INPUT TO THE REPORT OF THE HIGH-LEVEL PANEL ON GLOBAL ASSESSMENT OF RESOURCES FOR IMPLEMENTING THE STRATEGIC PLAN FOR BIODIVERSITY 2011-2020

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CLUSTER REPORT ON RESOURCE REQUIREMENTS FOR THE AICHI BIODIVERSITY TARGETS

TARGET 7: AGRICULTURE COMPONENT

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ESTIMATING THE RESOURCE REQUIREMENTS FOR MEETING AICHI TARGET 7 WITHIN THE AGRICULTURE CLUSTER (2011-2020)

INTRODUCTION TO THE TARGET

At the tenth CBD meeting, in October 2010, the most recent addition of the 'The Strategic Plan for Biodiversity 2011-2020' was confirmed, which included the 20 Aichi Targets, the full set of targets can be seen in the Appendix. In order to achieve these targets, the resource requirements for each one must be established. Although there are 20 targets, assessing the resource requirements for all these targets is beyond the scope of one piece of work. Thus, in order to achieve an in-depth and accurate estimation of the resource requirements necessary in achieving each target, they will be assessed individually. The focus of this report will be Target 7.

'Target 7: By 2020, areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity' (CBD).

Our focus is mainly on the agricultural element[1] and the importance of biodiversity within agroecosystems and the ways in which current agricultural practices can be made more sustainable in terms of their impacts on system biodiversity.

In recent years doubt has grown over the ability of global agroecosystems to meet global food demand in a sustainable way (IAASTD 2009). Agricultural production must continue to grow to feed the growing global population, but the point of this report is to outline ways to do so whilst also reducing / stopping the negative impacts of agricultural growth. This objective touches on current debate on agricultural productivity and sustainable intensification (SI - see below), with one diversion from that debate. At the outset, we are assuming our definition of biodiversity-friendly agriculture implies a *production* rather than consumption side focus; i.e. the focus here is largely limited to within the farm gate. However, some elements of the SI literature highlight post-farm gate food use (e.g. reduction of post harvest loss) and potentially the issue of consumption. For example, decisions to adopt organic standards in low income countries may be driven by retailer (and ultimately consumer) pressure in OECD countries. Alternatively, some literature, specifically in relation to livestock products, highlights the essential issue of over-consumption as the fundamental problem leading to biodiversity loss from agricultural intensification and expansion. Addressing these demand-side issues is beyond the scope of this report. However, it is important to note that what appears to be a technical fix from a production perspective cannot be viewed as somehow independent from the demand side, which is where much of the finance and (market) incentive will derive. In other words, our cost calculation needs to be hedged with some understanding of how market demand will shape production. This will also have a bearing on the proportions of private versus public sector financing of system change (see below).

As defined Target 7 is still vague and cannot be obviously defined and interpreted using any readily available technical definition of agricultural sustainability or "biodiversity-friendly" agriculture that is universally applicable in the wide variety of global farming systems. There is essentially no obvious production template as a basis for benchmarking cost requirements. Elements that are appropriate to small scale systems in some parts of the world may not be applicable in other systems. Although we might consider OECD farming as a somehow technically proficient benchmark on some environmental criteria, the literature suggests technical deficiencies in other aspects. Similarly, although appealing, reversion to more low input or organic systems is unlikely to be a politically acceptable objective in terms of implicit opportunity costs and for meeting food security objectives. Ultimately we have to consider (costs relating to) technical measures that are most likely to affect sustainable global agricultural production more generally. This means considering the best ways to affect technology transfer and aggregate behavioural change in production decisions of millions of formal and informal producers. Recall that the first objective of the majority of these producers will be food production. We

[1] Aquaculture and forestry being addressed in other targets

therefore need to consider where this objective is (or can be made) consistent with a biodiversity objective that is in most cases an indirect outcome of agriculture[2].

Target 7 can be informed by a significant body of research considering sustainable agriculture more generally (Pretty et al 2006) and more recent literature seeking to define sustainable intensification (SI) in agriculture (e.g. Tscharntkea et al. 2012, GOS 2011). Earlier interest in sustainable agriculture derived partly out of concern about poor yields in low income (predominantly) small holder production. The focus here was predominately the improvement in resource productivity with no specific focus on biodiversity outcomes. More recent SI literature has been given considerable impetus by renewed concern over global food security and the environmental and social trade offs implicit in a drive to feed a population of 9 billion people. The SI literature initially recognises the contested definition of sustainability in the agricultural context, but also acknowledges the competing tensions to deliver on targets for national and global food security, local livelihoods (including indigenous foods), biodiversity conservation and the reduction of greenhouse gas emissions from the sector. From the perspective of biodiversity conservation, the SI agenda attempts to balance these competing objectives. There is recognition that it is important to stabilise production on existing land area to prevent further expansion into remaining biodiversity habitat (land sparing versus land sharing). This makes sense given the existing global stock of land (under intensive production) relative to remaining wild areas (figure 1). .

The SI literature also recognises that it does not make sense to focus uniquely on agricultural reform that targets one of these objectives (e.g. biodiversity) to the exclusion of other more global drivers of biodiversity loss (emissions reduction and climate change). Thus the literature attempts to find common interventions on both production and consumption sides to remove threats, and to define the environmental, economic and social limits to agricultural growth.

