



## Editorial

The Kyoto Protocol has been ratified by 129 countries, including all the world's major industrialized countries (except the United States and Australia) which accounted for almost 62% of greenhouse gas (GHG) emissions from industrialized countries in 1990. The protocol came into effect in 2005, and commits those countries to reducing their GHG emissions between 2008 and 2012. To make it easier to respect undertakings to reduce emissions, "flexibility" mechanisms have been introduced, creating markets for emissions reduction certificates. The Clean Development Mechanism (CDM) allows States and industrial entities in the developed world to invest in developing countries, by implementing projects (energy, planting) that are "cleaner" than they would have been in the absence of "carbon" credits. Financial mechanisms should eventually cover the complete life cycle of products, by encompassing production systems and sectorial policies.

For CIRAD, the financial mechanisms relating to carbon constitute opportunities to create a new development dynamic in the South. It is working to establish reliable, controllable carbon budgets, to improve production systems, to develop innovative technologies that could serve to reduce emissions, to analyse the socioeconomic impacts of the solutions proposed, and so on.

If you are interested in the carbon market, or would like to work with us on reducing the greenhouse effect, please get in touch.

**Isabelle GUINET**  
CIRAD Technology Transfer  
and Development Office

### "Carbon" networks

CIRAD is involved in carbon flux measurement research networks worldwide: Fluxnet global network, CarboEuroflux, CarboAfrica and Asiaflux regional networks, etc. The measurement sites run by CIRAD and its partners in sparsely covered tropical zones are essential components in these major networks. CIRAD's results in various types of plantings—eucalyptus in Congo and Brazil, rubber in Thailand, coconut in Vanuatu and shaded coffee in Costa Rica—have been integrated into the networks' databases.

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### Characterizing crop root development

CIRAD is organizing a training course in methods for analysing the root systems of annual and perennial crops in Réunion in December 2008. The methods concerned are original and as simple as possible, to enable their use in the field. The course, entitled *Racinsitu*, will last five days. It is intended for students, researchers and technicians specializing in agronomy or physiology, with an interest in the relations between the soil and plants. Several sessions have already been held in Senegal and Réunion, and others may be organized on request.

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### A Masters selected by the ORPHEME cluster

CIRAD, the Institut Pasteur, the University of Montpellier 2 and Kasetsart University in Bangkok are to launch a Masters in infectious, vector-borne and food-borne diseases, in Thailand in March 2009. The course is open to students and professionals from France and Southeast Asia. It will lead to a dual French and Thai diploma. This university course, which fits in with the ORPHEME competitiveness cluster's priority of "infectious and tropical diseases", has just been approved by ORPHEME.

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### Emergence of economic intelligence

Economic intelligence has gradually become more structured, as a result of studies by various teams working on information management, with a view to responding to the constraints of an ever-changing economic environment. A collective work on the history and foundations of economic intelligence in France has just been published, with the participation of CIRAD: *"Intelligence économique, co-construction et émergence d'une discipline via un réseau humain"* (Economic intelligence, co-construction and emergence of a discipline via a human network). It provides an introduction to the range of approaches and their respective merits.

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### Mediterranean fruit trees

CIRAD, INRA, the CNRS and the Universities of Montpellier (Plant Development and Genetic Improvement, and Center of Evolutionary and Functional Ecology Joint Research Units) are participating in a research programme on the domestication and genetic diversity of Mediterranean fruit trees (olive, almond, grapevine and fig), in conjunction with several Mediterranean countries. Under the programme, they recently received a delegation from Morocco, from the University of Tetouan and the Institut marocain de recherche agronomique (Meknes and Marrakech regional centres) in Montpellier, to draw up new projects and take part in supervising theses by the programme's five PhD students.

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# Science

## GREENHOUSE GAS EMISSIONS IN AFRICA

Africa is very vulnerable to climate change, for ecological and socioeconomic reasons. In view of this, the European CARBOAFRICA project (15 European and African organizations and 11 sub-Saharan countries) is setting up the first continuous greenhouse gas (GHG) measurement network, in Africa. The aim is to quantify, understand and predict GHG emissions in Africa.

