Project no. INCO-CT-2005-517644

CORRIDOR

Working group on evaluation and synthesis of information on tree cover to balance productivity and biodiversity in agricultural landscapes along the Mesoamerican Biological Corridor

Specific Support Action

Integrating and strengthening the European Research Area

Priority A2 Rational use of natural resources

**Final activity report**

**Period covered:** 1 Jan – 31 Oct 2006 **Date of preparation:** 30 Nov 2006

**Start date of project:** 1 Jan 2006 **Duration:** 10 months

**Project coordinator:** Fergus Sinclair

**Organisation:** University of Wales Bangor, UK

**1. Project objectives and major achievements during the reporting period**

The main objectives of CORRIDOR were achieved in the project period. These were to co-ordinate activity and build capacity to develop a research strategy for defining thresholds for tree cover in agricultural landscapes along the Mesoamerican Biological Corridor (MBC). Specifically the support action aimed to:

* synthesise existing information on levels of tree cover in pasture- and coffee-dominated landscapes and their impacts on agricultural production and biodiversity from Mexico to Colombia along the MBC,
* establish common protocols for collection, storage and interpretation of data on dispersed tree cover within agricultural landscapes amongst the countries comprising the MBC and their relationship to biodiversity and farm productivity, and
* develop a strategic regional plan for research and associated development measures to define thresholds of tree cover that balance ecosystem services and agricultural productivity for different landscape contexts along the MBC.

The project ran only for one reporting period. Both contractors (University of Wales Bangor and CATIE) were fully involved throughout the period and successfully engaged key researchers from other institutions in the region to review specific aspects, principally effects of tree cover on a) pasture productivity and biodiversity (Dr Yasmin Cajas, Corpoica, Colombia and Dr Celia Harvey, Conservation International, US) and b) coffee productivity and biodiversity (Dr Lorena Soto Pinto, Ecosur, Mexico and Meybelyn Escalante, Costa Rica). The main activity of the project was focussed around three workshops which were successfully held at CATIE and well attended by key research groups from the region. The three workshops comprised one on silvopastoral systems, one on coffee systems and a final synthesis workshop. Reports on the effect of tree cover on biodiversity and productivity in pasture and coffee systems were presented and discussed at the worshops, culminating in the development of research protocols and a research and development strategy for understanding threshold levels for tree cover in the region.

The work of the project involved bringing together existing information collected by various research groups working with trees in agricultural systems in the region and collation and synthesis of this information to produce a regional research and development strategy. Delegates from key research groups formed two core working groups to collate information on tree cover on pastures and coffee, respectively, and their impacts on biodiversity and productivity. The collated information was discussed and refined at regional workshops on trees on pasture and trees in coffee plantations, respectively, with participation of key players from countries in the Mesoamerican region. Protocols for collecting and interpreting data on tree cover, biodiversity and productivity on pastures and in coffee were developed at the workshops and key gaps in knowledge identified. A synthesis report on tree cover in the entire agricultural matrix around remaining forest along the MBC (combining data on coffee and pastures) was prepared and discussed in a third workshop at which a regional research and development strategy to define and achieve thresholds for tree cover along the MBC was formulated.

**2. Workpackage progress of the period**

***2.1 Workpackage 1: regional workshop on trees on pastures***

The objectives of this workpackage were: i) to synthesise existing information on levels of tree cover in pasture and their impacts on farm productivity and biodiversity along the proposed Mesoamerican Biological Corridor (MBC); ii) to establish common protocols for collection, storage and interpretation of data on dispersed tree cover within pastoral landscapes amongst the countries comprising the proposed MBC and their relationship to biodiversity and farm productivity.