The SI debate recognises the plurality of farming systems and the ways in which sustainability can be interpreted along a spectrum encompassing organic low input systems to more intensive high input industrialised agriculture. It makes no prior value judgements about the ethical basis of the characteristics of neither these different systems, nor their applicability in different socio economic and ecological contexts. But for the purposes of this report, the literature does help to narrow down a shorter list of technical interventions that can be seen as general investment needs in large parts of global agriculture. We therefore pursue this literature as a pragmatic means to defining the basis of our cost estimates.

Note that the measures implied under this target have potential impacts on a range of policy areas; specifically, water policy, forestry and energy. It is also important to highlight the potential impacts on local, national and international food security objectives. The latter may be influenced by altered patterns of production and international trade. These impacts are listed as follows.

Table 1

Policy area	Potential impact
Water policy	Potential quantity and quality impacts from reduced irrigation (demand) and excess nutrient run-off
Forestry	Land sparing will likely reduce extensive land use and encroachment into forest margins
Energy	Potential trade offs between system diversity and (formal and informal) demand for biomass and other bioenergy crops Altered land use and implications for water demand (see above) with potentially beneficial consequences for hydro infrastructure

[2] An obvious exception being in terms of the deliberate conservation of plant and animal genetic resources in situ or in ex situ collections.

Food security & nutrition	The evidence base on intensification (land sparing) and consistent yield maintenance is poor. Evidence suggests that more diverse systems may come at the expense of a yield penalty (e.g. Wale 2008). In other words, biodiversity conservation implies an opportunity cost.

Links to other targets

As the predominant land use associated with significant external impact, agriculture inevitably interfaces other sector targets. Indeed, it is possible to draw a link between the sector and almost every other Aichi target, thereby complicating the apportionment of intervention costs.

The most conspicuous links are to 3 (incentives), 5 (e.g. coral reefs), 6 (e.g. restoration, aquaculture, coral reefs), 8 (pollution), 10 (coral reefs), 11 (PAs) 13 (genetics), 14 (restoration). Links can also be made for targets on enabling and awareness expenditures. Later in this report, we also highlight potential links to macro economic policy.

The most problematic overlap concerns the issue of diffuse pollution from agriculture and apportioning a cost to this activity that is not double counted under target 8 and potentially in any other sector impacted by water and atmospheric emissions from agriculture (and product life cycles). Target 8 apparently includes measures to reduce nutrient runoff from upstream agricultural operations through the use of best management practices. Although we have been in contact with the contractors for 8, this issue is unresolved. We suggest that target 7 will actually deliver some of the objective in target 8.

Clarification of overlap with Target 13 is important, specifically the costs of ex situ collections to safeguard plant and animal genetic resources. This is significant since Target 7 leaves scope for debate about what biodiversity we are aiming to safeguard. For Target 13 could account for much of the plant and animal genetic material in ex situ collections. Some recent cost estimates for plant genetic resources have been produced (see Koo et al 2002). The implication of target 7 is that we are concerned less with the diversity of agriculture per se, rather with its role as a proximate driver of habitat loss. However, the genetic target 13 (safeguarding existing genetic resources) is distinct from proactive breeding opportunities and using genetics to (sustainably) intensify production, for example by improving animal feed conversion ratios. The use of genetic improvement in plant and animal breeding offers considerable scope for increasing resource productivity or use efficiency (improving the ratio of outputs to inputs), which is an element of SI. At this point, the convergence of public and private genetic research in agriculture is such that some of target 13 objectives will be met by 7.

ACTIONS

If we are concerned with altering agricultural practice then the scope for potential interventions becomes very wide indeed. A starting point (though not one clearly considered in the guidance) is to think about measures that could be economically efficient or else are win –win.

To be more pragmatic the definition and identification of actions and interventions should further consider the scale at which it is meaningful to consider these with a view to global cost aggregation.

A fully forensic study would consider the widest variety of production systems and the suite of interventions that could potentially move production from a baseline trajectory onto one that could be deemed biodiversity-friendly. However, the combination of systems, agro-ecological environments, baselines and incremental measures leads us to conclude that for this target this task is even more complex than the analytical hierarchy suggested by Barrera (2012) Table 2.

