

Wither Agricultural DSS?

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EXTENDED ABSTRACT

Agricultural decision support systems (DSS) may be argued to have passed sequentially through phases of unbelief, euphoria and disappointment and to be passing into either a phase of maturity with realistic expectations of the technology or to abandonment. This paper proposes that agricultural DSS in their widest sense still have a significant role to play in shaping land use and management to meet society's changing requirements. The paper draws its conclusions from the experiences of a team developing farming-systems models and from market research into the commercial potential of such models as DSS.

Within the agricultural DSS literature several reasons have been identified for the limited impact of DSS. Two convincing explanations are that DSS can lack credibility as useful tools and that land managers are resistant to ceding agency in their decision making processes. A third factor is that DSS are trying to enter a niche market already filled by consultants and advisors with well established track records and who are well integrated within the social process of decision making. Credible efforts to overcoming these barriers have undertaken a comprehensive approach to DSS development including the testing of component models, the cost-effective provision of data and the use of participatory action research methods to develop DSS *with* rather than *for* practitioners. Despite shrewd analysis of the problems and viable strategies for overcoming them the development and deployment of DSS still faces criticism that it does not address practitioner needs and socio-political circumstances that can mean insufficient resources are available to implement best-practice.

To abandon DSS as a techno-centric dead-end would be premature. Agricultural systems remain the principal land using sectors in terms of area for much of the world and the effects of management decisions have profound effects for both rural and urban communities. There remain significant *win-win* improvements to resource management within farming systems that are possible and for which agricultural DSS are a suitable vehicle to influencing practice.

For rural land use it is increasingly necessary to recognise the complex trade-offs between the multiple objectives of stakeholders. This is particularly

apparent where outcomes at scales above the land management unit are considered important (e.g. water quality and bio-diversity). Appropriately developed and deployed, agricultural DSS have the capacity to encapsulate scientific, practitioner and stakeholder knowledge and to present the consequences of alternative land use scenarios. They may thus inform the debate on achieving an appropriate balance between economic, social and environmental outcomes. Agricultural DSS are therefore relevant to constituencies of stakeholders beyond land managers. Technically future agricultural DSS would be likely to form part of analytical frameworks that place agricultural systems within the context of wider socio-ecosystems. In this role a DSS or its outputs would be deployed within social-learning processes and function as an object around which parties can debate issues. An example of using a DSS as part of an integrated assessment of EU CAP reform concludes the paper.

1. INTRODUCTION

Within the literature there exists an increasingly well developed analysis of the factors that underlie the effectiveness of DSS particularly in tying the successful use of DSS back to the way in which they are developed. The paper appraises our past and current efforts in promoting the use of simulation model based farm-scale case-studies as a basis for decision support in the context of the DSS development literature. We argue that while there are models of best-practice for DSS development that can ensure their relevance and use, differences in socio-political circumstances and the intended outcomes of the DSS based processes probably mean that such models are not universally applicable.

2. DEVELOPING AND DEPLOYING DSS

Biethahn and Nissen (1995) in discussing the applications of new technologies in management present a framework that is useful in understanding the development of agricultural DSS. They argue that if one graphs expectations of an innovation against time then there is a characteristics series of phases (a modified version of their graph is presented in Figure1).

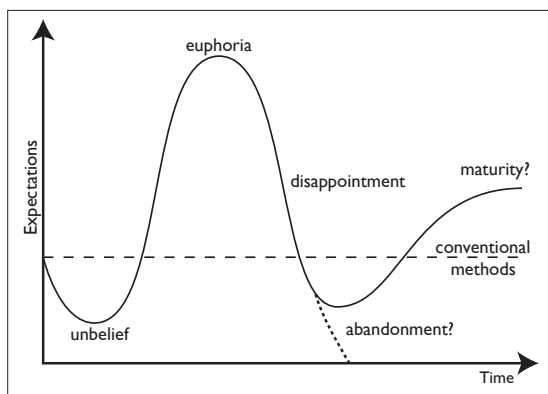


Figure 1. Expectation phases for technologies - modified from (Biethahn and Nissen, 1995)

