AGRI-BIODIVERSITY INDICATORS:
A VIEW FROM UNILEVER SUSTAINABLE AGRICULTURE INITIATIVE

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Ecosystem/Habitats Impacted by Agricultural Activities

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Abstract

Unilever is one of the largest consumer goods businesses in the world and sources and three-quarters of its raw materials from agiculture. We have therefore undertaken a major project 'the Sustainable Agriculture Initiative' to develop guidelines for sustainable farming practices that will ensure continued access to our key raw materials. We are developing indicator systems to monitor and benchmark processes and progress. Our biodiveristy indicators have been developed for a range of crops relatively independently by several Pilot Projects. We are now in the process of collating and evaluating the different systems and approaches. This paper discusses the indicators we have worked on, and relates our findings to the OECD approach to agri-biodiveristy indicators.

Keywords sustainability, food, agriculture, biodiversity.

Introduction

Unilever is one of the largest consumer goods businesses in the world. Our food and home and personal care brands are on sale in over 150 countries, and include Flora/Becel spread, Dove soap, Knorr, Lipton, Magnum, Lux, Omo and Cif.

Agriculture provides more than three-quarters of the raw materials for Unilever's branded products. Our supply chains are therefore challenged by the environmental, social and economic constraints on agriculture, and our markets are continually changing in response to growing consumer concerns about food safety and the environment.

We have therefore undertaken a major project 'the Sustainable Agriculture Initiative' to develop guidelines for sustainable farming practices that will ensure continued access to our key raw materials.

Message from the chairmen:

One of the challenges in our strategy to build a robust business in the 21st century – called Path to Growth – is to ensure that our actions are compatible with sustainable development.

Finding ways to balance economic, environmental and social challenges is absolutely necessary if we are to follow a sustainable path. If we get this wrong, we will increasingly find ourselves in an unsustainable relationship with society.

Antony Burgmans and Niall FitzGerald, Chairmen of Unilever

As well as guidelines, we are developing a range of indicators to use to monitor progress in our own pilot projects across a range of crops. Some of these indicators are applicable across many crops , but others are inevitably be crop- or region- specific. All our chosen indicators are intended to support at least one of our 'Sustainability Principles'.

Unilever believes that sustainable agriculture should support the following principles:

- It should produce crops with high yield and nutritional quality to meet existing and future needs, while keeping resource input as low as possible.
- It must ensure that any adverse effects on soil fertility, water and air quality and biodiversity from agricultural activities are minimised and positive contributions are made where possible.
- It should optimise the use of renewable resources while minimising the use of non-renewable resources.
- Sustainable agriculture should enable local communities to protect and enhance their well-being and environments.

In 1998, Unilever established sustainable agriculture pilot projects for five crops that are particularly important to our foods businesses; oil palm, tomatoes, peas, spinach and tea. More pilot projects on these and other crops and farming systems followed later. The indicators we have developed differ significantly from those appropriate to an OECD programme in several important ways;

- The indicators are crop- or farm- based. OECD indicators relate more easily to geographical regions or political units
- Some of our crops are grown in none-OECD countries (oil palm, tea).
- In some countries, and for some crops, the sophistication and availability of background information from which to develop indicators may be limited (e.g. local Biodiversity Action Plans or soil maps may not exist - or the crop may be considered sufficiently 'minor' by National Research Institutes that few data are available on critical pests or diseases)
- Our indicators relate to things farmers can actually do (i.e. management) rather than the larger-scale consequences of action or inaction.
- In general, we have tried to develop indicators that will respond to management changes in a relatively short time-frame (although we have not always succeeded e.g. in areas related to soil composition and functionality)
  - The assessment of frog abnormalities is an example of a short term indicator and
  - The assessments of vegetation (native) size, shape and floristic composition are examples of indicators influenced over the longer term.
- Our indicators tend to avoid issues related to subsidies (either crop, social- or environmentally-based) and support for farming systems.

Nowhere has the diversity of opinions on the implications of 'sustainability' been as great among pilot project members, partners and other stakeholders as in the area of biodiversity and its relationship with crop production! We agree that biodiversity is important for its intrinsic value, because it is a vital part of the natural capital resource we aim to preserve for future generations and that biodiversity provides important 'ecosystem services' – but we are less sure how to 'value' biodiversity in terms of indicators.

The various pilot projects have developed a wide range of potential indicators at the crop, field or farm scale, and we are still trying to learn from the different approaches that have been used. This paper will attempt to relate the findings from several projects to OECD indicator proposals.

Most of the indicators discussed below appear in our 'biodiversity' indicator cluster but others (e.g. those related to pesticide use and choice, or pollution or ecosystem services) appear elsewhere, related to soil fertility, soil loss, nutrient management, pest management, water, product value, social and human capital or local economy clusters.