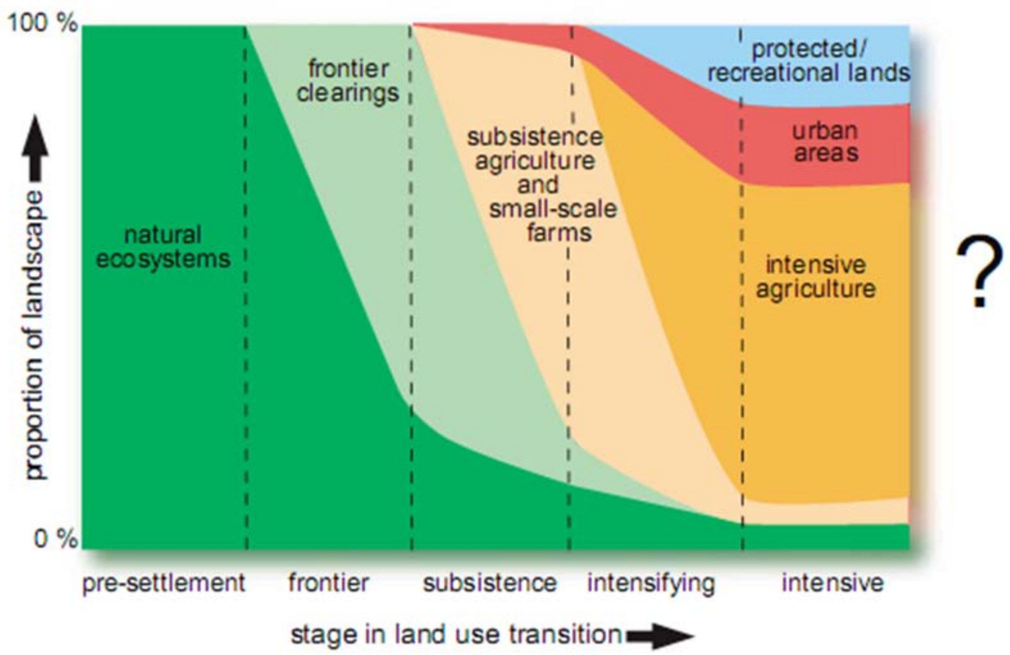
Table 2 Methods to Calculate Resource Requirements (Barrera 2012)

Method	Name	Description

A	Simple	Estimates from literature based on country level
B	Middle of the Road	Estimates relying on information from within the country itself or information from other places that is suitable for extrapolation
C	Detailed/ Complex	Estimates which rely on expert analysis to establish an estimation for a specific measure and a related work plan within a specific country. Most desirably, within country research

Noting that there is no technical definition of biodiversity-friendly or even sustainable agriculture, we simplify the task by considering measures that can be globally applicable in a variety of contexts. Our report draws on an extensive review of the SI literature with the aim of identifying a shortlist of globally applicable actions. Much of this literature departs from the observation of the implications of land conversion trajectories (figure 1 Foley 2005) and the debate around land sparing versus land sharing (Box 1), as well as forms of integration in production systems. In the light of much of the historical evidence on habitat loss there is compelling case for promotion of the land sparing narrative, with implications for the way production can be intensified on existing land. However, it is important to note that there is no consensus on the overall impact of either strategy for biodiversity, with considerable system and regional variation in the impacts of either approach. Some authors (e.g. Tscharntke et al. 2011) highlight how low input smallholdings that dominate in many developing countries are essentially multifunctional (and biodiversity-friendly) by default.

Figure 1: Land Transition (Foley et al. 2005)



Box 1 Contested themes within the sustainable intensification literature

Box 1

Land Sparing vs Land Sharing

Production yield decisions by agroecosystem managers can impact the total area of land under farming.

- *Land sharing: if conservational agriculture is adopted in a large agroecosystem, mixing with other sources of biodiversity. This could, increase biodiversity within the farm, however potentially lower yields. This might cause prices increases in the general market, thus further land expansion elsewhere.*
- *Land Sparing: If intensification was to take place, this land conversion could be avoided. However, concern exists over the type of intensification and the risk the intensification may take place alongside the expansion.*

(Tscharntke et al. 2011) claim that although traditionally land sharing is deemed more biodiversity sustainable, sensitive intensification i.e. land sparing, should be preferred as there is no loss of biological control, land sparing compliments small farm holdings more so than land sharing and avoids the risk of more waste through live stock which occurs through land sharing.

The Scope of Integration

- *Vertical Integration: Developing technology and methods for increasing productivity in an intensively biodiversity sustainable manner at global level*
- *Horizontal Integration: analysing and restructuring agricultural markets and conserving/ increasing biodiversity at current production levels at a regional/ national/ local level (Kassam et al. 2010) hence increasing production yields in the long term*

The land sparing/sharing literatures are useful in highlighting alternative definitions and methods of intensification that take us closer to a range of measures that can be a possible basis for a global costing exercise. (e.g. Revkin 2011 or Pingali (2012) see figure 2 and 3

