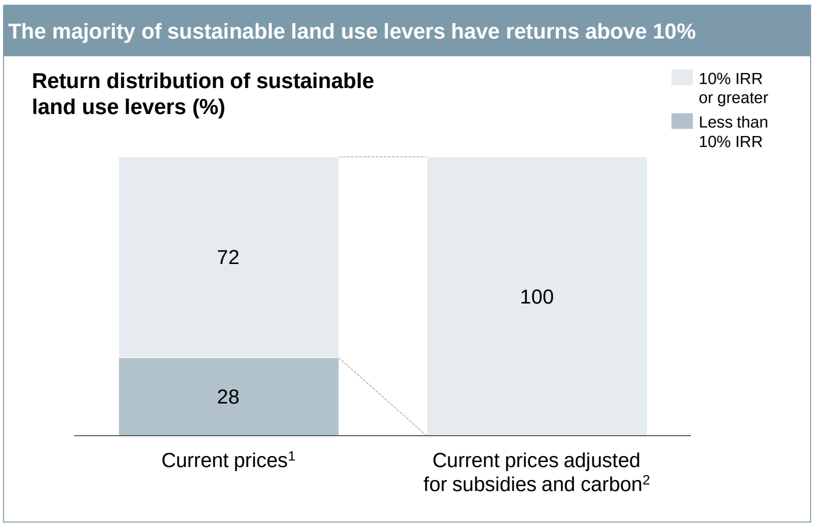
84 *Business Brief: Opportunity lost*, Economics of Land Degradation, 2013.

85 Green growth and sustainable cattle intensification in Para, The Nature Conservancy, December 1, 2015.

86 *Forest Investment Review*, Forum for the Future, July 2009.

EXHIBIT 7

Many of the sustainable land use levers have attractive returns



1 Internal rate of return (IRR) based on current prices including taxes and subsidies.
2 IRR based on current prices adjusted for subsidies in water, energy, and food plus a price of $30 per tonne of carbon dioxide equivalent emissions.
SOURCE: McKinsey Global Institute; Forest Investment Review; Literature review; AlphaBeta interviews

Given these potentially attractive returns, why are not more of these sustainable land use investments being pursued? Based on our interviews with investors, a number of key risks were identified:

- **Political risk.** This was one of the largest areas of risk, including factors such as the risk of cancellation of the manager/owner's concession or lease by the government; import/export embargo imposed against the country; forced abandonment or divestiture of the asset by the government; selective discrimination against the investor, and land-tenure related risks. The lack of clarity about land ownership was identified by investors as clearly the major source of concern in this category of risk.[87] Academic evidence shows that land tenure issues can inflate operating costs as much as 29 times over a normal baseline scenario.[88] The costs range from delay of projects to outright expropriation of land. Land tenure issues also increase the costs and risks associated

87 This finding is consistent with past investor research in this area. For example, the Clinton Foundation (2008) surveyed a group of 27 institutional investors and found political risk (including land-tenure issues) to be the largest area of concern for the investors.

88 *The Financial Risks of Insecure Land Tenure: An Investment View*, The Munden Project, December 2012.

with financing. For example, forests and forest land are often not accepted as collateral because of uncertain tenure.[89]

- **Policy risk.** This relates to risks related to incentive arrangements (e.g., carbon offsets) or transaction costs (e.g., costs associated with aggregating smallholder farmers into a collective arrangement of sufficient investible scale).
- **Technology risk.** This relates to risks associated with immature, and therefore, risky technologies. This is generally less of an issue for most sustainable land use levers, but it is important for some, such as second generation biofuels. Key technologies such as ligno-cellulosic (LC) are still at an early stage of moving into industrial scale application with falling costs.
- **Currency risk.** This relates to risks associated with currency volatility. For example, there are often insufficiently liquid markets to enable effective hedging. The currency risk varies depending on whether products are sold to international or local markets, and the currency in which key inputs are paid.

These risks drive expectations of returns among investors that could range from 8 to 10 percent (in the case of standard forestry projects using mature technologies in developed markets) up to as high as 19 percent in some developing markets (Exhibit 8).[90] This is consistent with feedback from investors. In a review of investors as part of The Forest Investment Review, it was shown that commercial investors expected returns from African forestry between the high teens to 20% net per annum.[91] Return requirements are also significantly higher for newer investors. McKinsey found on average new forestry investors to have a hurdle rate of 15–20%, several percentage points higher than experienced investors in the space.[92]

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89 FAO (2012). *Timberland in Institutional Investment Portfolios: Can Significant Investment Reach Emerging Markets.* Report by R. Glauner, J. A. Rinehart, P. D'Anieri, M. Boscolo, H. Savenije. Forestry Policy and Institutions Working Paper No. 31. Rome.