*Progress towards objectives*

The workshop was successfully held at CATIE from 21 to 28 August 2006. The date was moved back from April to August to allow time for engaging consultants to prepare background review material on the status of tree cover on pastures in the MBC region and its effects of productivity (completed by Yasmin Cajas of Corpoica, Colombia in close association with Muhammad Ibrahim at CATIE) and on biodiversity (completed by Celia Harvey of Conservation International in close association with Fabrice de Clerck and Diego Tobar at CATIE). A large database of key research publications and their findings was developed at CATIE to underpin the reviews and experience from the recently completed EU FRAGMENT project co-ordinated by Fergus Sinclair and Celia Harvey was heavily drawn upon. The reviews were presented at the workshop and formed the basis for identification of gaps in knowledge and development of protocols for future research.

The workshop was well attended and enjoyed active participation from key researchers in the region. In addition to CATIE staff and postgraduate students, there were two participants from UWB (Fergus Sinclair and Hussain Omed), and 10 participants from various central American countries (three from Colombia, two each from Guatemala and Mexico, one each from Nicaragua, Honduras and Panama) and Celia Harvey from the USA.

Key results included identification of i) key gaps in knowledge (addressed in the regional research strategy in the synthesis workshop) and ii) lack of comparability of methods for assessing tree cover and its impacts on productivity and biodiversity of pastures (addressed in the research protocol).

Key gaps in knowledge include virtually no data on pasture productivity – nearly all research reports standing biomass rather than more rigorous assessment of productivity over time. While there is clear evidence that tree cover on pastures supports considerable animal diversity along the MBC data were skewed geographically (with particular emphasis (>50% of studies) on Mexico and Costa Rica, several studies in each of Nicaragua and Colombia but only single studies in other countries) and with respect to animal taxa (birds were well studied along the whole isthmus, studies on insects, spiders and bats were also reported from several countries but information on amphibians, reptiles and mammals was sparse. Studies were reasonably well distributed with respect to different climatic zones but not in relation to remaining forest resources because of a tendency to choose study sites that were important for cattle production rather than forest connectivity. There were few integrated studies that related productivity and/or biodiversity directly to tree cover, but a doctoral thesis and project report from Costa Rica suggested that dispersed tree cover in pastures up to around 15-20% favoured both productivity and biodiversity. Beyond this, productivity tended to decline but, for most taxa, biodiversity, particularly of key forest species of conservation concern, increased. Positive effects on productivity varied with site conditions but included reduction of heat stress in shaded animals and increase in water use efficiency of shaded pasture. Different forms of tree cover retained in pasture (dispersed trees, riparian forest strips, secondary forest blocks, fallow areas and live fences) clearly supported different biodiversity – so that there were additive effects of many contrasting forms of tree cover at a landscape scale. The implication here is that each form of tree cover retains some but not all features of forest habitat and there are differences amongst the forms of tree cover in what is provided. There was evidence that management interventions to retain tree cover could increase the biodiversity supported by pasture landscapes through, for example, retention of trees and staggered rather than widespread pruning of live fences.

The key methodological issues surrounded lack of comparability of data (that precluded meta analyses despite a large number of studies) because of differences in tree inventory methods and sampling design and intensity in relation to various animal taxa. Opportunities to compare effects of tree cover on various animal taxa and relate this to pasture productivity were further restricted because usually only a single taxa was assessed in any one study or site and rarely did measurements of productivity and biodiversity coincide. The recommended protocols for research have made available key tabulated guides for tree inventory and sampling that should improve comparability of data collected in future.

*Deviations from the project work programme and corrective actions taken*

The timings of the pasture and coffee workshops were swapped – the pasture workshop put back from April 06 to August 06 because of the time required to engage consultants and prepare the review material for the pasture workshop.

*List of deliverables, including due date and actual/foreseen submission date*

Deliverable 2. Report on data available on tree cover in pastures along the MBC and its impact on productivity and biodiversity (due date in proposal April 06; delivered date August 06 to coincide with revised date of the workshop).

Deliverable 3. Protocols for collecting and interpreting data on tree cover in pastures (due date May 06 delivered September 06 to allow incorporation of the proceedings of the workshop whose dates were revised from April to August).