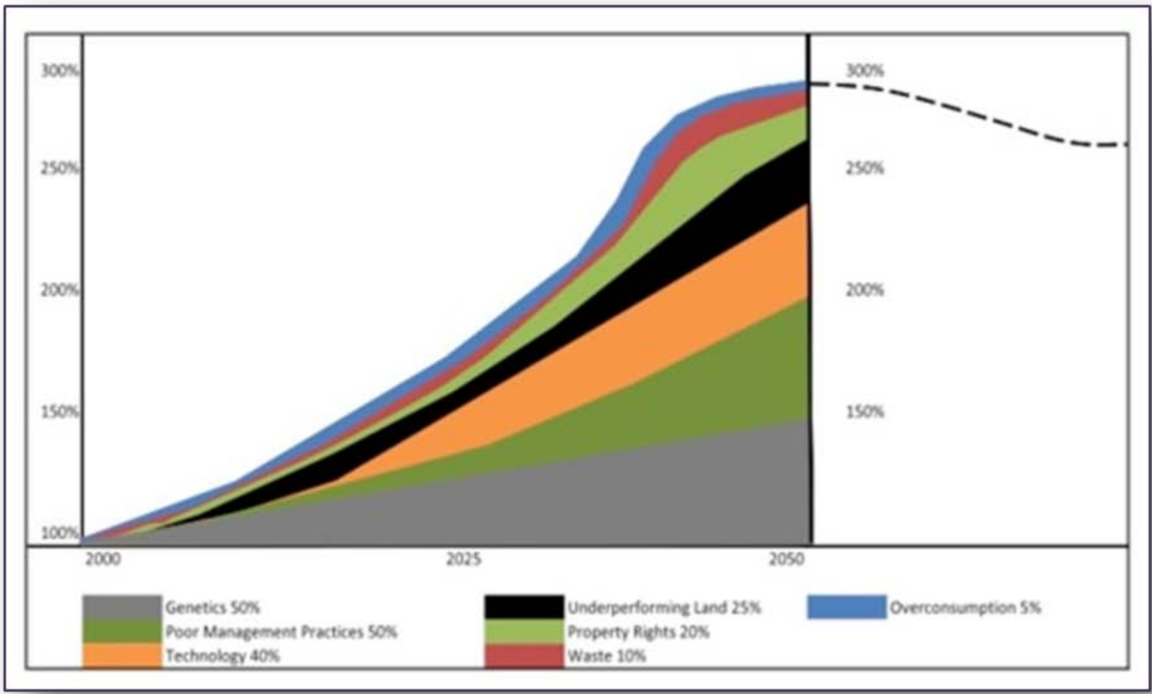


Figure 2: Increasing agroecosystem Production by 2050 without Land Expansion (Revkin 2011)

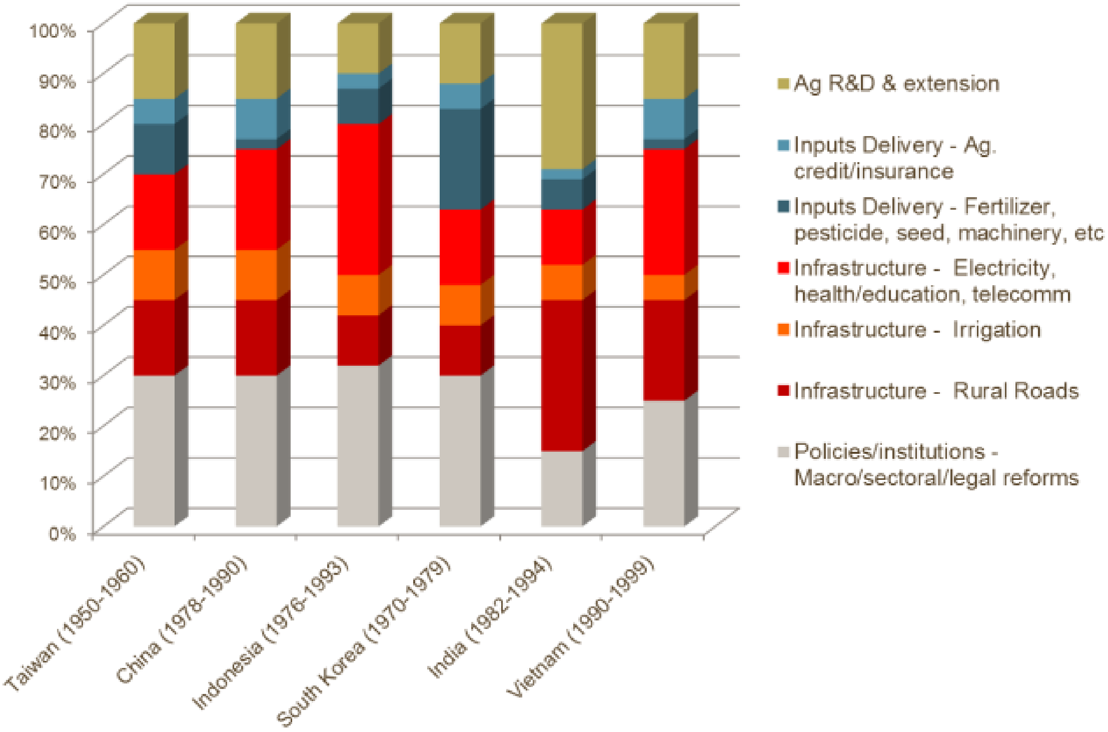


Figure 3 measures underlying global agricultural productivity growth

We identify 6 measures (with sub categories) detailed in Table x. The list is not exhaustive and their proven impact on biodiversity is typically indirect. Some of the measures are self-evident. Measure 1 is based on the premise we need to be able to measure what we want to manage, and that there is a need for an improved evidence base for defining biodiversity metrics specifically in the context of agriculture. This would largely move debate forward in relation to exactly what facets of biodiversity agriculture should be targeting[3]. Measure 2 on the improved use of plant and genetics (selective breeding and potential genetics and GM) to improve resource use efficiency, a component of sustainable intensification. Measure 3 implies that extension services (where they exist) probably need training to improve biodiversity awareness and extension practices (e.g. in relation to the use of selective breeding and genetics). Measure 4 aims to improve production efficiency (including post harvest losses) and simultaneously provides the incentive to internalise externalities while providing the relevant signals to the demand side (as previously mentioned). Measure 5 identifies a range of more field-level practices. Measure 6 is more focused on arguably the most egregious *proximate* institutional failure contributing to land degradation in hotspot areas[4]. We do not identify any other macro level interventions (e.g. agricultural trade liberalisation), since this would likely take us outside the immediate remit of the study and we assume these to be addressed under the macroeconomic target. We are uncertain as to the content of that target, but suggest possible overlaps. For example, import restrictions and tariffs in developed countries, exchange rate misalignment, high inflation and public procurement of agricultural production[5] can all have identifiable impacts on agricultural practices and land use intensity.

