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Using agro-ecological zones to promote European collaboration in organic farming research

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Summary

Agro-ecological and other spatial information can be used to improve our understanding of organic farming research issues, inform the application of research from one area to another, and support collaboration and prioritisation within regional research programmes. Of the 25 organic farming research priorities identified by the IFOAM EU Group in 2004, 15 were related to regional differences in agro-ecological conditions. The other priorities were potentially affected by spatial differences in political, institutional and socio-economic conditions. In relation to agro-ecological data, the capacity to identify i) general agro-ecological areas and ii) areas with specific agro-ecological advantage or stress seems particularly useful. The use of a geographic information system (GIS) to integrate spatial data to identify and display such areas is illustrated with two examples.

Key words: geographic information system, GIS, climate, regions, algorithm

Introduction

From 1985 to 2002, certified organic farming in the European Union (EU-15) expanded from 0.1 to 4.4-4.8 million ha, representing about 3.7% of the total utilisable agricultural area (European Commission, 2004; EEA, 2005). This has increased the demand for organic farming research, but research managers have limited budgets and hence it is useful for such managers to identify those research priorities where collaboration is possible. This is particularly the case within initiatives such as the EU-sponsored CORE Organic project (European Commission, 2005). Moreover, because organic agriculture involves the management of farms as “nearly-closed systems”, it is more dependent on specific site-conditions than other forms of agriculture (FAO/IFOAM, 1998).

Spatial data, particularly when used in a geographical information system (GIS) to form maps, can improve our understanding of and ability to communicate the magnitude and regional extent of specific research issues. It can also support the appropriate transfer and application of existing research from one area to another. This paper reports briefly on part of a review which sought to identify how agro-ecological and other spatial data could help inform the prioritisation of organic farming research in Europe (Burgess *et al.,* 2006).

Examples where spatial data have been used to prioritise agricultural research include the USA where a criterion for national funding is that the research deals with national or regional, rather than local problems (US Department of Agriculture, 2006). Matrices are another tool used by decision makers to focus on the important issues when prioritising, with one axis representing options and other axes describing factors such as agro-ecological zones (Mutangadura and Norton, 1999; Fisher *et al.,* 2005).

Materials and Methods

The review was based on information obtained from scientific papers, research reports, and websites. This particular paper focuses on agro-ecological data (i.e. climate, landform, and soil characteristics), but land cover, administrative, agricultural, and environmental spatial information were also considered in the full study (Burgess *et al.*, 2006). In 2004, the IFOAM EU Group identified and described 25 key research priorities for organic farming in Europe (IFOAM EU Group, 2004). These descriptions were used to identify which priorities were associated with spatial differences in agro-ecological, political and institutional, and socio-economic conditions.

Results

Each research priority identified by the IFOAM EU Group (2004) was related to spatial differences in political-institutional, socio-economic or agro-ecological conditions (Table 1).

Table 1. The 25 research priorities described by the IFOAM EU Regional Group (2004). Those mentioning spatial differences in political-institutional, socio-economic or agro-ecological conditions are identified (*).

Research cluster and options			Spatial issues			Brief description of the agro-ecological issue, for those options mentioning spatial differences in agro-ecological conditions
			Political/ Institutional	Socio-economic	Agro-ecological	
Plant production	1.1	Soil and plant health			*	“technologies...tested in different climatic regions”.
	1.2	Novel pesticides	*			
	1.3	Plant breeding			*	“crops better adapted to stressful environments”.
	1.4	Mediterranean pests			*	Mediterranean and temperate systems are different.
	1.5	GMO co-existence	*	*		
Livestock production	2.1	Husbandry and welfare	*	*	*	“different...systems...compared...to optimise use of...contradictory aims (welfare, environment…)”.
	2.2	Livestock breeding			*	Systems “adapted to stress environments” “indicators...tested in...macro-climatic regions”.
	2.3	Immune systems and stress tolerance	*		*	“interactions between…system/method (e.g. intensity, housing)…environment and breeds...” .
	2.4	Alternative medicine	*	*		
	2.5	Dairy production free of antibiotics			*	“holistic concepts.... Prevention strategies by optimising ...housing and free ranging regime...”.
	2.6	Alternatives to synthetic vitamins			*	“in different countries… analyse if and under which conditions insufficient vitamin supply occurs”.
Socio-Economic	3.1	Attitudes of society	*	*		
	3.2	Regionality	*	*	*	“the “bioregions” approach ... should be analysed”.
	3.3	Organic purchasing		*		
	3.4	Social-economics of co-operation	*	*	*	“agronomic, ecological, economic advantages or and obstacles to different forms of co-operation”.
	3.5	WTO requirements	*	*	*	“scientifically quantified and qualified under the extreme variation of site and climate conditions”.
	3.6	Consumer behaviour		*		
Quality, health and security	4.1	Food processing	*			
	4.2	Health and taste		*		
	4.3	Quality and health		*		
	4.4	Certification costs	*			
	4.5	Food security and organic food	*	*	*	“world-wide study to explore….constraints on organic agriculture in ensuring…food security”.
Environ-ment	5.1	Biodiversity			*	“effectiveness of different…systems...in a case study…”. “Recommend…for different ecotypes...”.
	5.2	Nutrient cycles			*	“recommendations...adapted…regional conditions”.
	5.3	Climate change			*	“Long-term comparison trials in different climate zones... as a data source for modelling”.