They identify four such phases that compare performance of the innovation with existing conventional practice, these are: unbelief, euphoria, disappointment and finally maturity. Within this framework we would argue that agricultural DSS are somewhere between disappointment and maturity. The Biethahn and Nissen framework may, however, be unduly optimistic in that perhaps two alternatives exist after disappointment, maturity or abandonment, and it is the latter that has been the fate for sufficient agricultural DSS to give cause for concern. While there are excellent analyses of the causes of disappointment and pathways to maturity (reviewed below) it is interesting to perhaps consider if the

problems of agricultural DSS may not have their roots in the period of euphoria, particularly in techno-centric development processes?

Highly persuasive analyses of the disappointment to maturity phases of agricultural DSS have been presented by Australian-based researchers. These identify the *problem of implementation*, that is the lack of sustained use of agricultural DSS in a way that influences practice (Carberry et al., 2002). This has been seen to have parallels in past attempts to apply DSS based on Operational Research and other approaches within industrial management (McCown, 2002). A key conclusion from this review was that it is only through the existence of a partnership between researcher and practitioner, *within* the research project developing the DSS, that there is much hope the plans generated by the DSS will be implemented.

This analysis was further developed by McCown (2002) in arguing that DSS should try to empower decision makers rather than forcing them to cede agency to *black-box* tools developed by others. This perhaps explains the relative success of ration programmes¹ and accounting tools² since these can be seen as an aid to the land manager in taking control of an activity that may have relied on others such as feed merchants or book keepers. The McCown analysis also identifies the credibility of DSS as being the key to the success of DSS. Credibility is a complex mix of social and technical aspects that requires developers to concentrate on both social networking and the quality of models/data within the DSS. In cases where these are found to be lacking it is necessary to invest resources in improving or providing them (Carberry et al., 2002). Credibility is a far more convincing explanatory property than more techno-centric explanations such as user-friendliness, simplicity or transparency.

The FARMSCAPE approach to developing and deploying agricultural DSS stands as a demonstration of what can be achieved with a participatory action research (PAR) approach, but the form of research may be a necessary yet not sufficient criteria for success. Despite PAR the project was criticised as *ignoring the research needs of farmers* and while that view has been rebutted, there remains concern that those farmers who adopt DSS tend to be the most innovative.

It is important that PAR not be seen as a panacea for agricultural DSS. As Jakku et al. (2004) note PAR has both practical and methodological/ethical challenges. Practically PAR is resource intensive, time consuming, can result in outcomes that are caricatured by conventional researchers as lacking

¹e.g. www.rumnut.com

²e.g. www.farmplan.co.uk

in rigour and results in fewer peer reviewed journal articles. These are all features that mean funding agencies are less likely to want to undertake PAR based development of DSS. Methodological and ethical challenges include the difficulty of identifying stakeholders, the raising of expectations that cannot be fulfilled and unintended negative consequences. Current research teams may also lack personnel trained in the social science theory that underpins the design and/or experience in conducting participatory approaches. Tokenism in participation is a real danger since it both destroys the good will of stakeholders and discredits PAR when projects fail to deliver.

Agricultural DSS development in the UK has also been affected by changes in the EU policy agenda which continues to move from food security and the prosperity of the agricultural sector towards multi-functional rural land use. Prosperity of the farming sector is balanced with food safety, environmental protection and sustainable development (Scottish Executive, 2001, 2002; Policy Commission on the Future of Farming and Food, 2002). While there is disagreement on the extent to which EU agricultural systems are in reality post-productivist (Wilson, 2004) policy change has had profound effects on EU research agendas.

While progress on environmental or resource management depends on the actions of individual land managers there are governance and cooperation issues at a range of scales that complicate the provision of decision support (Wilson, 2004). Where there are multiple-stakeholders, for example in strategic decision making on sustainable development or improving management of common pool resources, when there is uncertainty and disagreement on the goals to be achieved (agreeing normative values) and/or where scientific knowledge is ambiguous then context, social and cognitive factors may combine to make PAR less effective (French and Geldermann, 2005). In these circumstances the role of the DSS may be to act as a *boundary object* to help the communication between stakeholder groups with differing perspectives and knowledges (Jakku et al., 2004).