Indicator development

The Australian tomato pilot designed a useful process for selection of biodiversity indicators that involved;

- Detailing a exhaustive range of possible fauna and flora indicators
- Evaluating each indicator based on five primary criteria;
    1. Measurable,
    2. Interpretable against a threshold value,
    3. Representative of high quality biodiversity,
    4. Sensitive to environmental change,
    5. Cost effective.
- Developing a revised list of indicators for on farm assessment.

Given the wide array of possible indicators, this approach to indicator selection and review provided an objective process for indicator selection and adoption.

The oil palm and tea projects used a rather different approach, perhaps more suitable for crops grown in several countries, in some of which the background information on agro-biodiversity might be limited.

- Identifying the critical biodiversity 'issues' that the indicators should relate to
- Identifying potential indicators to use in relation to each issue
- Gathering data together to
    1. see how the available data related to the proposed indicators across several sites in different parts of the world (i.e. was the indicator transferable?)
    2. evaluate the available data against the proposed indicator to determine whether the result was a
        - quantitative or semi-quantitative output,
        - sensitive to change in management,
        - could be used to compare operations and management practices and was
        - not oversensitive to short-term changes (e.g. bird migration dates)

1. Genetic diversity

1.1. Genetic diversity - in crop of interest

Oil palm and tea pilot projects have developed an indicator for this parameter based on the results of a questionnaire. The long term sustainability of production of these crops was felt to be strongly dependent on the maintenance of a wide genetic base ('genebanks') from which future progenies, varieties or clones could be developed. We agreed that larger plantation companies and growers have a responsibility for the maintenance of this resource – either directly or by support of local, national or international research collections. The questionnaire is designed to assess

- whether there are appropriate breeding and selection programmes in place, and
- whether growers have access to the 'new' material produced by the breeding programmes

Although some of our own pilot project companies do have their own genebanks and breeding programmes we clearly do not see this as being mandatory for all growers. What is more important is that the farm should show **support** for germplasm collections (or at least lobby for their establishment if they do not exist). Small-scale growers of perennial crops should reduce their vulnerability by planting more than one

– preferably unrelated - clone (or variety) of a tree crop such as tea and should have access to new varieties as they are developed.

By contrast, conservation of genetic resources is considered to be a commercial (plant breeding companies), state or international issue by most farmers and for most crops. None of the annual-crop projects has felt the need to develop indicators for this parameter.
For many crops the ownership of genetic resources and germplasm collections is a highly competitive business. Breeding companies often have exclusive collections and do not share these. State and internationally-funded organisations do nevertheless have some germplasm collections – for instance there is a tomato germplasm bank at the University of California at Davis, funded by the University of California. Local tomato growing operations contribute to the maintenance of this resource as part of a relationship in which information and advice are offered in return.

Genetic diversity is therefore clearly an important political issue and one that should be addressed by OECD indicator systems. But we argue that the number of varieties registered or certified for marketing, either in total, divided by area or by crop production may not relate well to the reduced risk (now or in the long-term) that genetic diversity brings. The number of varieties on the market is a reflection of the successes of breeding companies, and not necessarily of the maintenance of a wide genetic base – after all a plant breeder can create thousands of potential new varieties in an afternoon for some crops.
As extreme examples, two varieties of one crop may differ in their genetic base by only a few genes (for instance a change in flower colour); conversely, a polyploid species may have an extremely wide genetic background within a single variety. If a variety has a narrow genetic base (also available in gene banks), and has no obvious merit (profit, quality, taste, disease resistance, ease of growing, traditional r⊥le etc.), does it matter if it disappears? We therefore believe that indicators related to variety mix should relate to the genetic diversity of the varieties.
Public/private conservation of genetic diversity will vary for different crops, but it may be sufficient to view the sum total for another indicator related to the safeguarding of genetic diversity.

1.2 Genetic diversity – related to impact of farming on native ecosystems
This is an important issue, e.g. in Australia, where the diversity of seed stocks of native species is declining. However, addressing the issue directly is beyond the scope and budget of all our pilot projects.

2. Species diversity
2.1. Species diversity - Plants and animals using the crop or farm as habitat
At least three of our projects, the peas project begun in 1998 and a more recent projects looking at tomatoes in Australia and whole-farm and rotational crop systems (based in the UK) are basing their work on

- detailed census systems (animals, birds, insects etc.)
- habitat assessments and
- relating crop and farm features to seasonal and locational differences in wildlife that uses the crop or farm as habitat.

This work has been superbly supported by a wide range of volunteer and commercial partners with biodiversity census expertise – the British Trust for Ornithology, the Wildlife Trusts, Centre for Ecology and Hydrology , Farming and Wildlife Advisory Group and University of Essex (micro biological diversity) in the UK and via. 'Outsourced Environmental' in Australia.
Baseline biodiversity assessments are an excellent starting point for the 'journey' towards farm management plans incorporating environmental enhancements. Such biodiversity assessment systems will also satisfy the requirements of a wide range of stakeholders and researchers who wish to understand the relationships between species and their habitat requirements.