Table 3 Target 7 measures

Measure	
1	Establish a global measurement scheme for agroecosystem biodiversity
2	Global R& D into agroecosystem genetics a. Focus on increased pest/ disturbance resistance b. Focus on increased nutritional uptake/ productivity
3	Establishing regional extension costs and needs
4	Restructuring the production side of the agricultural market a. Increased market access and transport infrastructure for producers b. Improved access to variety of seeds for producers c. Certification of BISA[6] goods
5	Encouraging integrated conservational agriculture in a BISA setting a. No/ reduced tillage b. Reduced external inputs c. Crop rotation and polyculture d. Effective livestock management e. Effective and economically efficient irrigation
6	Effective adaptation of policy and institutions: property rights

[3] We had originally anticipated this element as a systematic review as part of this study, however the extent of review protocols requires more time than was available.

[4] Arguable because the issue of subsidies could actually be more damaging *fundamental* driver

[5] This is more strictly a micro economic issue - i.e. use of government monopsony.

[6] Biodiversity intensive sustainable agriculture

The main problem faced with in trying to cost these measures is that we have no rigorous baelie. In other words, it is demonstrably not the case that current expenditure in these areas is zero, so the appropriate question relates to the incremental cost over current targeted efforts.

METHOD OF ASSESSMENT

There are several potential sources of information that could inform cost estimates but all are problematic in terms of the potential to cover the vast array of potential interventions implied by even a short list of measures

- Private sector expenditures
- Existing qualitative and quantitative literature comparing biodiversity-friendly interventions in agricultural systems
- Project databases by bilateral and multilateral and NGO project sponsors

Because of the (global) public good nature of biodiversity loss there is arguably a larger incentive for public expenditures to be directed as stemming further loss. But the private sector is also realising that biodiversity loss can in some instances seriously compromise business prospects. There is growing evidence that this is leading to considerable private investments to safeguard the asset base. Private biodiversity investments are also being driven by consumer demand and more transparent sustainability principles.

Private sector expenditures would be highly revealing if they could be captured systematically. Several multinationals are now moving to secure supplies of agricultural commodities directly from smallholders, offering improved expertise, inputs and even significant infrastructure to improve production practices. Examining the pros and cons of this tendency, FT (2012) suggests for example that Nestle plan to spend SFr 110 million on plant science and sustainability over the next 10 years. This is dwarfed by annual sales of SFr 83.6 bn in 2010. However, with more time, drilling into such figures might facilitate the verification of some relevant measures and activities, as well as helping to distinguish capital/recurrent and private/public costs.

Some existing academic literature provides some indication of the implicit costs of moving to less intensive systems to reduce external costs (e.g. Wale 2008, which considers indigenous landraces). In some cases, biodiversity impacts are explicitly stated, but these are normally conflated in qualitative considerations of overall environmental externalities. It is therefore typically unclear how to apportion costs to the biodiversity objective. Ultimately, beyond more conspicuous niches such as organic farming, there are few systematic reviews of the literature explicitly linking system interventions (and much less frequently their costs) and biodiversity outcomes. Even the organic reviews are contested, offering conflicting evidence depending on the level of biological organisation under consideration (e.g. nematodes, invertebrates or birds). What is clear is that systematic changes for biodiversity can in some cases imply a productivity penalty or opportunity cost. This represents a potentially significant cost category that we have not addressed in Table 3. Conversely, systematic changes removing subsidies could offer win-win (i.e. cost savings). But to consider this cost category takes us into the domain of distinguishing between so-called perverse subsidies and those that incentivise the production of habitat. Accounting for opportunity costs ideally requires a farm scale optimisation approach, which few studies adopt.

Ideally a global cost picture might be derived from all three sources of data. But given the initial limitations of the foregoing approaches we initially opted to scrutinise project data bases to determine the extent of cost coverage. The main reason for this is that many of these projects are *prima facie* unambiguous in linking the intervention (and its costs) to a biodiversity outcome. We anticipated that existing project documentation would allow costs for each of our measures to be identified as a basis for regional and global aggregation. However, this turned out to be more challenging in practice. Specifically the level of accessible project appraisal data was a handicap, allowing only a broad-brush transfer of information. We are therefore suggesting a low level of confidence in these estimates.

GEF (Leitao et al. 2012), estimates that the global resource requirements needed to achieve Aichi target 7 are between $2.5billion and $3.8billion, there is little detail on the basis of this estimate, although we assume that the estimate is based on a set of incremental cost calculations. We therefore scrutinised project databases to identify projects that are deemed relevant to achieving each measure. The costs we identified are then scaled for each region to arrive at a global cost.