Agro-ecological differences appeared pertinent to 15 out of the 25 research priorities and differences in political/institutional and socio-economic conditions were associated with the remaining priorities. By analysing the descriptions, it was possible to identify three broad types of agro-ecological issue. Seven priorities (1.1, 1.4, 2.2, 3.2, 3.5, 5.1, and 5.3) identified the need to undertake research relating to different agro-ecological areas. Eight options (1.3, 2.1, 2.2, 2.3, 2.5, 2.6, 3.4, and 5.2) identified the importance of spatial differences relating to specific agro-ecological advantages, stresses or types of animal husbandry. A further two options (4.5 and 5.3) related to food security and climate change implied the use of agro-ecological data to run detailed computer models.

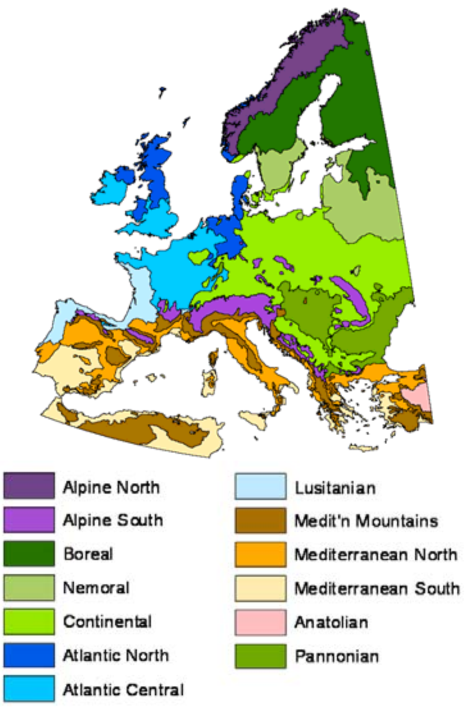
Discussion

The above results suggest that the principal types of spatial agro-ecological information needed to inform the prioritisation of collaborative organic farming research in Europe are the identification of i) general agro-ecological areas and ii) areas of specific agro-ecological advantage, stress, or form of animal husbandry. In each case, there is a need to identify the available spatial data and a method to handle the data. For Europe, there is a range of spatially-formatted climate, elevation, soils, land cover, administrative boundary, agricultural and environmental data that is available free of charge (Burgess *et al.*, 2006). There are also a number of commercially-available geographic information systems that can be purchased to store, integrate, manipulate and display such data.

General agro-ecological areas

General agro-climatic classifications of Europe include the Koeppen climate description (FAO, 1999). Metzger *et al.* (2005) also describe a statistical stratification of Europe into 13 environmental zones (Figure 1a) on the basis of climate and topography, with further divisions into 84 strata. This is available as a vector dataset and it provides a method to identify similar agro-ecological areas or strata for modelling or scaling-up exercises.

