FWG-P-08-10

An Innovative 'Closed Loop' System for Sustainable Biofuel, Food and Feed Production.

This project brief has been developed following feedback from the Fuels Group. The project will benefit from members' expertise in particular those who are able to provide input from specific experience of the case studies listed in the project brief. Members are invited to volunteer to participate in a steering group that will provide comment on the findings and the draft report.

1. Purpose

The purpose of the study is to outline ways in which biofuel production can be integrated with food and feed production by making multiple use of crops, including residues and by-products. It will investigate real world examples that demonstrate the concept and identify current hindrances to their more widespread uptake.

2. Background

As the nascent biofuels industry grows rapidly, so too do concerns about its effects on the environment and food production internationally. The greatest threat the industry faces is competition for land. There is an urgent need to find innovative ways of integrating food and fuel production rather than setting the two in competition with each other.

One commonly sited solution is to use residues from food crops (straw, corn stover etc) to make biofuels with the aid of 2nd generation technologies. However, these technologies are still immature and likely to be expensive initially. An alternative that is often overlooked is to turn that model upside down, producing biofuel crops and using the residues for food production. With such co-production of food and biomaterials, the biofuel industry could become a catalyst that empowers greater local food production and prosperity internationally, whilst providing ultra-low carbon fuels for the UK / European markets. This multiple use of land offers the potential to increase productivity using existing resources and easing pressure on expansion into precious ecosystems and natural habitats. Furthermore, if production of biofuels and co-products can be integrated at farm scale, it is possible for water and nutrients to be recycled in a 'closed-loop' system that mimics the cycles of nature and avoids the concept of 'waste' so

common in modern industrial agriculture. Thus, the system can allow for industrial processes (slurry treatment, fuel processing, paper manufacturing from crop residues) to be combined with significant increases in efficiency.

3. Objectives and Exclusions

The study is aimed at:

- Policy makers, both in environment and international development.
  Providing evidence to counter claims that biofuel expansion *always* reduces food production or increases deforestation. Demonstrating that it is possible to increase food productivity and produce low-carbon biofuels synergistically. This report aims to inspire policy makers to think creatively, using biofuel demand to help address some of the world's most pressing challenges by maximising use of resources.

- Businesses in the biofuel industry
  Highlighting market opportunities and ways to increase efficiency of operations, applicable to existing biofuel plants as well as future constructions. Also giving strategic insight into possible future trends in biofuels production internationally.

- Research organizations
  Highlighting areas for further research and development that could help the biofuels industry to continue its growth with maximum benefits for sustainable development.

The study will seek to:

- Establish what the ‘closed loop’ concept means in the context of sustainable fuel, feed and food;
- Bring together existing research on potential uses for residues from the crops and will provide case studies where systems have already been developed;
- Identify steps that existing operations may take to optimise their approach and move towards a ‘closed loop’ system.

The study will:

- Provide specific examples of how it may be used for four biofuel crops typical of different agro-climatic zones. The crops are:
  - wheat (ethanol in UK/temperate countries);
  - sweet sorghum / sugar cane (ethanol in subtropics);
  - oilseed rape (biodiesel in UK/temperate countries) and
  - oil palm (biodiesel in tropics).

- Explain and illustrate how the whole system can be closed to make maximum use of resources in each situation. Uses for the residues (eg. livestock feed

from distillers' grains in wheat) which themselves produce by-products (slurry) and a process for treating them will be illustrated.

- Identify obstacles to implementation and highlight areas of policy that could help to accelerate uptake and adoption of such systems.

Activities

The research element will cover the sourcing and reading of a minimum of 20 reports, articles and papers in scientific journals. The purpose of this will be to uncover how the different systems work, how they might be adapted for use in biofuel production systems and the advantages and disadvantages of doing so.

For example:

- by how much do they increase productivity and save on costs?
- How well developed are they and how easily might they be applied to existing and future biofuel systems?
- Approximately how much land might be saved when compared with current 'standard' methods of production?
- In what other ways might adoption of these systems be better environmentally, socially or economically?
- What are the disadvantages or problems with these integrated systems?
- What are the drivers in countries where they have been adopted?

The research will also involve communication with the authors and institutions responsible for the research, development and reporting of relevant work. All of the following will be among those researched or contacted:
- Schmack bioethanol/biogas plant, Germany (http://www.bio-energyllc.com/About_Us.asp);
- Technical University of Denmark / Riso National Laboratory (http://www.risoe.dk/rispubl/energy_report/ris-r-1430s40_44.pdf);
- CIPAV, Colombia (http://www.cipav.org.co/index.php?option=com_content&task=view&id=101&Itemid=149);
- FAO, Rome (http://www.fao.org/DOCREP/006/Y5098E/Y5098E00.HTM);
- Newcastle University (http://www.ncl.ac.uk/afrd/research/integratedagric/);
- Dr. Jeremy Woods, Imperial College (http://www3.imperial.ac.uk/people/jeremy.woods);
- Dr. John Benemann / IEA Biofixation Network (http://www.co2captureandstorage.info/networks/Biofixation.htm);
- Malaysian Palm Oil Board (http://www.mpob.gov.my/);
- Prof. George Chan / ZERI Institute (http://www.zeri.org/case_studies_pigs.htm);
- VK-NARDEP, India (http://www.ashdenawards.org/winners/vknardep).