Interestingly, neither of the UK-based projects has felt the need to incorporate the priorities defined by UK local government 'Biodiversity Action Plans' (BAP) into their own action plans[3]. Part of the reason for this is that the on-site assessments and management plans for the Pilot Projects go way beyond those envisaged in a BAP, and a BAP may lack practical guidelines that enable farmers to develop suitable management plans. However, in the UK projects, many of the same stakeholders, partners and specialists are the same as those consulted by the local authority in developing the BAP and it seems likely that similar management priorities will emerge. For instance, some of the biodiversity baseline assessments in the UK have been directly related to farmland species e.g. skylarks *(Alauda arvensis)* , yellowhammers *(Emberiza citrinella)* arable weeds or butterflies that are in decline, a decline thought to be directly related to modern conventional farming practices; in Australia, the pilot project is working with local authorities (Government Agencies, Catchment Management Groups etc.) to identify vulnerable and endangered species on a local and regional scale and where possible linking these into on farm biodiversity management plans.

The local government/catchment management goal of 'no net loss' of biodiversity has proved to be an important conceptual framework from which to develop indicators for the Australian tomato project.

Indicators

Once census data has been collected for our pilot projects, indicators will be developed based on changes in species, numbers or habitats present. It will obviously be impractical and prohibitively expensive to perform detailed surveys similar to our pilot project baseline surveys in every year and on every site. We will be talking to partners and stakeholders to help identify the 'key' species or habitats that need to be monitored over the years to develop appropriate indicators. The peas project is evaluating the numbers of plant, butterfly and bird species/ha as useful indicators, as well as 7 'key' bird species. The UK-based projects see certain bird species as potentially-useful indicators – also identified by the BTO, RSPB[4]and UK Government as indicators of 'quality of life'. However, thinking in the Australian project is that fauna indicators will be over-affected by factors such as migration, climatic issues and connectivity within the whole region – over which the farmer or local land holder has little control – and that such indicators are therefore unlikely to be useful.

We are in agreement that our indicators should be related as closely as possible to practical measures that farmers can take. Farmers clearly have more control over habitat than over the presence or absence of particular species. There is a general feeling within the pilot projects that habitat-based indicators are going to be much more useful for our purposes than species-based indicators.

2.2. Species diversity - Enhancing the farm environment for biodiversity

Where existing knowledge or research can make the link between individual species and their habitat requirements, indicators can be developed based on enhancing the farm environment for that species. The peas pilot project, for example, has been able to link pea management systems to skylark breeding and foraging requirements, and has developed an indicator based on 'skylark selection value'.

The farm project has really brought home to us the low biodiversity value of conventional short-term set-aside in the UK. Enhancement of field margins, either specifically for game birds (Game Conservancy Trust, UK) or as wild flower meadows with high value for butterflies and bees (300 %+ increases *The Manor Farm Project –Farmed Environment Company*, Yorks, UK) as well as being aesthetically pleasing (Figure 1) - can result in significant improvements in the biodiveristy value of farmland. Many of declining farmland species within the EU were historically associated with low-intensity grazing meadows

[3] Around 160 Local Government Action Plans are in preparation or being implemented across Great Britain. Each Action Plan works on the basis of partnership to identify local priorities and to determine the contribution they can make to the delivery of the national Species and Habitat Action Plan targets. The Bedfordshire and Luton area (within which the Colworth Farm project lies) has just published a BAP for ' Arable and horticulture ecosystems '.

[4] British Trust for Ornithology and the Royal Society for the Protection of Birds

and haymaking practices, and 'wild flower' field margin mimics many of the characteristics of grassland managed in these 'traditional' ways. Current CAP set-aside systems do nothing to encourage the development of this type of margin enhancement on set-aside.

Our tea pilot project sites in both Kenya and S. India have also committed themselves to large programmes deasigned to enhance the biodiversity of the farm environment by planting native tree species, mainly in field margins or along riparian strips or in specific 'arboreta'. Native tree planting programmes are also important considerations for developing 'Biodiversity Enhancement Plans' for tomato-growing farms in Australia.

In our farm project in the UK, we are measuring the agro-ecological benefit of flower margins and beneficial insect attractants (Semio-chemicals) placed within field margins (3D Farming DEFRA LINK project) for renewable crop protection systems or IPM. We are also attempting to green to the 'middle of the field'. In our UK farm project we already have one years data on the impact of non-use of pesticides and its effect on flora/birds and crop yield and quality (Wildlife Trusts, BTO Colworth project work 2001, unpublished). The initial impressions are encouraging i.e. less inputs results in more diversity

Indicators for environmental enhancement that we do develop are likely to be in two main areas

- related to enhancements made for individual endangered, threatened or vulnerable species where these have been identified, and the link has been made between the species and critical aspects of habitat (e.g. nesting sites, foraging sites) or timing of farm operations, and
- more general enhancements to encourage a wider diversity of wildlife (e.g. nesting or roosting sites, wildflower areas or native tree planting schemes).