***2.2 Workpackage 2: regional workshop on trees in coffee plantations***

The objectives of this workpackage were: i) to synthesise existing information on levels of tree cover in coffee plantations and their impacts on farm productivity and biodiversity along the proposed MBC; ii) to establish common protocols for collection, storage and interpretation of data on dispersed tree cover within coffee plantations amongst the countries comprising the proposed MBC and their relationship to biodiversity and productivity.

*Progress towards objectives*

The workshop was successfully held at CATIE from 23-25 May 2006. The date was moved forward from July to May because the process of engaging consultants to prepare background review material on the status of tree cover in coffee landscapes in the MBC region and its effects of productivity and biodiversity was faster than for the respective reviews for pastures and so it was sensible to hold the coffee workshop before the pasture workshop. Meybelyn Escalante from Costa Rica working in close association with Philippe Vaast at CATIE and Lorena Soto Pinto from Ecosur in Mexico prepared review material. An Endnote database of research publications and their key features was developed at CATIE to underpin the reviews and experience of the recently completed EU CASCA project co-ordinated by Philippe Vaast of CIRAD was heavily drawn upon. In addition Fabrice de Clerck at CATIE attempted several meta analyses of tree and coffee productivity data from trials across Central America for which data were available at CATIE. The reviews were presented at the workshop and formed the basis for identification of gaps in knowledge and development of protocols for future research.

The workshop was well attended and enjoyed active participation from key researchers in the region. In addition to CATIE staff and postgraduate students, Fergus Sinclair attended from UWB and there were representatives from institutions in Nicaragua, Honduras, Colombia, Mexico, El Salvador and Guatemala.

Key results included identification of i) key gaps in knowledge (addressed in the regional research strategy in the synthesis workshop) and ii) lack of comparability of methods for assessing tree cover and its impacts on productivity and biodiversity of coffee farms and landscapes (addressed in the research protocol).

One of the most striking findings of the review work was the lack of a stable relationship between shade level and coffee productivity across studies and sites, attributed to i) differences in how and when shade cover was measured and ii) uncontrolled variation in other management factors that affect productivity, such as fertiliser use and the timing and extent of tree pruning. Canopy phenology (tree leaf area duration and its manipulation through pruning) emerged as a key factor affecting both assessment of tree cover (assessments taken at different times yield different results) and productivity (shade at different times of the year has different impacts on coffee production – at flowering it may reduce fruit set but later in may prolong maturation with positive impacts on quality). Lack of detailed knowledge on tree phenology was identified as a key constraint and research, including of farmers’ local knowledge about when trees are in leaf, identified as a priority. Tree phenology (of flowering and fruiting as well as leaf duration) is also important for assessing effects of tree cover on biodiversity.

Studies of biodiversity in coffee were geographically and taxonomically skewed with by far the most effort on birds, trees and ants in Mexico. There were also quite a few studies of these taxa in Costa Rica, and eight in Panama but we found no published data on biodiversity associated with coffee at all from Honduras. Considerable research on weeds and insects from a pest perspective, contributed to the knowledge available on biodiversity in coffee but with the same geographical bias towards Mexico as for other taxa. Since coffee is strategically located close to remaining protected forest, many studies explicitly related biodiversity in coffee to tree cover within the coffee and forest biodiversity. Despite the large number of biodiversity studies in Mexico, there were very few instances where coffee productivity and biodiversity were measured at the same site making it impossible to draw direct conclusions relating thresholds of tree cover to biodiversity and productivity simultaneously. The one published attempt to make such an analysis took data on tree cover and ant diversity from one site and compared it with modelled coffee productivity in relation to tree cover, based on data from a different site. This suggested that minimum tree cover thresholds that support ant diversity were at about the maximum level beyond which coffee yields decline so that there was a direct trade-off between biodiversity and productivity. However, it was also apparent that relationships between tree cover and biodiversity vary with taxon, and while trees in coffee can provide habitat connectivity for canopy species (especially some threatened bird and butterfly species), they do not necessarily do so for understorey species (other bird, butterfly, insect and mammal species).