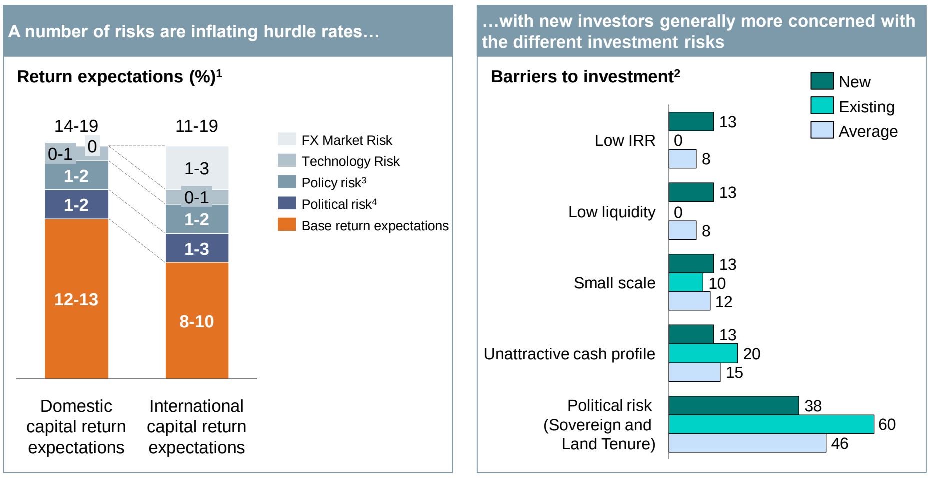
90 Project Catalyst, *Making fast start finance work*, Briefing Paper, ClimateWorks Foundation and European Climate Foundation, June 7, 2010.

91 *Forest Investment Review*, Forum for the Future, July 2009.

92 *Forest Investment Review*, Forum for the Future, July 2009.

EXHIBIT 8

A number of risk factors inflate the hurdle rate demanded by investors for sustainable land use projects



1 Based on interviews with investors for a range of sustainable land use projects.
2 McKinsey survey of investors (ranking out of 100).
3 Includes risks related to incentive arrangements (e.g., carbon offsets) or transaction costs (e.g., costs associated with aggregating smallholder farmers into a collective arrangement of sufficient investible scale)..
4 Includes both sovereign and land-tenure related risks.
SOURCE: Project Catalyst; McKinsey; Forest Investment Review; AlphaBeta interviews

In addition to these risks, there are other challenges. These include high search costs involved in identifying potential projects; transaction costs involved in developing projects (particularly those involving a large number of actors, such as smallholder-related projects); and being able to support the necessary mind-set shift in farmers that will ensure a successful transition to more sustainable practices.[93]

93 *Conservation Finance From Niche to Mainstream: The Building of an Institutional Asset Class*, Credit Suisse and the McKinsey Center for Business and Environment, January 2016.

5. Implications for TFA agenda

Our analysis suggests three broad areas could be useful for TFA to consider going forward:

1. **Strengthen the fact base.** There is a need to strengthen the fact base in this area in a number of ways. First, more 'jurisdictional-wide' analysis of economic impacts that go beyond isolated interventions will be important to demonstrating that these sustainable land use interventions are significantly positive at scale. This is particularly important for issues such as smallholder and large scale farm yield improvement where there is already clear positive evidence of strong positive economic impact at the intervention level, but it is less clear if these impacts are significant at the regional level. Second, more sophisticated control group approaches will be useful for providing a more robust assessment of cause and effect. Third, more 'meta-analyses' are needed that understand what works in each area and under what conditions. Our research review found that in many cases the 'devil is in the detail', and how interventions were implemented had a significant bearing on the degree of economic impact. Fourth, in some areas (e.g., second generation biofuels, feed efficiency), there are a lack of case studies to analyse the economic impact on these interventions. Finally, as explained in the previous chapter, there are a number of areas in which the sizing of the investment opportunities could be strengthened.
2. **Work with stakeholders to address the risks and barriers constraining investment.** There is an opportunity for TFA to work with investors, donors, multilateral organizations and local governments to help address the risks and barriers constraining investment in this area. The analysis showed that this could have significant impact on new investors in this space who tend to have significantly higher perceived values of risk and hence higher hurdle rates on returns. Opportunities include working with donor organizations such as DFID and NORAD to scale up investment in projects with 'demonstration effects'; to find ways to bring investors and project developers together to develop a pipeline of investible projects; to explore opportunities to expand the coverage of existing institutions covering country risk such as the Multilateral Investment Guarantee Agency or the Overseas Private Investment Corporation; to work with donors and multilateral organizations on reducing land risks through scaling up land titling approaches; and to reduce currency risk by seeking to expand the coverage of long-term local currency-hedging products. This is the approach taken by the TCX Currency Exchange Fund.[94]
3. **Engage policymakers and investors.** There is a large opportunity to engage policymakers and investors to help them better understand the size of the opportunity and to support the mind-set shift required to achieve a significant pace of change at scale. From an investor perspective, particularly little is known about the long-term profitability of investment vehicles in the sustainable land use space. From a policymaker perspective, there is a real case for sharing of best practice approaches on sustainable land use interventions and how to maximize local economic impacts. Our analysis has found a number of different and

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94 See the fund's Web site for more detail at https://www.tcxfund.com/.

often innovative approaches being taken in different geographies, but it is not clear to what degree these approaches are being effectively shared. Another avenue here could be to incorporate sustainability issues into trade agreements. For example, the China-South America Sustainable Soy Trade Platform includes sharing best practices on supply chain management to ensure soy imported to the China market is in compliance with local laws (e.g. the Brazilian Forest Code).

