CO1995 C44: AGRONOMY

CHALLENGES OF LOCAL RESOURCE MANAGEMENT (LRM) FOR SUSTAINABLE OILSEED RAPE PRODUCTION

E. SCHNUG, S. HANEKLAUS

Institute of Soil Science and Plant Nutrition, Federal Centre for Agricultural Research, Bundesallee 50, D-38116, Braunschweig, Germany.

ABSTRACT

Local Resource-Management (LRM) is an innovative concept in which traditional methods of field and laboratory soil science are combined with modern procedures and techniques of geostatistics, information handling (GIS) and interpretation together with satellite aided positioning (GPS). This technology opens challenges for the control and spatial manipulation of agricultural inputs such as fertilisers and provides a major tool for a sustainable oilseed rape production in which the problems arising from inherent variability of soils may be addressed successfully.

INTRODUCTION

One of the biggest barriers for an efficient use of fertilisers and other inputs to soils and crops is the spatial variability of soil parameters. Within a single field this can easily be higher than the variability of the same parameter within the surrounding landscape (Schnug et al., 1995). This has consequences for the effectiveness of all variable inputs which are likely to interact with soil parameters. This particularly concerns fertilisers but also certain chemicals for plant protection and weed control. In broader terms one can easily argue that the efficiency of non chemical inputs like irrigation water or seed rates may also depend on and be influenced by the spatial variability of soil features. In the particular case of fertilisers, the result is the disturbing proximity side by side of deficiency and surplus. The first with the result of not satisfying the potential yield and the diminished efficiency of other inputs the second with strong impacts on ecosystems and thus on the sustainability of plant production. Pollution of ground and surface water from agricultural sources, especially with nitrates, is becoming an increasing problem for water resources (Wendland et al., 1993). As earlier attempts to solve the problem failed (Anon, 1994a), farmers are now facing increasing political driven restrictions for fertiliser use (Campbell, 1994; Tunney, 1992). The most recent contribution towards a solution is the recommendation of the Paris and Oslo Commission (PARCOM) to make balanced fertilisation on a field/farm level operational by applying ´Best Environmental Practice` (BEP) for fertilisation in agriculture (PARCOM, 1994). In establishing BEP for fertilisation it should take account of crop requirements and sources of nutrients and their optimal utilisation, regardless of from which source they are derived. At the operational scale it is agreed that balanced fertilisation is only achievable at a field level ***or lower***, but the administrative level for establishing BEP for fertilisation in agriculture should be the farm (PARCOM, 1994). As fields can be of any size, the secret for a successful implementation of balanced fertilisation is the term ***or lower***. The maximum size for the operational scale need to be areas of homogenous features in terms of nutrient dynamics. Extensive studies of soil variability reveal that the average size of these areas is 500-5000 m^2 (Murphy et al., 1994).

NEW TECHNICAL AIDS FOR AGRICULTURAL PRODUCTION

Knowledge about limited fertiliser efficiency due to the spatial variability of soil fertility parameters is probably as old as fertilisation itself. In the past farmers have tried to address inputs manually to varying soil features. However, although this meets the basic idea this way has been very limited. The challenge to deal with this problem by technical means, however, is not only related to technical solutions on the side of agricultural implements (Buschmeier, 1994), but much more to the problem of positioning, navigation and data processing (Anon, 1994b; Schnug et al., 1994). The real breakthrough did come definitively at the end of the eighties with the availability of the 'Global Positioning System (GPS)' to civil users (Hurn, 1989) together with the very rapid development of speed and storage capacities of personal computing equipment. The GPS/computing systems employed in today's agricultural machinery mostly rely on the so called 'Differential GPS' served by DOS processors which allow easy positioning with a positioning accuracy between 3-5 m and storage capacities for the data of up to thousand hectares at a cost level below 10.000 ECU.

THE CONCEPT OF LOCAL RESOURCE MANAGEMENT (LRM)

Computer Aided Farming (CAF) has been the favourite term for the agricultural implementation of this new techniques in the late eighties (Schnug, 1994). Like 'precision farming' this term focused only on a technical aspect but did not acknowledge the idea behind it. Local Resource-Management (LRM) is a term which is devoted to the idea of improving the efficiency of resources by managing them locally. LRM is an innovative concept with a modular structure (Schnug et al., 1993) in which traditional methods of field and laboratory soil science are combined with modern procedures and techniques of geostatistics, information handling (Schnug and Junge, 1994) and interpretation (BOLIDES, Schnug et al., 1994) together with satellite aided positioning (GPS, Anon, 1994b). The objective of LRM is simply to increase the efficiency of fertiliser and other agricultural inputs by identifying the spatial variability of soil fertility and addressing inputs according to the spatial variability of soil properties. An example for spatial variable N-fertilisation to oilseed rape is given in figure 1: compared to common uniform application rate (hatched box), the consideration of the spatial variability of potential yield, organic matter and the terrain model reduced the amount of N by 40%.