The protocols for data collection on biodiversity and productivity in relation to tree cover in coffee, propose a new and more pragmatic classification of coffee systems than the prevailing system and the inventory of tree cover at individual tree, plot, farm and landscape scales. Integrated assessments of tree cover, biodiversity and productivity at the same sites are encouraged together with a geographical and taxonomic spread of studies along the MBC to develop a better understanding of the connectivity that trees in coffee contribute.

*Deviations from the project work programme and corrective actions taken*

The workshop was moved forward by two months, from a planned schedule in July to May 2006. This was because the process of engaging consultants to prepare background review material on the status of tree cover in coffee landscapes and its effects of productivity and biodiversity was faster than for the respective reviews for pastures and so it was sensible to hold the coffee workshop before the pasture workshop. The change has no adverse consequences for the activity.

*List of deliverables, including due date and actual/foreseen submission date*

Deliverable 4. Report on data available on tree cover in coffee plantations along the MBC and its impact on productivity and biodiversity (due date in proposal June 06; delivered date April 06 to coincide with revised date of the workshop).

Deliverable 5. Protocols for collecting and interpreting data on tree cover in coffee (due date August 06 delivered October 06 following incorporation of perspectives from the synthesis workshop held in September).

***2.3 Workpackage 3: synthesis workshop***

The objectives of this workpackage were: i) to synthesise information on tree cover in the agricultural matrix (on pastures and in coffee plantations) in the Mesoamerican region; ii) to formulate a regional research and development strategy to define thresholds for tree cover in the agricultural matrix along the MBC.

*Progress towards objectives*

The synthesis workshop was held at CATIE from 26-29 September 2006. Three staff attended from UWB (Fergus Sinclair, John Healey and Rachel Taylor) and Professor Ken Norris (a biodiversity expert) also attended from Reading University in the UK. Other notable participants were the subcontractors that prepared the state of knowledge reports (Lorena Soto Pinto, Yasmin Cajas and Meybelyn Escalante) as well as experts from the USA (Celia Harvey and Stacy Philpott), Mexico (Sergio Guevara) and Panama (Jefferson Hall).

The key findings of the synthesis workshop were that research needed to be systematically located along the MBC rather than concentrated at the two ends (Mexico and Costa Rica / Panama), assessment of tree cover needed to be comparable (using the protocols proposed in deliverables 3 and 5) and include the temporal distribution of leaf cover in addition to its maximal extent. The priority for biodiversity assessment was tree characterisation (cover, diversity, stratification) since this was well correlated with habitat provision for other taxa. Beyond this, a more even spread of research along the MBC and amongst taxa was necessary to develop an understanding of the effectiveness of trees on pasture and in coffee to contribute to habitat connectivity for different species. While some coffee studies were related to key elements of the biological corridor, pasture studies were not and, therefore, there was a critical need for integrated studies in landscape mosaics comprising forest, coffee and pastures in key parts of the corridor to develop a quantitative and qualitative assessment of their relative contribution to habitat connectivity and the cost to farmers of maintaining tree cover at levels effective for biological conservation.

*Deviations from the project workprogramme and corrective actions taken*

The workpackage was run as planned and achieved its objectives on schedule.

*List of deliverables, including due date and actual/foreseen submission date*

Deliverable 6. Regional research and development strategy (due date October 2006, delivered as planned).

***2.4 Workpackage 4: dissemination***

The objective of this workpackage was to disseminate project information.

*Progress towards objectives*

The project website was up and running from April 2006, increasingly populated with material as the project progressed.

Key elements of the protocols and regional strategy were also publicised via the LEAD (Livestock Environment and Development) website www.Fao.org/ agriculture /lead and as inserts in Agroforesteria en las Americas – a regional publication from CATIE that reaches over a thousand key research and extension locations in Latin America (http://web.catie.ac.cr/informacion/rafa/).

*Deviations from the project workprogramme and corrective actions taken*

None.

*List of deliverables, including due date and actual/foreseen submission date*

Deliverable 7. Project Website (available as scheduled since April 2006)

***2.5 Workpackage 5: project coordination and management***

The objective of this workpackage was to ensure smooth running of the project.