2.3. Species diversity- Ecosystem services provided by biodiversity

The ecosystem services we feel to be most relevant to our projects are

- soil fertility maintenance and enhancement by micro-organisms and micro-fauna
- soil and water micro-organisms that detoxify waste, pollution and runoff.
- soil micro-organisms and plants affecting nutrient supply and availability – nitrification, denitrification, phosphate availability (mycorrhyzae and acidic root exhudates)
- soil saprophytic micro-organisms reducing the pathogenic potential of any soil pathogens present
- predatory mites, insects etc. that reduce pest and disease organism numbers
- insectivorous birds and mammals that feed on pests
- seed-eating birds and mammals that eat weed seed (and may also damage crop)
- trees as pumps for water to help lower water tables (important for tomato-growing in Australia and possibly in tea-growing in Assam – although tea is itself a tee, tea rooting systems do not survive well in water that is waterlogged).
- Riparian strips of mixed vegetation, including tree species, that protect watercourses from agricultural runoff.
- Trees as windbreaks, shelter or shade for workers (tea in India) or farm stock
- Nitrogen fixation by shade trees (tea in Assam)
- Carbon fixation and storage

Indicators some projects have proposed or developed indicators for one or more of these 'ecosystem services', where there is the scientific knowledge available to relate the biodiveristy to the benefit. Other projects have preferred to deal with these issues indirectly, such as by developing a 'questionnaire approach' to the implementation of Integrated Pest Management principles (including an understanding of the role of predator species in pest population management).

Unilever is also working with partners to work towards an **economic evaluation of biodiversity** that could be used as part of Life-Cycle Analysis or as Sustainable Agriculture indicators. A good example of this type of indicator would be 'clean-up costs' for water contaminated with pesticides before it can be used for drinking. This approach is not enthusiastically endorsed by all pilot project members, who point out difficulties in assigning a 'value' to conserving genetic material or the relative benefits of Nitrogen fixation vs. eco-tourism

2.4. Species diversity- none-native species threatening agro-production or agro-ecosystems
None of our pilot projects have felt the need to develop indicators in this area. However, by carrying out baseline biodiversity surveys, we understand the importance of these non-indigenous species e.g. Muntjak deer in the UK– which prevent coppicing and devour bluebells (*Hyacinthoides non-scripta*). Introduced species are clearly an enormous problem in Australia.

3. Ecosystem diversity
Land stewardship issues and habitat have been high on our agenda in many discussions, in particular

- in terms of landscape mosaics within the farm, habitat diversity and links (riparian strips and wildlife corridors) between habitats, and
- in terms of appropriate use of land.
- in terms of 'functional diversity' of species present or habitats present

3.1. Ecosystem diversity – landscape structure
We are investigating methodologies to evaluate farm landscape structure in terms of
habitat area, isolation and connectivity in several of the pilot projects. Most pilot projects have collected data on land use on the farm, and we now hope to collect data on the nature of connections within the landscape to determine whether this approach (e.g. Swetnam, R.D. (1999)) yields useful indicators. The nature of the connections will vary with project – they will be hedgerows and stream margins for the UK farm project, windbreaks, drainage ditches, roadsides and riparian reserves for tea projects.
Indicators are currently related to the proportion of available land used for different purposes (e.g. % of natural forest on Australian tomato farms, % of land in forest reserves on tea estates). Indicator Performance Thresholds may then be related to catchment management or state level targets where these are available. It will be important to
Such indicators are relevant to the OECD 'Wildlife habitats' indicators 'changes in area of semi-natural habitats on agricultural land'.

An understanding of the implications of such targets for local farmers, such as is developing within our pilot projects (for instance, developing agronomic 'best practices'), may also be useful to the local government in developing and refining targets.

Where such targets do not exist – or maybe even when they do exist, to provide a common baseline for comparisons – a baseline may be set in terms of biodiveristy 'value', where '100%' represents natural vegetation and unpolluted watercourses and habitats that have priority in local , national or international conservation plans (such as extensive grazing land or habitats necessary for the survival of endangered species) (see Figure 2). Alternatively, the 'V' index methodology developed by ICRAF as part of the 'Alternatives to Slash and Burn' programme may be particularly useful for tropical crops. The 'V' index can be used at any scale and may therefore be particularly useful for assessing the same crop grown in large plantations, small farms or agroforestry.
In future, some projects may also develop indicators based on landscape interconnectivity (wildlife corridors, links between important habitats etc.) or the size/shape of landscape features related to edge-effects. However, there is also a feeling that 'connectivity' and 'habitat features' are too difficult to work with because of difficulties in determining threshold values for them and their lack of sensitivity to farm management practices. For these reasons they were eliminated from the tomato project assessment process.