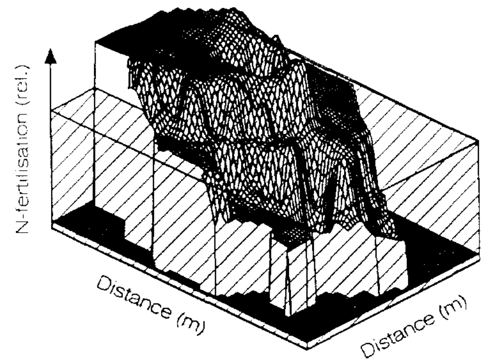

FIGURE 1. Application map for N fertilisation to an oilseed rape on a loamy moraine soil in Northern Germany (hatched box: standard rate of 180 kg/ha N; 3D surface: N rate optimised according to the spatial variability of potential yield, organic matter and the terrain model)

This concept opens challenges for a control and spatial manipulation of any variable input and provides the best chance the best chance for a sustainable oilseed rape production in which the problems arising from inherent variability of soils may be addressed successfully. Meanwhile all technical parts necessary for LRM, combine harvesters (Hanecklaus et al., 1995, Murphy et al., 1994), sampling systems, management software for spatial data and implements such as fertiliser spreaders, are commercial available and it is now possible to enter a new age of agricultural land use (Schnug and Holst, 1994).

CHALLENGES OF LRM FOR SUSTAINABLE OILSEED RAPE PRODUCTION

LRM and its techniques are ready to be used and in the past two years it has been established on numerous European farms. It is to be expected that its future impact on agricultural practice will be as strong as the introduction of mineral fertilisers or farm mechanisation in the past. The benefits of LRM are the identification and localisation of spatial yield limiting factors resulting in increased fertiliser efficiency with minimised losses to the environment. Soil protection will be improved too because information will provide a better base for reliable decision making (Lamp and Basten, 1994). Last not least, the tools for spatial operation will also guarantee that the complex knowledge and skills of farm management can reach soils and crops even with untrained staff. LRM is not devoted to high tech it just uses it to improve and protect soil fertility as one of the most important resources of man.

REFERENCES

Anon (1994a) Daenen melden Misserfolg beim Gewaesserschutz. *Kieler Nachrichten* **230**

Anon (1994b) Einsatz des Globalen Positionierungssystems in der Landwirtschaft. *In: Elektronikeinsatz in der Landwirtschaft. KTBL Arbeitspapier* **175**, 249-263 Landwirtschaftsverlag GmbH Münster-Hiltrup

Buschmeier, R. (1994) Einsatz von Bordcomputern im CAF. *Ibidem* 167-169

Campbell, P. (1995) EC policy regarding pollution of agricultural origin; the Nitrate Directive. *Proc. VIII CIEC Conference Salamanca 1994 (in press)*

Haneklaus, S., Rühling, I. and Schnug, E. (1994) Evaluation of the spatial variability of seed yield and its application to the improved use of natural resources and inputs in oilseed rape production. *This volume*

Hurn, J. (1989) GPS A guide to the next utility. *Trimble Navigation, Sunnyvale*

Lamp, J. und Basten, M. Möglichkeiten der rechnergestützten Pflanzenproduktion (CAF) im Bodenschutz. *In: Elektronikeinsatz in der Landwirtschaft. KTBL Arbeitspapier* **175**, 162-166, Landwirtschaftsverlag GmbH Münster-Hiltrup

Murphy, D.P.L., Haneklaus, S. and Schnug, E. (1994). Innovative soil sampling and analysis procedures for the local resource management of agricultural soils. *Transactions of the 15th World Congress of Soil Science* **Vol. 6a**, 613-630

PARCOM (1994) Draft PARCOM decision on balanced fertilisation and surplus limits and draft PARCOM recommendation on best environmental practice for fertilisation in agriculture. *Oslo and Paris Commissions, New Court, London 15 December 1994*

Schnug, E., Murphy, D., Evans, E. and Haneklaus, S. (1993) Local Resource-Management in computer aided farming: A new approach for sustainable agriculture. *In: Fragoso, M. A. C. and Beusichem, M. L. van (eds.), Optimization of Plant Nutrition*, p. 657-663, Kluwer Acad. Publ. Dordrecht.

Schnug, E. (1994) Computer Aided Farming (CAF) für den Weg in die Zukunft der Pflanzenproduktion. *In: Elektronikeinsatz in der Landwirtschaft. KTBL Arbeitspapier* **175**, 132-134, Landwirtschaftsverlag GmbH Münster-Hiltrup

Schnug, E. und Junge, R. (1994) Strukturierung des Interpretationsmoduls und Konzeption des LORIS (Local Resource Information System). *Ibidem* 150-154

Schnug, E. und Holst, P. (1994) CAF - Realisierung einer ökologischen und ökonomischen Landwirtschaft. *Ibidem* 175-178

Schnug, E., Heym, J. and Murphy, D.P. (1994). A boundary line determination technique (BOLIDES). *Proceedings of the 2nd International Conference on Site-specific Management for Agricultural Systems.* American Society of Agronomy, Madison, WI (in press).

Schnug, E, Oswald, P.and Haneklaus, S. (1995) Organic manure management and efficiency: Role of organic fertilizers and their management practices. *Proc. VIII CIEC Conference Salamanca 1994 (in press)*

Tunney, H. (1992) The EC nitrate directive. *Aspects of Applied Biology* **30**, 5-10

Wendland, F., Albert, H., Bach, M. und Schmidt, R. (eds) (1993) Atlas zum Nitratstrom in der Bundesrepublik Deutschland. *Springer-Verlag Berlin-Heidelberg*