*Progress towards objectives*

The project ran smoothly according to plan. Adjustments were made, principally swapping the order of the coffee and pasture workshops in response to information that engaging sub-contractors and completing review of tree cover in coffee was going to be quicker and easier than for pastures. This adjustment was successful and the programme was completed satisfactorily. Liaison with CATIE was straightforward by email and telephone in addition to the regular contact facilitated by the three workshops.

*Deviations from the project workprogramme and corrective actions taken*

The only major deviation from the workplan was to swap the sequencing of the coffee and pasture workshops to accommodate the logistics of engaging subcontractors and completing reviews of the two sectors respectively. In the event it was easier and quicker to review coffee than pastures and so the order was swapped. This revised strategy proved successful.

*List of deliverables, including due date and actual/foreseen submission date*

Deliverable 1. Project presentation (produced as scheduled).

Deliverable 8. Final report (produced as scheduled).

Deliverable 9. Final plan for using and disseminating knowledge (produced as scheduled).

**3. Consortium management**

Management of the project was straightforward as there were only two contractors (UWB and CATIE). Dr Fergus Sinclair, project coordinator from UWB, visited CATIE in February 2006 for planning of the workshops and again in October 2006 for liaison with respect to the final report. Sub-contractors were hired and delivered review material on time for workshops as required and set out in the activity descriptions above. Participation at workshops was full and appropriate to the purpose of the project. The only major adjustment to the programme of work was to change the ordering of the coffee and pasture workshops occasioned by the availability of sub-contractors in the respective areas to complete the reviews to the timelines requires for the workshops.

**Annex – plan for using and disseminating the knowledge**

**Section 1 – Exploitable knowledge and its Use**

Not relevant to CORRIDOR.

**Section 2 – Dissemination of knowledge**

The project website (<http://corridor.bangor.ac.uk/>) has been up and running from April 2006, increasingly populated with material as the project has progressed.

Key elements of the protocols and regional strategy have also been publicised via the LEAD (Livestock Environment and Development) website www.Fao.org/ agriculture /lead and as inserts in Agroforesteria en las Americas – a regional publication from CATIE that reaches over a thousand key research and extension locations in Latin America (<http://web.catie.ac.cr/informacion/rafa/>). Rachel Taylor presented a poster on Spatial behaviour of Neotropical birds in a Costa Rican agricultural landscape at the Center for Biodiversity and Conservation Eleventh Annual Spring Symposium at the American Museum of Natural History in New York in April, 2006.

The key intended users of the information generated in this project are researchers working along the Mesoamerican Biological Corridor and CATIE (together with the wide range of workshop participants during the project) are excellently placed to ensure that the information is disseminated and used where it most matters, in the design and implementation of research on tree cover and its relationship to productivity and biodiversity in coffee farms and pastures along the MBC.

The most critical findings of the work relate to ensuring comparability of data through the application of the protocols (Deliverables 3 and 5) and systematic targeting of research effort geographically and in relation to a range of plant and animal taxa and the connectivity of the MBC (Deliverable 6). Opportunities to publish the review material as scientific journal articles will be pursued post–project but there major value resides in informing best practice in research design within the Mesoamerican region already achieved through the dissemination activity documented above.

**Overview table**

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| **Planned/ actual dates** | **Type of dissemination** | **Type of audience** | **Countries addressed** | **Size of audience** | **Partner responsible/involved** |
| 27-28 April 06 | Conference | Research | North and South America, Europe | 500 | UWB |
| From April 06 onwards as deliverables produced. | Publications (inserts in *Agroforesteria en las Americas*)  | Higher education/research/extension | Central and South America | >1000 | CATIE |
| April 06 onwards /achieved | Project website | Higher education/research/general public | Worldwide | Potentially global – likely up to 1 million | UWB |
| June 06 onwards / achieved | FAO LEAD website | Higher education/research/general public | Worldwide | Potentially global – likely up to 10 million | CATIE |

**Section 3 – Publishable results**

Not relevant to CORRIDOR.