3.2. Ecosystem diversity – appropriate use of land

For all farming systems it is important that crops are planted on appropriate soils and slopes and in a suitable climatic area. This basic tenet is profoundly disturbed when subsidy systems (mainly in OECD countries), traditional farming systems developed in times of lower population density or different climatic conditions, or increasing wealth or poverty of populations intervene. Conventional [traditional] farming methods may then be used inappropriately on land outside 'sustainable' growing zones, or intensification may burden the agri-ecosystem beyond its intrinsic ability to self-renew. Good examples of this are found throughout the world where livestock overstocking has resulted in serious land degradation.

The first fundamental requirement for assessing appropriate use of land for our projects is to try to determine the parts of the farm where growth of the crop of interest is uneconomic, and to use the land in these areas for other purposes. The reasons for the failure of any field or part of a field to provide an economic return are varied – drainage, accessibility difficulties, expensive location to irrigate, shading, pest problems, continued vandalism etc. In some cases (e.g. farm project) this will be done using GPS monitoring systems on harvesting machinery. In other cases, other harvesting records or visual clues may be used.

We argue that just taking land out of production of one crop should be beneficial to biodiversity because the land will then be available to plant with something else (increasing functional diversity) or left as set-aside or other semi-natural habitat (that will have the *potential* for biodiversity-related enhancements , see above).

Ideally, of course, such land should not have been planted to the crop in the first place. Programmes such as in the palm oil pilot, where rainforest has never been removed in areas identified as of high biodiveristy value or low economic return (e.g. riparian reserves, habitats for particular species or slopes > 20^o) have remained unplanted since the plantation was first developed.

Indicators for these issues will therefore be related (most probably using a 'questionnaire approach' to scoring) to

- impact assessments performed in relation to land conversion to agricultural purposes
- identification of areas of low economic return or particularly high biodiversity value – and not planting crop inappropriately in such areas
- appropriate planting of our crops of interest in relation to the whole farm portfolio (crop rotation systems, location, soils, woodland or tree crops on most vulnerable soils and watersheds, agroforestry where appropriate etc.)
- no inappropriate planting of the crops of interest e.g. rocky outcrops, fragile soils, frost pockets, thin soils, unimproved hut sites for tea in Africa,, areas that are regularly swamped for peas in the UK.

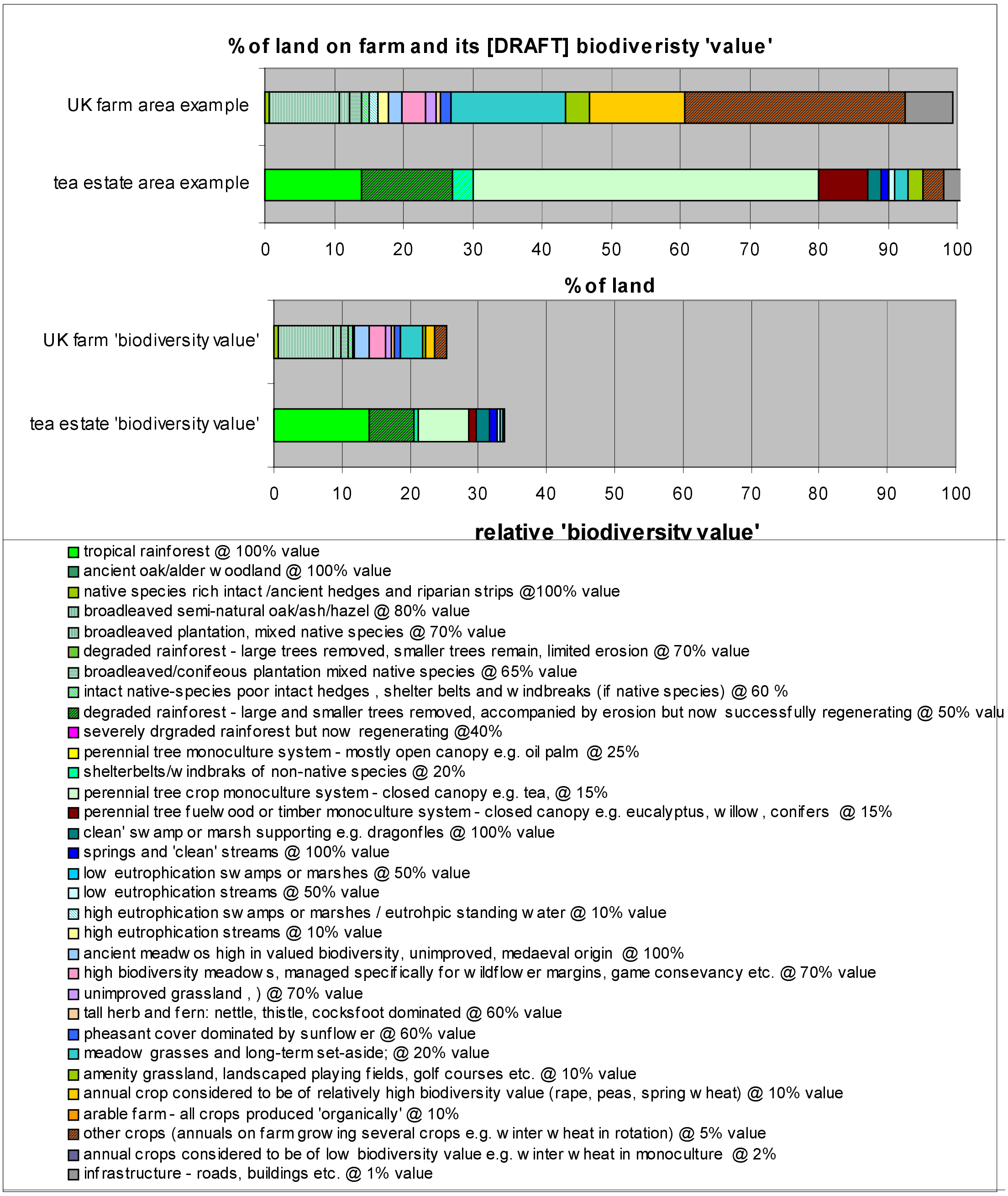
These ideas are most closely related to OECD indicator proposals on 'changes in semi-natural habitats on agricultural land' although they obviously relate to land use on a larger scale.