**Standard procedures are being drawn up to quantify carbon stocks and fluxes in forest ecosystems**

Besides taking continuous measurements in grassland regions and on eucalyptus trees in Congo, CIRAD and its partner UR2PI are working on the carbon sequestration potential of reforestation projects and

the possibilities of reducing gas emissions following deforestation and forest degradation. Standard procedures are being drawn up to quantify carbon stocks and fluxes in forest ecosystems. These procedures should eventually integrate the reference systems included in the United Nations Framework Convention on Climate Change and be of use in establishing between-country flexibility mechanisms. ■

### Are you interested in our measurement procedures?

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## CARBON BUDGETS IN AGROFORESTRY

The CO<sub>2</sub> budgets of forests worldwide show that evergreen tropical rainforests are characterized by high carbon capture and production, while coconut palm plantations under comparable conditions perform in a very similar way.

CIRAD is working on the greenhouse gas balance of agroforestry plantations based on coconut, coffee, oil palm, etc., with a view to proposing cropping systems that are efficient in terms of carbon capture, and thus good at reducing greenhouse gas levels. In Central America, planting trees in coffee plantings increases the carbon stock in the biomass from 10 to 30 t/ha, compared to coffee monocultures. This “ecosystemic” service rendered could be rewarded through a certification mechanism. A flux tower has just been installed in Costa Rica, in partnership with CATIE, to measure CO<sub>2</sub> fluxes in a planting combining coffee and *Erythrina*, a tree that fixes atmospheric nitrogen. ■

**planting trees in coffee plantings increases the carbon stock in the biomass**

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### Are you interested in agroforestry plantations?

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## SOCIOECONOMIC IMPACT OF INDUSTRIAL FORESTRY PLANTATIONS

Brazil is a pioneer in the field of industrial charcoal production for its steel mills. Its industrial system combines large-scale eucalyptus plantations (several tens of thousands of hectares) with charcoal production and consumption. In a situation of rising land prices and social and political reluctance to extend the area of industrial plantations, small plantings of rapid-growing trees (a few tens of hectares) are an alternative source of supply and are currently the object of development programmes.

Under the European ULCOS (Ultra Low CO<sub>2</sub> Steelmaking) project, CIRAD is conducting research in Brazil aimed at comparing the different production scales, on a cost structure basis, throughout the supply chain providing steelmaking charcoal of silvicultural origin. In addition to the question of land access, the main difference between the production scales appears to be the degree of mechanization of planting, harvesting and carbonization operations. ■

### Are you interested in biofuel-type plantations?

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Measuring CO<sub>2</sub> flux above a coffee-based agroforestry planting, Costa Rica.

# Market

## QUANTIFYING CO<sub>2</sub> IN TROPICAL PLANTINGS

To assess the contribution of the main types of tropical plantings to global efforts to reduce the greenhouse effect, CIRAD has acquired expertise in measuring water and CO<sub>2</sub> flux using the eddy-covariance micrometeorological method in perennial plantings of eucalyptus in Congo, coconut in Vanuatu and rubber in Thailand, and is due to be working soon on agroforestry systems in Costa Rica.

Continuous measurements above the canopy are combined with quantification of carbon stocks and CO<sub>2</sub> flux in different compartments of the ecosystem (biomass, hair root mortality, soil respiration, etc). This information is of interest to the managers of large plantations who are keen to see their contribution to reducing the greenhouse effect certified.

**expertise in measuring water and CO<sub>2</sub> flux using the eddy-covariance micrometeorological method**

Under the European ULCOS (Ultra Low CO<sub>2</sub> Steelmaking) project, CIRAD is also working in Brazil with the forestry research organization IPEF and 11 forestry companies, on the influence of biophysical factors on the sustainability of eucalyptus wood charcoal production. CO<sub>2</sub>, water and mineral fluxes are being analysed in a seven-year eucalyptus crop rotation system. ■

### Are you interested in carbon sequestration by plantations?

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## TRAINING IN THE CARBON MARKET

The carbon market offers new opportunities for agricultural development in the South, by supporting ecosystems on the one hand, and helping to reduce gas emissions and thus the greenhouse effect on the other. Numerous countries and firms are interested in knowing more about the financial mechanisms concerned and mastering the methods for evaluating carbon levels in their ecosystems.

# Technology

## ► COGENERATION OF ELECTRICITY AND HEAT FROM WOOD WASTE

Wood processing plants produce large quantities of wood waste. Moreover, most of the plants in Africa are at isolated sites, and thus need to be energy self-sufficient.