The most comprehensive lists of projects were acquired from the GEF and CGIAR project databases. The organisations included are shown in Table 4. Project briefs can be viewed at http://www.thegef.org/gef/project_list and http://cgmap.cgiar.org/projectListView.iface?ctr=0&mapstatus=0_0_2

Table 4 Organisations

Database	Included Organisations
GEF and implementing bodies	GEF, World Bank, FAO, UNDP, UNEP,
GGIAR	Africa Rice Centre (Africa Rice), Biodiversity international, CIAT, CIFOR, CIMMYT, CIP, CP on Water and Food, Generation CP, Harvest Plus CP, ICARDA, ICRISAT, IFPRI, IITA, ILRI, IRRI, IWMI, SSA CP, World Agroforestry Centre, World Fish Centre

Data

We screened over sixty projects (with actual or planned expenditures within the period 2009 -2013) for measure-relevant information. We used a spread sheet to allocate project cost information to each measure and where relevant identified spending by region. Sheets separated the CGIAR and GEF projects since we expected the former to be using full cost accounting for measures. Each project was scrutinised for the measure-specific resource requirements that would be needed to achieve the stated measures. Projects that did not contain clear cost data were not considered further. We discovered that the appraisal sections of several projects were lacking or incomplete, meaning that the detailed costing of project elements was not identifiable. This also prevented the clear identification of capital and recurrent costs. The project timing did not allow us to follow up missing information with project managers (where these were indicated). Any project that was deemed relevant, to whatever extent, to the stated measures was originally included in the two spreadsheets. After which, a more detailed review was undertaken on each project in order to see if they could provide any indication to the amount of resource requirements that would be needed to achieve the stated measures.

The process of matching projects information to measures required some subjective judgement. With CGIAR projects, we were able to narrow down the correspondence using the categorisation of CGIAR priorities (Appendix Figure 3: CGIAR Priorities).

In order to estimate a measure resource requirement, the project priorities were matched to our measures. Thus expenditure on a certain priority would indicate the quantity of resource requirement needed for the associated measure. For example, priority '1a= Promoting conservation and characterisation of staple crop' (CGIAR 2005), approximates to our measure 5: Integrated conservation agriculture in a BISA setting. Thus any spending on priority 1a would be placed within the Measure 5. Because of the (unanticipated) variable appraisal sheets we were unable to break down project costs into individual capital and recurrent elements this was an unanticipated drawback of relying on these data bases. We did subsequently note that the World Bank (WB) project database provides more projects with appraisal details. However that database does not provide a clear delineation of projects that can be unambiguously addressing the agriculture-biodiversity link. Screening WB projects would therefore be time-consuming.

Drawing mainly on the CGIAR projects, a crude assessment was undertaken by assuming the identifiable regional spend (once allocated to our measures) could essentially be assumed to represent the regional cost (per hectare of agricultural area) of moving the world onto a measure-specific biodiversity-friendly trajectory. That is, measure spend in a limited area as identified by the project represents the desirable annual spend for an objective that would ideally be applicable globally (minus the original project area spend). In short, we identified global agricultural areas[7] from FAO databases and multiplied a project cost across an entire area with some adjustments. The aggregate cost per measure could then be derived. Since not all regions were covered by the CGIAR projects[8], we scaled our input costs (to reflect a crude difference in purchasing power parity) to approximate the per hectare costs that would pertain in regions not covered. This element assumed an input cost index = 1 for that stated project cost, which is assumed to apply to US/Europe, with all other regions being multiplied by an index <1 to represent cost differentials. This assumption can be modified to give a second scenario (2) below where average costs are unadjusted in the aggregation. The actual index of input costs in global agriculture is a gross approximation from numerous industrial data sources that could not be matched perfectly to the inputs we could anticipate in the projects. All CGIAR projects were originally entered in US dollars (USD) at 2010 level but converted to USD (2012) using a GDP deflator. The indicative costs match the project periods which are 2011-2013.

There are many potential biases in this procedure; estimates combine potential and both over and under estimate needs. Arguably for example, we are estimating costs for many areas that are already managing on a sustainable basis or which are in fact biodiversity-poor. But we could equally argue that the per hectare costs as calculated are actually very small relative to average agricultural returns in many parts of the world. Note also that we are making no allowance for any opportunity cost that might be implied by the conservation effort. Given the already tenuous assumptions made here, we have not projected these estimates forward. Aside the issue of future input costs, any forward projection would also require us to be specific about opportunity costs.

ASSESSMENT OF RESOURCE NEEDS

RESULTS & DISCUSSION

For the measures we could match 2 cost scenarios are defined (Table 5). The input cost adjustment makes a small difference and our aggregate cost for three years is around $6 billion, with the highest cost being associated with product certification (4c) and property rights (6).