3.3. Ecosystem diversity – functional diversity

Rather than developing species-based inventory approaches to assess diversity, the projects based in tropical areas (where species classification is more complex, expensive and regional are unlikely to be already available) will probably be evaluating biodiveristy within habitats on the farm in terms of 'functional diversity' or 'plant functional attributes'. This is a procedure that derives plant functional types from functional attributes. This approach has worked well for ICRAF in assessing agroforestry systems in Indonesia and W.Africa

The ***indicator*** we develop for this parameter, 'Functional Diversity Index' will probably use local rainforest (if available) diversity as a baseline. For larger farms, the index should be calculable from the % of land used for each crop or other purpose (see 3.1.), once these land types have been calibrated, although different types of sampling will be appropriate for smallholder and agroforestry growing systems. If this indicator works well, and farmers efforts to conserve and enhance biodiveristy can be quantified using this method, it will avoid the never-ending debates on the 'value' assigned to particular land uses as shown in Figure 1.

Figure 1. Example of a potential 'biodiversity value' indicator
Discussions with stakeholders will be critical to agree 'values' to use for various habitats if this is to become a useful indicator.



4. Other issues and potential indicators

4.1. Externalities of farm activities. Farm activities that affect off-farm biodiversity

Many of the indicators we have developed for clusters other than 'biodiversity' will impact on off-farm biodiveristy.
We have identified examples of the main indicators from our draft listings as in Table 1.

Table 1. Impacts of farm-based activities on on-farm and off-farm biodiveristy

Cluster	*Parameter*	*Impacts on biodiversity*			
		On-farm	*Local*	*National*	*World*
Soil loss	Soil loss /ha	***	**		
Nutrients	N loss to water	**	**	*	
	P loss to water	**	**	*	
Pest management	Pesticide losses to water	**	**	*	
Energy	Total energy use/ha or tonne of product			***	**
	Polluting emissions, Nox, Sox, ozone depleters	*	***	**	*
	Greenhouse gases & carbon credits			*	****
Water	Consequences of extraction and drainage for downstream users	*	***	*	
	BOD/COD in effluent	*	***	*	

We are in the early stages of developing a methodology for combining the data we have on the diversity of land use areas on the farm (see section 3.1. above) with the above indicators to develop a 'Biodiveristy footprint' indicator. One option for this is to use an 'auditable questionnaire' (Table 2) and another to develop a more quantitative approach (Figure 2).

4.2. Land conversion issues

Our remit is to address the issue of 'sustainability' in current crop growing areas.
Our sustainable agriculture projects are **not** designed to evaluate the implications of land conversion from forest, grasslands or wetlands to farmland – the issue addressed in the OECD indicator 'uncultivated natural habitats'. However, Unilever does have views in this area, particularly in relation to rainforest destruction and forest conversion. As a major palm oil buyer, we feel that an industry-led Code of Practice needs to be introduced in the palm oil industry. This should address the issue of rain forest conservation for plantation establishment as well as all other aspects of sustainable plantation management. In order for a Code of Practice to be credible, it is vital that it is supported by the whole palm oil community. We believe that regulations and enforcement, and stricter requirements both from financiers and governments are also essential in helping to curb unwanted rain forest destruction.