The purpose of contacting individuals will be to get an update on latest work, lessons learned and to discuss how current knowledge might best be applied to the biofuels industry specifically.

Exclusions
The study is generic and will not seek to provide specific cost analyses or greenhouse gas balances for any of the systems described.

4. Outline Project Deliverables and Plan

Following discussions based upon this proposal the work is expected to commence in January 08 and will be completed at the end of March 2008.

The main deliverable will be a report, the first draft of which will be delivered in early March 2008. The document will be subject to review by a project steering group and based upon received comments a final report will be submitted at the end of March 2008.

Constraints
All milestone payments must be completed by the end of March 08.

5. Deliverables and Communication Plan

This project will managed by a small project steering group with representatives from key sectors.

The Fuels Working Group (FWG) of LowCVP will oversee the project and members will be able to comment upon documents. The next meeting of the FWG is scheduled for 15th February 2008.

Project sign-off will be via the project steering group in March. Should this not be possible the Director of LowCVP and Chair of the Fuels Working Group will sign off the report.

The programme of activity is shown below. All meetings will be held in London.

Date	**Action**
15.02.08	Advisory group request at Fuels working group meeting
w/c 3rd March	Outline report submitted with initial findings
w/c 10th March	1st advisory group meeting
w/c 24.03.08	Final report submitted
w/c 31.03.08	Final advisory group meeting

6. Consultant details

Craig Jamieson – Consultant

Craig has provided consultancy services for companies, charities and government, including:
2006 - Present: Development work in Africa, focusing on sustainable rural development and biofuel production. Working mostly with NGOs such as SUSCOM and Bulembu Ministries Swaziland. Undertook feasibility studies for installation of a 4.5MW £1M biomass power station to run on timber wastes with carbon trading; 1000 household sewage treatment system using anaerobic digestion; proposed ethanol plant from sweet sorghum with integrated dairy unit; applied for funding to support the projects. Built local capacity by training a young local agriculturist to manage the project in Swaziland, with ongoing support as necessary.
2007 - Present: Non-Executive, Kilimanjaro Biofuels Corporation. Planning oilseed biofuel production in Kenya.
2006 - Present: Director, Sustainable Palm Oil Company. Linking producers in Ghana with potential markets in Europe and Africa.
2004 – 2005: Worked on pioneering rural development project in SW England. Supported rural businesses, assisted in successful fundraising bids.
2003: Business Advisor, Microfinance Company, Kyrgyzstan, Central Asia (voluntary).

Craig obtained his Masters degree with Distinction (MSc Sustainable Rural Development from the Royal Agricultural College and undertook specialist research in advanced biofuel production.

7. Report Outline

Introduction
- Pressures on land resources
- Food demand and growth, especially protein
- Natural habitat destruction
- Growth in demand for biofuels as a threat
- Potential solutions

2nd Generation Technologies:
- Biofuel from food residues v food from biofuel residues
- Current status

Closed Loop System
- Description and rationale
- Options for components of system
  - Cattle / other livestock
  - Paper
  - Bio plastics
  - Anaerobic Digestion
  - Microalgae
  - Fish

- Combined heat and power
Feasibility

Case Study: Wheat Ethanol System
DDG for cattle
Anaerobic Digestion of slurry
Biogas for heating distillery
AD residues return nutrients to wheat field

Case Study: Sorghum Ethanol System
Stem juice for ethanol with bagasse for animal feed
AD of animal slurries
Dry leaves and biogas for heating
Sorghum grain is basic food for local farmers

Case Study: Oilseed Rape System
Pressed seedcake for animal feed
Potential uses for stems and leaves in feed, fibre and energy

Case Study: Oil Palm System
Current use of residues in oil palm mills
Extra residues not used, eg fronds for paper and fibre
Algal treatment of wastewaters
Use of algae in high value fish feed or other livestock feed
Water and energy recycling

Benefits to Sustainable Development
Multiple use of land: co-production of food and biomaterials
Increased efficiency of industrial processes (biorefinery)
Investment in land
Highly productive system
Job creation
Eradication of 'waste'
Ultra-low carbon fuels when co-products considered

Obstacles to Uptake
Market failures
Technical barriers
Areas for R&D
Government policies to speed adoption

Conclusions