Table 5 Table Total global measure costs for the whole period (2011 – 2013)

Measure	Scenario 1 ($millions)	Scenario 2($millions)
1	215	225
2	311	239
3	117	144
4.a	57	61
4.b	9	10
4.c	2685	2784
5	398	363
6	2523	2617

[7] An alternative population numeraire was ruled out since we assume that spend should be related to agricultural area rather than population density

[8] We used the following grouping: North America, LAC, Europe, Former Soviet Union, SSA, North Africa, West Asia, East Asia, South Asia, South East Asia, Oceania

We can expect the trajectory of costs to change through time since several measures are associated with high initial costs and are further correlated with income growth (Table 6). For example, the establishment of better property rights through cadastral surveys, legal process and (potentially) compensation are costs that are initially borne by both the public and private sectors. As countries grow the rural of law and legal statute are observed to safeguard these rights once they are established. This transition also accounts for greater private sector confidence and thus investment in agricultural supply chains. Other measures are also significantly affected by income growth, which can influence the transfer of expenditure/investment between the public and private sectors. This is the case for agricultural R&D, the returns to which become 'capturable' by private investors. In this scenario, the only government role is to define the regulatory environment that steers investment to deliver public goods as ancillary outcomes. Such is the case with plant and animal genetic R&D in many BRIC countries. Rising incomes are also a catalyst for consumer demand for greater information on food provenance and related externalities. Again (in the case of product labelling), while initial costs may be born by the public sector, these are soon displaced by private sector incentives and initiatives.

Table 6

Measure		Cost periodicity
1	Establish a global measurement scheme for agroecosystem biodiversity	100% up front cost
2	Global R& D into agroecosystem genetics c. Focus on increased pest/ disturbance resistance d. Focus on increased nutritional uptake/ productivity	All categories are annual costs
3	Establishing regional extension costs and needs	Annual cost in perpetuity
4	Restructuring the production side of the agricultural market d. Increased market access and transport infrastructure for producers e. Improved access to variety of seeds for producers f. Certification of BISA[9] goods	a)one off up front, b) annual in perpetuity, c) one off
5	Encouraging integrated conservational agriculture in a BISA setting f. No/ reduced tillage g. Reduced external inputs h. Crop rotation and polyculture	Annual (covering spending on all categories)

[9] Biodiversity intensive sustainable agriculture

	i. Effective livestock management j. Effective and economically efficient irrigation	
6	Effective adaptation of policy and institutions: property rights	One-off cost

We are cannot be totally confident that the level of analysis here provides a conservative global estimate, which could ideally be built up by more micro evidence on what works and in which countries. Since our initial list of interventions is likely to be contested there is limited value in following through with a full range of additional caveats on these estimates. Suffice to say that as well as defining measures, we would also need to review the global coverage of empirical farm scale optimisation models in order to understand some of the likely opportunity costs of inserting any alternative management measure into a farm system. As noted with the reference to macro economic estimates, we also have to be aware that there are likely to be significant and far-reaching general equilibrium impacts of significant shifts in production practice. As a thought experiment, consider just the implications of significant organic conversion in one country, let alone regionally or globally. Putting aside the potential food security element, adding together the likely welfare impacts from demand and supply shifts in terms of both inputs and organic outputs is a formidable task. It is unclear what these impacts might amount to or even their sign.

Table 7 Summary cost table

Investment needs (US$ million)	Recurrent expenditure per annum (US$ million)	Average annual expenditure (2013 – 2020) (US$ million)	Total global resource needs 2013 – 2020 (US$ billion)
5480 – 5,687	835 - 756	1,520- 1,467	12.2 – 11.7

Ultimately, target 7 is one of the most challenging targets in terms of:

- the lack of both the likely lack of consensus on measures, including consensus on their effectiveness, efficiency and equity.
- the inconsistent baseline of their application
- the available data on which to base estimates

In contrast the literature on sustainable agriculture (encompassing some biodiversity impacts) suggests numerous examples of ancillary impacts in terms of human health impacts including direct nutritional benefits and indirect benefits from reduced pollution to water and air (see Friel et al 2009, Pretty et al 2006). Indeed, Indeed, given current institutional arrangements for managing carbon and the urgency of emissions reductions, it seems that biodiversity benefits are likely to come about indirectly as a result of a focus on cost-effective reduced deforestation (REDD) initiatives Karousakis (2009). This bundling of objectives is also likely to be significant in terms of conservation funding.

Funding

The public good nature of biodiversity loss suggests that there are obvious market and informational failures that can only be addressed with public funding. Many biodiversity objectives are already addressed in Overseas Development Assistance (ODA), much of which is being re-focused on agricultural productivity. But ODA is clearly insufficient to meet all needs and it is therefore important to be clear on priorities and to improve our understanding of where the best returns to outlay are available. This implies a better understanding of the biodiversity effectiveness of what we do spend. In other words, while emphasis on valuation is important, ex post evaluation of the success of spending (i.e. where does conservation work?) is extremely rare, including our understanding of the success of existing agri environmental schemes.

But in the case of food production it is clearly the case that the private sector is implicated in terms of the need to invest to safeguard its (natural) asset base and in terms of responding to consumer demand for biodiversity and other environmental niche attributes.

Private sector funding has the potential to grow but market development requires a range of institutional investments that allow markets to work. These include the establishment of property rights and certification bodies. Property rights are important to turn the current rhetoric of Payments for Ecosystem Services (PES) into reality. PES encompasses a wide variety of hypothetical market transactions that can mobilise private investment. However, much of the current literature suggests that many schemes are still reliant on public funding. There is a need to understand better the potential to grow the private-private category of transactions. Some off these options include potentially controversial arrangements that involve larger corporate investors taking further control of supply chains in developing countries. Recent rhetoric around 'land grabbing' has shown that such arrangements, even where open to public scrutiny, can be politically sensitive irrespective of the benefits to host countries.