a) General agro-ecological areas



b) User-defined agro-ecological areas

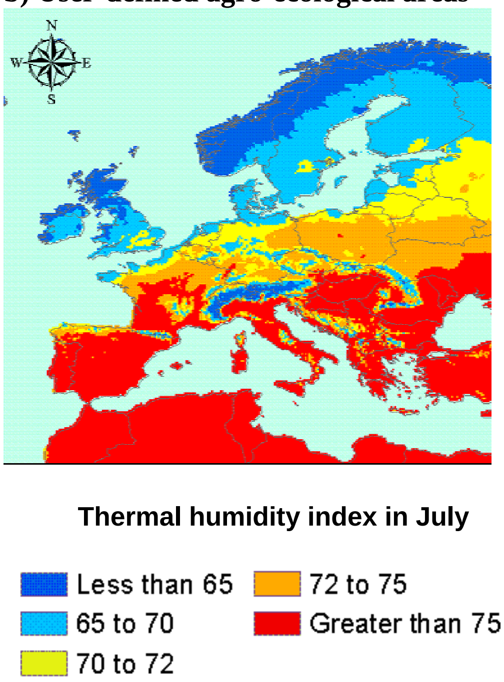


Fig.1 a) The 13 agro-climatic areas in Europe proposed by Metzger *et al.* (2005) and b) an example of user-defined agro-ecological area based on the thermal humidity index for July in Europe (Burgess *et al.* 2006).

User-defined agro-ecological areas

For specific situations, such as plant breeding or livestock husbandry research, it can be helpful to use a GIS to identify user-defined agro-ecological areas. For example in plant breeding it may be useful to identify areas susceptible to a particular disease on the basis of monthly rainfall. In livestock husbandry, Figure 1b provides an example where spatial mean-monthly climate data from the International Water Management Institute (2006) were combined with an algorithm reported by St-Pierre *et al.* (2003) to illustrate where the level of heat stress in July may affect cattle welfare and productivity. A temperature humidity index greater than 70 is reported to reduce the welfare and productivity of dairy cows, whilst the critical level for beef cattle is 75 (St-Pierre *et al.*, 2003). Within a GIS it is relatively easy to produce similar graphs for the average situation for other months or for a month in a specific year. The constraining step is usually the ability to specify an algorithm to define an agro-ecological area. Where algorithms can be specified, such maps can inform where different regions in Europe could collaborate on organic farming research.

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References

Burgess P J, Sannier C A D, Stephens W, Morris J. 2006. Use of agro-ecological and other spatial data to inform prioritisation of organic farming research in Europe. Final report to DEFRA contract OFO355. Silsoe, Bedfordshire: Cranfield University. 25 pp.

EEA (European Environment Agency). 2005. *Agriculture and Environment in EU-15 – the IRENA Indicator Report.* EEA Report 6/2005. Copenhagen: EEA.

European Commission. 2004. Organic farming in the EU. Memo/04/145. Brussels: European Commission. http://www.europa-kommissionen.dk/upload/application/6697349a/udl.pdf

European Commission. 2005. Organic Food and Farming Research in Europe. Luxembourg: European Commission. http://ec.europa.eu/research/agriculture/pdf/organic_farming_en.pdf

FAO/IFOAM (Food and Agriculture Organisation of the United Nations/International Federation of Organic Movements). 1998. FAO/IFOAM Meeting on Organic Agriculture Report. 19-20 March 1998. FAO: Rome.

FAO. 1999. Global Climate Maps. Accessed 11 July 2006. http://www.fao.org/sd/EIdirect/climate/EIsp0002.htm

Fisher D R, Simpson D, Vira B, Chambers W B, Davidson D J. 2005. Chapter 3. R.03 Assessing responses. In: *Ecosystems and Human Well-being: Policy Responses. Findings of the Responses Working Group*, pp. 71-93. Washington: Island Press.

IFOAM EU Group (International Federation of Organic Agriculture Movements – EU Regional Group) 2004a. Future research priorities of organic agriculture. Policy paper of the IFOAM EU Group September 2004. Accessed 16 September 2005. http://orgprints.org/4041/01/ifoam-2004-OA-future-research-priorities.pdf

International Water Management Institute. 2006. IWMI World Water and Climate Atlas. Accessed 11 July 2006 http://www.iwmi.cgiar.org/WAtlas/atlas.htm

Metzger M J, Bunce R G H, Jongman R H G, Mücher C A, Watkins J W. 2005. A climatic stratification of the environment of Europe. *Global Ecology and Biogeography* **14:**549-563.

Mutangadura G, Norton G W. 1999. Agricultural research priority setting under multiple objectives: an example from Zimbabwe. *Agricultural Economics* **20:**277-286.

St-Pierre N R, Cobanov B, Schnitkey G. 2003. Economic losses from heat stress by US livestock industries. *Journal of Dairy Science* **86:**(Electronic Supplement):E52-E77

US Department of Agriculture 2006. United States Department of Agriculture Agricultural Research Service Integrated Farming Systems National Program. Accessed 11 April 2006. http://www.ars.usda.gov/research/programs/programs.htm?docid=331&npnumber=207&page=2