In future, we hope to evaluate the use of our indicators to determine whether they provide useful insights into land conversion from one crop to another (e.g. rubber to oil palm), or of varying crop rotations (e.g. including peas or oilseed rape in rotations) or of different production systems.

4.3. Wildlife as indicators

Biodiversity surveys and evaluations can be used as 'bio-indicators' for a number of issues related to agricultural sustainability. The Australian tomato project is using developmental abnormalities in local frog populations as an indicator of the externalities of farm management practices. Algal blooms in farm ponds and watercourses are an obvious indicator of inappropriate nutrient or soil management.

Table 2. proposal for 'Biodiversity footprint' indicator based on responses to a questionnaire.

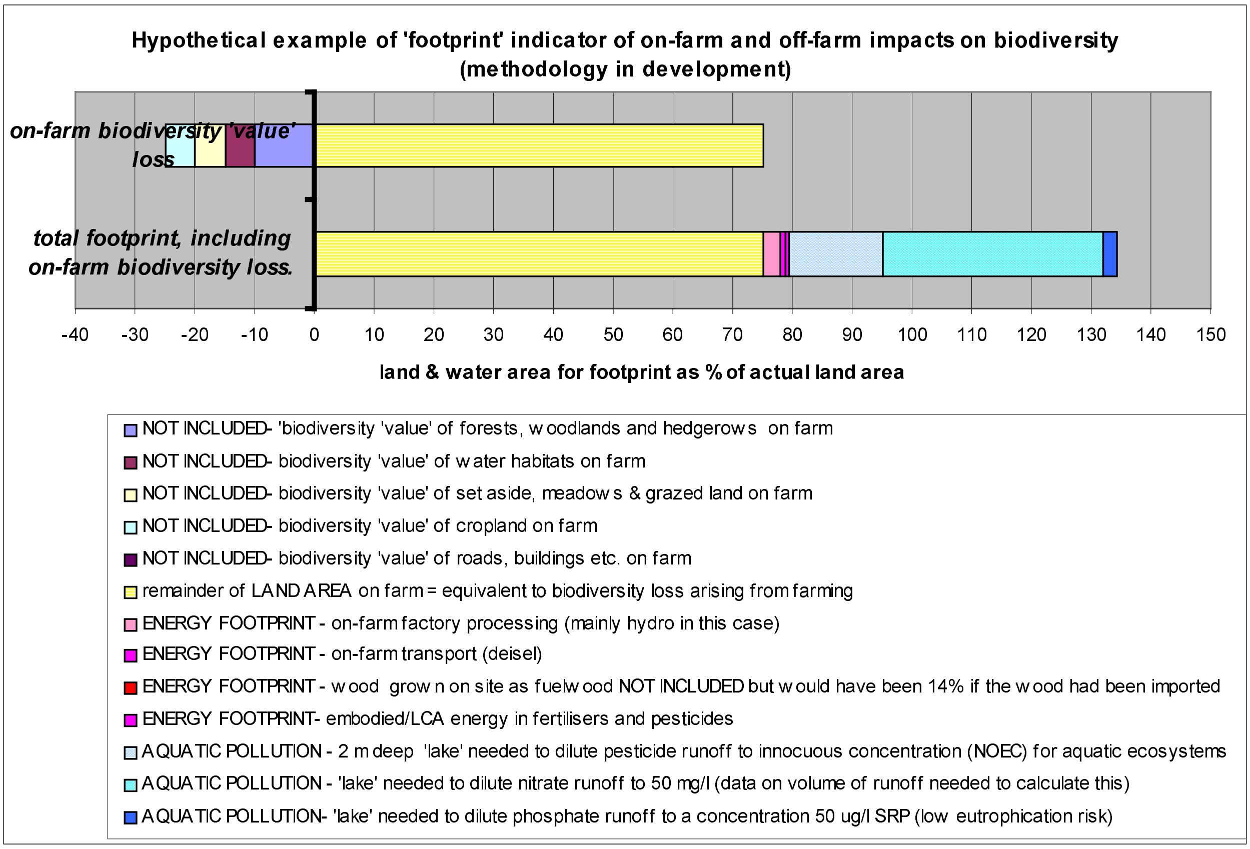
	Question	*Answer*	
1	Has there been a site survey to determine if rare or endangered species (of local, national or international importance) or ecosystems are present on site?	Yes	Score 10. Go to 2.
		Partial	Score 9. Go to 2.
		No	Score 8. Go to 2.
2	Are there action plans being taken to help conserve such species or ecosystems identified (whether or not as a result of a full survey)?	Yes- for all species identified (or no specific species identified)	Keep score. Go to 3.
		Partial	-1. Go to 3
		No	-2. Go to 3
3	Are riparian reserves maintained along major watercourses?	Yes	Go to 4.
		No	-5. Go to 6.
4	Are these wide and deep enough to cover areas vulnerable to floods, to "catch" a high proportion of runoff and so prevent the ingress of soil, silt and pesticides into waterways?	Yes	Go to 5.
		No	-1. Go to 5.
5	Are riparian strips (and wildlife corridors, if present) planted with native species?	Yes- and selection criteria include value for wildlife	+1. Go to 6.
		Yes	Go to 6.
		No	-1
6	Do planting plans and land management plans take into account wildlife protection such as maintaining wildlife corridors, keeping strips of native trees to link riparian strips to pockets of forest, locating villages away from the forest edge (less temptation to use forest for firewood)?	All of these	Go to 7
		Some of these	-1 go to 7
		No	-2 go to 7
7	If BOD/COD is present in effluent (parameter 6.5.[1]), is this discharged into a small or sensitive aquatic life (e.g. fish, dragonfly larvae)?	No BOD/COD	Go to 8
		Low BOD/COD discharging into large river.	-1 Go to 8
		High BOD/COD OR discharge into sensitive waterway	-2 Go to 8
		High BOD/COD AND discharge into sensitive waterway.	-2 Go to 8
8	If runoff of P (parameter 3.4. [1]) into streams is ever significant, does the watercourse eventually enter a P-sensitive (eutrophication-sensitive) water body such as a large lake?	No sig. P runoff	Go to 9
		No sensitive water body.	Go to 9
		Sig. Losses into sensitive water body.	-2 Go to 9
9	If runoff of N (parameter 3.3. [1]) into streams is ever significant, does the watercourse enter an N-sensitive (eutrophication-sensitive) water body such as an estuary? Or an N-sensitive (naturally poor in nutrients) ecosystem?	No sig. N runoff	END- record score
		No sensitive water body or ecosystem	END- record score
		Sig. Losses into sensitive area.	-2 END- record