Electricity cogeneration stations use waste to produce both electricity and heat that can be used to dry timber. As the waste is not burnt "in the open", this technology does not emit the greenhouse gases CO<sub>2</sub>, or methane. It is a promising way of generating energy to replace petroleum products.

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CIRAD has looked at the possibility of setting up a 2500-kW electricity generating station at the *Congolaise Industrielle des Bois* plant at Pokola in the Republic of Congo. Such a station would avoid the equivalent of 96 000 tonnes of CO<sub>2</sub> emissions per year. ■

### ► Are you interested in cogeneration?

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## ► BIOFUEL PRODUCTION AND USE

The CO<sub>2</sub> produced by burning fuels obtained from biomass, or biofuels, does not increase greenhouse gas levels, since the carbon emitted was initially drawn from the atmosphere by that biomass during its growth. This applies, for instance, to sunflower, cottonseed, palm and coconut oil.

develop the use of palm, coconut and castor oil to run electricity generators

In the tropical rural world, the fuels used to cover agricultural and energy requirements are primarily diesel fuels produced from petroleum.

To replace these fossil fuels and reduce the greenhouse effect, CIRAD is working to develop the use of palm, coconut and castor oil to run electricity generators. In particular, it is working in Cameroon, New Caledonia, Fiji and Brazil to adapt motors. These oils guarantee energy self-sufficiency by making use of a local resource and avoid the use of 3.2 kg of fossil CO<sub>2</sub> per kg of vegetable oil substituted for diesel. ■

### ► Are you interested in biofuels?

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## ► DIRECT SOWING, MULCH-BASED CONSERVATION AGRICULTURE

Monocultures with massive use of inputs result in environmental pollution and soil fertility losses. Direct sowing, mulch-based conservation systems (DMC), in which the soil is not tilled and has permanent plant cover, and which associate complementary plants that produce large amounts of biomass, protect soils and regenerate their fertility.

CIRAD is working on DMC in Brazil, Madagascar, Laos, Cambodia and Cameroon. The results obtained over the past ten years reveal a general tendency towards increased carbon stocks in soils cultivated in this way. Atmospheric CO<sub>2</sub> sequestration can reach 1.5 t/ha/year in rationally fertilized crop rotation systems, producing around 16 t of recyclable primary biomass (cereal and legume crop roots and mulch) per hectare, per year.

a general tendency towards increased carbon stocks in soils cultivated in this way

Eventually, using such systems could render substantial environmental services: erosion control, improved water quality, and alleviation of the greenhouse effect. ■

### ► Are you interested in conservation agriculture?

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CIRAD therefore runs theoretical and practical courses on these topics, for both the public sector (project leaders, research sector) and the private sector (industrial groups, NGOs, design offices). Since 2005, it has held several courses in the Congo Basin, on the financial opportunities offered by the carbon market and making grant applications with a view to mobilizing such mechanisms in forestry supply chains. In 2007, it also organized a course in methods for evaluating biomass and carbon quantities in the forests, forest plantations and agroforests of Congo, along with the University of Brazzaville and the FAO. ■

knowing about the financial mechanisms concerned and mastering the methods for evaluating carbon levels

### ► Are you interested in the carbon market?

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## ► CHANGES IN THE MECHANISMS RELATED TO CARBON MARKETS

Carbon markets are now a reality. The current so-called "Post-Kyoto 2012" international talks are intended to improve how the existing mechanisms operate and broaden their scope, to include agriculture, forest management, etc, even if this means creating new mechanisms such as the one to "Reduce Emissions from tropical deforestation and Degradation in Developing countries" (REDD)

or that relating to forest conservation.

broaden their scope to include agriculture, forest management

CIRAD is working alongside developing countries to assess approaches that would both safeguard the interests of such countries and comply with the main principles of the Framework Convention on Climate Change, its Kyoto Protocol, and other conventions such as the one on Biodiversity. For instance, with other partners, it is supporting negotiators from countries in the Congo Basin in sub-regional and intercontinental talks to prepare for United Nations negotiations. ■

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## ARCELOR MITTAL

ARCELOR MITTAL is the world's largest steelmaker, and leads the way in the steel industry. CIRAD and ARCELOR MITTAL have been working together since 2003 on reducing greenhouse gas emissions from the European steel industry.