Appendix: Methodology for investment sizing

Opportunity	Description	Sizing assumptions	Cost assumptions	Sources
Intervention-specific levers				
Large-scale farms	Improving yields on large-scale farms (more than 2 hectares)	Based on FAO and the McKinsey Global institute study we have assumed large scale farms to be 70% of agricultural land. Assuming that 20-40% of large-scale land area for Brazil and 10-30% for all other countries would lead to yield improvements.	*Advanced economies (e.g., Brazil):* Capex of $80/hectare for improved equipment for advanced precision farming. *Less advanced economies (e.g., Indonesia, DRC):* Capex of $455/hectare for improved capital equipment).	McKinsey Global Institute (based on expert interviews)[95]
Smallholder farm yields	Improving yields on smallholder farms (less than 2 hectares)	Based on FAO and McKinsey work, smallholder farms are assumed to be 30% of agricultural (non-cattle) land. Yield improvements applied to 10-20% of the smallholder farms.	Capex of $600/hectare for improved capital equipment.	McKinsey Global Institute (based on expert interviews)
Land degradation	Reducing the degradation of land and restoring land that is already degraded	Expert interviews suggest it is possible to restore 80% of land suffering low to moderate levels of degradation; and 60% in the case of severe to very severe degradation. Assume that 5-10% of moderately degraded land opportunity will be realised; and 2-4% of severely degraded land opportunity will be realised.	*Moderate degradation restoration:* Sample of case studies from Niger, Nicaragua, Ethiopia, South Africa, Bolivia, Kyrgyzstan, China, and Peru. Capex of $690/hectare. *Severe degradation restoration:* Sample of case studies from Tajikistan and Nepal. Capex of $2,800/hectare.	Based on case studies from World Overview of Conservation Approaches and Techniques.

[95] *Resource revolution: Meeting the world's energy, materials, food, and water needs*, McKinsey Global Institute, November 2011.

Opportunity	Description	Sizing assumptions	Cost assumptions	Sources
Sustainable forestry management	Reduced impact logging approaches	Apply to 20-30% of non-degraded land (which is 67% of agricultural land).	Prevention of land degradation: capex of $2-$10/hectare based on costs to implement no-till agriculture across irrigated and rain-fed croplands.	TBI (http://theborneoinitiative.org/)
Food waste	Reducing post-harvest food waste (excludes food waste in the supply chain or end consumer waste)	Apply to 10-20% of the agricultural land under perishable/non-perishable production.	Postharvest waste: *Non-perishables:* capex of $200/hectare to prevent waste during storage and transportation. *Perishables:* capex of $140/hectare to prevent waste during storage and transportation.	McKinsey Global Institute
Cattle intensification	Sustainable cattle intensification, including through improved feed supplements	Apply to 10-20% of cattle intensive agricultural land.	$459 per hectare	TNC case study for Para
Accelerated penetration of second-generation biofuels	Ramp up of investment into second-generation biofuels by accelerating production of second-generation plants	Country estimates are based on share of agriculture land.	Biofuels market is estimated to grow at a CAGR of 49.4% over 2014 - 2020 and it is expected to be valued at $23.9 billion in 2020.	Allied Market research
Reforest	Replanting of trees. Includes costs for purchasing harvesting equipment and planning software.	1.5 billion hectares globally of land that can be restored with trees, plants and other land use, according to Global Partnership of Forest Landscape Restoration (GPFLR), South Dakota State University and the IUCN. Applied country breakdowns based on share of forest area. Assume 1-2% of opportunity realised.	$1,000-$1,500 per hectare	Expert input and Global Partnership of Forest Landscape Restoration (GPFLR), WRI, South Dakota State University and the IUCN.
Agroforestry	Crop selection and mix approaches	Apply to 10-20% of total agricultural (non-cattle) land by country	Capex of $80 per hectare	Expert input

Opportunity	Description	Sizing assumptions	Cost assumptions	Sources
Cross-cutting enablers				
Land certification	Implementation of lend certification programmes	Assume it applies to 40-60% of smallholder land titles in Africa; 30-50% in Indonesia and 10-20% in Latin America	$80 per hectare	World Bank
Spatial planning	Establish spatial plan			
Training government officials	Train government officials on sustainable land use policy frameworks			
Community engagement	Community engagement processes including behavioural change and local enforcement	Assume it applies to 40-60% of arable land in Africa; 30-50% in Indonesia and 10-20% in Latin America	$4.6 million annually for 120,000 hectares (combines many of these items) – equates to $38 per hectare	Indonesia ex-Mega Rice project
Core infrastructure	Soft infrastructure (e.g., market information, fire brigades, education, health) and hard infrastructure (e.g., electricity, roads)			