Work Package 1.7: Sustainable Crop Systems

- **Required Output 1: Understand and define quantitatively the social, economic and environmental components that confer resilience on arable land use systems.**

Summary

When considering the existing state of arable land in Scotland, it was clear how little knowledge there was of its ecological functioning, and of the recent historical changes in crop sequences and agronomy that led up to its present state. Without this knowledge of recent history and present state, it would be impossible to devise new cropping systems with greater ecological and economic resilience. Accordingly, a major study on farms was conducted from April 2007, supported by analysis of changes documented in the annual agricultural census and other surveys over the past 25 years. The census data was used to examine change in the types of crop and the agronomic inputs, and showed that in the last quarter century, Scottish arable-grass farming had diversified and its regions become more different in terms of the crops, their inputs and the estimated capture of solar energy by fields. The effect these differences might have had on fields was not known, and so a major *baseline study* was carried out on around 100 fields, representing a wide range of farm types, to examine a number of important aspects of the soils, plants, inputs, yield, economics and wider environmental impact. The early results show that fields across arable-east Scotland differ greatly but more as a result of field-management than geography. Among the inputs, the effects of nitrogen and other fertiliser, soil tillage and weed management have the most effect on farm biodiversity and on external impacts such as the ‘carbon footprint’.

Progress was made in two other major areas of work. A general biological-physical framework was developed by which to examine the flows of energy and carbon in fields. The framework uses a ‘common currency’ through which the capture and use of solar energy by crops is compared with the use of fossil energy in establishing, fertilising, protecting and harvesting the crops. The framework will be used subsequently in the project to compare cropping systems and to predict the best future systems that can then be tested on farms. The other area of work involved refining and field-testing a range of indicators for assessing the condition of a field. Some of the indicators measure the physical and microbiological state of the soil, while others assess the food webs, the economic viability of fields and the public acceptability of different farming practices and landscapes. The measurements so far under this required output will soon tell us where we’ve come from and where we are now. Assessing the responsiveness to previous change will enable us to identify those features of arable land that are robust and self-conserving and also those that sensitive and need active intervention to secure long term sustainability of function.

- **Required Output 2: Understanding of how crop management practices may be developed and used to optimise the management of social, economic and environmental components that confer resilience on arable land use systems, particularly those, reducing or reversing adverse environmental impacts whilst maintaining economic sustainability.**

Summary

The emphasis in the first two years was on the first required outcome - and more specifically on understanding the way changes to arable/grass agriculture over recent decades had given rise to the existing states of fields. Work on this second required outcome aimed to prepare the way for major, on-farm experiments that would be laid down in the second half of the five years and would be expected to continue beyond the life of this work package. This preparatory work was of two kinds. The first was to identify varieties of main crop species that would bring, in themselves, environmental benefit or resilience to global change. These varieties would have one or more of the following characteristics: (a) the ability to suppress weeds using much reduced or no chemical herbicides, (b) the ability to use applied fertiliser more efficiently with less waste to the environment or to better mine mineral nutrients in the soil, and (c) the ability of root systems to cope with dry, compacted or waterlogged soils. Substantial progress was made with all three characteristics, to the extent that varieties and genetic traits that reduce environmental cost have been identified (mainly in barley, wheat and potato) and can henceforth be tested in future on-farm experiments. The second kind of work comprised testing concepts and methods on plot-scale experiments that would generate (within a field) a wider range of conditions than would normally be found in commercial agriculture. The purpose was, in some cases to assess the degree to which a field was resistant to change, the rate at which it might be altered and the limits within which it works sustainably: An example of this is an experiment that generated a wide range of soil carbon content: the extremes of the range were sub-optimal for crops while a 'safe' mid-range was identified. The purpose in other cases was to obtain data that could be used to test the framework and model that is being developed under the first outcome. An example of this is the manipulation of the nitrogen balance of fields by imposing different crops, including grazing, and cereals undersown with legumes. Based on such research, the strategy for future field experimentation will be developed during 2008 and implemented from 2009.