Interview with Mr Jean-Pierre Birat, European coordinator of the ULCOS programme at ARCELOR MITTAL

### ○ What does ARCELOR MITTAL do?

ARCELOR MITTAL is a steelmaker with operations ranging from iron mining to steel manufacture. We produce 118 million tonnes of steel per year and have industrial facilities in 27 countries in Europe, Asia, Africa and the Americas.

### ○ How did you come to work with CIRAD?

ARCELOR MITTAL was one of the first industrialists to worry about the impact of its CO<sub>2</sub> emissions on global climate change. As long ago as 2000, we decided to invest in research to develop a "clean" production cycle. I met Olivier Hamel, a researcher from CIRAD, after a meeting of European project leaders. We had the same view of the climate change issue and the same concerns about finding solutions. In 2003, CIRAD became a partner in our European ULCOS (Ultra Low CO<sub>2</sub> Emission Steelmaking) project.

### ○ What has led you to work with developing countries?

One of the possible ways of reducing gas emissions from steel mills would be to use charcoal instead of fossil fuels. In Brazil, we have concrete experience of industrial

## ARCELOR MITTAL at a glance

Head office: Luxembourg  
Status: European limited company  
Staff: 320 000  
Turnover: 105 billion USD in 2007  
Field: steelmaking

steelmaking using eucalyptus charcoal. And the large industrial plantations in the tropics are likely to be able to produce sufficient quantities of quality biomass.

### ○ What, in your view, are the merits of high-pressure pyrolysis?

The conventional methods used to make charcoal from eucalyptus wood do not give good enough yields to satisfy the demand for charcoal from the European steel industry. To improve pyrolysis, CIRAD suggested working under very high pressure. The laboratory pilot has given good results, but we have yet to scale up the operation to an industrial level.

### ○ What are the most significant results of your collaboration with CIRAD?

Using results from central Africa and Brazil, CIRAD has shown us that eucalyptus charcoal could be used for steelmaking, with almost total "carbon" neutrality provided both plantations and carbonization are both clean and sustainable. It has also shed light on the global feasibility of this type of supply system, by comparing future food requirements, energy requirements and land availability. These factors are very important for our environmental strategy.

### ○ What will you be doing with CIRAD in future? Any new plans?

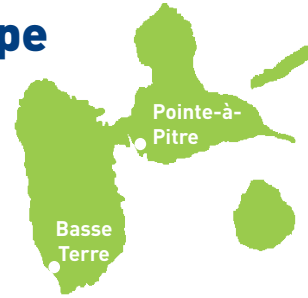
First of all, we have to finish the ULCOS project, which is due to run for another two years, and continue our studies of the sustainability of wood and charcoal production, land availability, competition with other crops, environmental impact, etc. In future, the whole of the life cycle will have to be analysed.

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## Guadeloupe

For 50 years now, CIRAD has been working for sustainable agricultural development in Guadeloupe, in the fields of



banana, sugarcane, pineapple, citrus fruits, animal pathology and the environment. With its research and development partners and the help of the local authorities and State services, it is helping to enhance Guadeloupe's scientific reputation throughout the Caribbean.

### CIRAD in Guadeloupe

has a staff of 112, including 23 researchers. Each year, it receives around ten students, providing teaching in the fields of agronomy, crop improvement and banana cropping systems as part of diploma courses. It has 63 hectares of experimental installations, two molecular and cellular biology laboratories, a radio-element laboratory, a cryopreservation unit, a reference GPS station, equipment for producing healthy in vitro plantlets, and an immunology and biotechnology platform.

CIRAD's operations in Guadeloupe run alongside those of INRA, Antilles-Guyane University and the Comité inter-organismes pour l'outre-mer tropical français.

### Main operating fields

With its research and development partners, CIRAD is working to develop a new type of agriculture that optimizes yields and quality while preserving the environment and biodiversity:

- Improving planting material (banana, sugarcane and yam);
- Designing ecologically intensive banana and fruit production systems that contribute to sustainable supply chain development;
- Studying and maintaining crop biodiversity: sugarcane, mango, yam, banana and ornamental plants;
- Studying the dispersion of pollutants.

With its research partners and health protection services in the Caribbean, CIRAD is studying how animal and plant diseases emerge and how the risks can be managed:

- Heartwater and transmitted diseases, West Nile virus, avian influenza, swine fever;
- Banana Cercospora diseases and viroses;
- Animal and plant epidemiological surveillance networks.

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