The issue of product certification offers another conduit for increasing biodiversity finance through growth of consumer demand. There are currently few direct market conduits for direct biodiversity transactions, and current labelling schemes appear to lack consistent certification protocols. Ultimately it is unclear how large this market could be, and a useful exercise would be to scope the market potential of all possible schemes and to determine the options for revenue sharing between all actors in the supply chain.

Finally, as mentioned in the context of biodiversity (ancillary) benefits, the relatively slow growth of biodiversity markets suggests that biodiversity is more likely to be bundled with the fate of global ecosystem carbon. Linking biodiversity and carbon credits more formally offers a more effective and economically efficient approach for overcoming the potential complexities of monitoring both carbon and biodiversity transactions. Similarly domestic and international biodiversity offsetting provides another potential avenue for conservation funding.

Gaps

This report has already highlighted significant data gaps in terms of being able to characterise measure costs in the variety of farming systems that characterise global agriculture. While there is a considerable body of empirical research on sustainable agriculture, much of this literature targets several objectives of which biodiversity may be only one element. Untangling the costs of targeting biodiversity in isolation may only be possible for a subset of measures and would still constitute a formidable systematic review process. We have also noted in passing that while it is possible to identify consensus about measures a priori, there is much less evidence on the ex post evaluation of the returns to any biodiversity investments. We simply do not have a consistent view of what is effective, which is a necessary pre requisite to the determination of efficiency of conservation spending.

This review has also indicated that a static review of costs also underestimates the more general equilibrium impacts of large scale modification to food systems. In fact, this is a critique that should apply to other targets. It is only realistic to consider costs in an economy-wide model that takes account of likely income and substitution effects that are possible with free trade.

Finally this review signals the need to identify relevant post farm-gate interventions, which include a better view of both post-harvest efficiencies (loss avoidance) and interventions at point of consumer choice and consumption. Our measures have accounted for some of the infrastructural improvements to increase sector productivity. However, there is a wide range of technological interventions to improve food storage and transportation (see World Bank 2011).

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APPENDIX

Appendix Figure 1: AICHI Targets (adapted from (CBD)

Strategic Goal	Target	Description
A: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society	1	By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably
	2	By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems
	3	By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated in order to avoid negative impacts and positive incentives for the conservation and sustainable use of biodiversity are applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions
	4	By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits
B: Reduce the direct pressures on biodiversity and promote sustainable use	5	By 2020, the rate of loss of natural habitats including forests is at least halved and where feasible brought close to zero, and degradation and fragmentation ins significantly reduced
	6	By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits
	7	By 2020, areas under agriculture, aquaculture and forestry are managed sustainably ensuring conservation of biodiversity
	8	By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.
	9	By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.
	10	By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and

Strategic Goal	Target	Description
		functioning.
C: To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity	11	By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.
	12	By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.
	13	By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.
Strategic Goal D: Enhance the benefits to all from biodiversity and ecosystem services	14	By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.
	15	By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.
	16	By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.
E: Enhance implementation through participatory planning, knowledge management and capacity building	17	By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.
	18	By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and

Strategic Goal	Target	Description
		effective participation of indigenous and local communities, at all relevant levels.
	19	By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.
	20	By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.

Box 1. CGIAR System Priorities, 2005–2015

Priority area 1: Sustaining biodiversity for current and future generations

Priority 1A: Promoting conservation and characterization of staple crops
Priority 1B: Promoting conservation and characterization of underutilized plant genetic resources
Priority 1C: Promoting conservation of indigenous livestock
Priority 1D: Promoting conservation of aquatic animal genetic resources

Priority area 2: Producing more and better food at lower cost through genetic improvements

Priority 2A: Maintaining and enhancing yields and yield potential of food staples
Priority 2B: Improving tolerance to selected abiotic stresses
Priority 2C: Enhancing nutritional quality and safety
Priority 2D: Genetically enhancing selected high-value species

Priority area 3: Reducing rural poverty through agricultural diversification and emerging opportunities for high-value commodities and products

Priority 3A: Increasing income from fruit and vegetables
Priority 3B: Increasing income from livestock
Priority 3C: Enhancing income through increased productivity of fisheries and aquaculture
Priority 3D: Promoting sustainable income generation from forests and trees

Priority area 4: Promoting poverty alleviation and sustainable management of water, land, and forest resources

Priority 4A: Promoting integrated land, water and forest management at landscape level
Priority 4B: Sustaining and managing aquatic ecosystems for food and livelihoods
Priority 4C: Improving water productivity
Priority 4D: Promoting sustainable agro-ecological intensification in low- and high-potential areas

Priority area 5: Improving policies and facilitating institutional innovation to support sustainable reduction of poverty and hunger

Priority 5A: Improving science and technology policies and institutions
Priority 5B: Making international and domestic markets work for the poor
Priority 5C: Improving rural institutions and their governance
Priority 5D: Improving research and development options to reduce rural poverty and vulnerability