1. parameter references are to indicators developed in 'clusters' other than 'biodiversity'

Figure 3. Example of a potential 'biodiversity footprint' indicator, related to externalities of on-farm activities

Discussions with stakeholders will be critical to agree values to use for parameters. In the example below, the 'biodiversity footprint' would be around 1.3 times the farm area.

The methodology (still in development) relies heavily on WWF/UNEP/Centre for Sustainability Studies methodology (see, for example, Chambers *et al,* 2000) and the concept of 'Critical Dilution Volume' (European Commission, 1995).



Conclusions

Unilever is engaging with a range of internal and external stakeholders to develop indicators that link into the sustainable production of our major raw materials. We have found it particularly difficult to develop indicators for biodiversity and wildlife habitat-related issues, but we feel that we are making significant progress with help from our current partners and in discussions with a range of people and organisations.

Many local and international voluntary governmental and non-governmental organisations (NGOs) have an interest in farming systems and crops from an environmental and social perspective especially regarding habitat and biodiversity impacts. We hope some of these organisations will be willing to engage with us in the various sustainable agriculture projects: their critique and their support are essential to help deliver the changes necessary.

In summary, we are engaging in a great deal of data gathering for some of our pilot projects and are in the process of developing indicators based on these data.

Workers on several pilot projects have concluded that they find habitat-based indicators more useful than species based indicators because habitats are the more stable part of the ecosystem and are the components over which farmers have most control.

In cases where assessments of fauna (especially birds) are likely to become important indicators, there is a real need for a much better understanding of the habitat- and other requirements of the particular indicator species.
The next steps include;

- Further rationalisation of indicators
- Data collection and evaluation for indicators
- Development of on farm biodiversity management plans and integration of biodiversity assessment and management strategies into on-farm EMS systems.(for crops where Unilever buys direct from growers)
- Incorporation of biodiversity issues into Birds Eye Walls 'Fieldsmans Handbook' and agreements with farmers on biodiversity management in relation to the pea crop
- Publishing 'Good practice guides' for oil palm and tea that include guidance on management for maintaining and enhancing on-farm biodiversity.

Acknowledgements

Most of the biodiversity baseline survey and evaluation work described superficially in this paper was performed by NGOs or academic partners. Much of this work is still at an early stage or contained within Unilever reports. We apologise of we have misrepresented these findings through misunderstanding and hope that more detailed information will be published in due course by the researchers themselves. Thanks are also due to to members of Unilever Sustainable Agriculture pilot projects and consultative groups for comments and data, including Vengeta Rao, Sikke Meerman, Hereward Corley and Jos van Oostrum.

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