Even accepting the caveats above, the clear success of FARMSCAPE over other DSS (in the Australian context and relative to the UK) might have been expected to generate similar approaches within the UK where there has been considerable investment in agricultural DSS research and there is scope for *win-win* improvements in resource management (£700 million to £1.1 billion estimated by the Environment Agency Bragg et al. (2005)). The remainder of this paper explores, from the perspective a team involved with agricultural DSS in Scotland since 1992, some of the possible reasons why the comprehensive

FARMSCAPE approach has not yet been adopted and suggests that while the socio-political circumstances in the UK may have been hostile to it, the essence of the approach has potential for addressing agri-environmental issues in UK.

3. PROJECT BACKGROUND

The lineage of the software tools that continue to be developed by the authors goes back into the 1970s with systems researchers working for the UK Hill Farming Research Organisation using models both as part of the research process and to communicate the outcomes to land managers. The early models had a principal focus on the prediction of off-take and growth of sheep (Armstrong and McCreath, 1985), later models also included forestry and did so in a spatially explicit manner using grids of cells (Maxwell et al., 1979). From the late 80's onwards there was a divergence in the models with semi-natural pastures tackled by one team with an emphasis on predicting the impacts of grazing on key herbage species (Hill Grazing Management Models I-III, and later HillPlan (Armstrong et al., 1997)) with the land use planning for upland farms undertaken within a second project (which perhaps significantly had no acronym), (Butcher and Sibbald, 1991). From 1993 onwards this latter model served as the basis for a land use planning DSS with development efforts focused on the integration of a geographical information system with the land use systems models (Matthews et al., 1999). The application focus during this period was on the strategic analysis of farming systems in order to assess the effects of, or responses to, policy with the client seen as the policy divisions of the then Scottish Office.

During this period there was an increasing pressure for research institutes to secure income in addition to their core government funding which was in decline. One of the options considered was to take the then prototype LADSS and to develop it commercially. There was significant debate about the nature of the commercialisation - with the debate informed by the Australian experience following a visit to CSIRO in 1995 and a workshop with a range of stakeholders in late 1997. This led to a formal market research survey, completed in early 1999. The outcomes of the market research led to a significant reappraisal of the efforts in DSS development and deployment (discussed in Section 6.).

4. MATERIALS AND METHODOLOGY

The market research was undertaken by Systems Insight (SI), a market research agency specialising in strategic and market assessment surveys, high tech-

nology marketing and small business development³. SI undertook a postal survey using a questionnaire designed in consultation with the LADSS project team. The questionnaire comprised 9 questions each with check box options and space for additional comments. The distribution of 175 individuals sent questionnaires, classified by target group, is shown in Table 1.

Table 1. Questionnaires by target group.

Target Group	Sent	Resp-%
A - Local Authorities	13	23
C - Corporate Land Owners	5	20
E - Rural Estates	9	55
F - Financial	10	0
I - Interest Groups	15	47
L - Land Use Agents	73	39
P - National Parks and Forests	8	62
S - Supermarket owned - farms	8	12
U - Utilities	27	25
O - Other	7	42

The breakdown of the table is interesting as it reflects the view of the development team that the tool could not profitably be delivered to individual land managers other than those responsible either for large holdings such as estates or those responsible for multiple holdings such as land use agents. The overall response rate was 35%, with significant variability around this figure for particular groups. The lower figures in some instances reflected unsuccessful targeting of appropriate individuals within larger organisations and the higher figures reflected the proactive follow ups by SI.

5. RESULTS

To assess the targeting of the survey the first question asked for the respondents' area of responsibility. The responses in Table 2 indicated that the respondents were broadly in the correct domain with economic, environmental and social responsibilities represented.

Table 2. Responsibilities of respondents.

Area of responsibility	Resp	%
Management/use advice	55	90
Economic impacts	40	66
Environmental impacts	39	63
Social impacts	26	42
Managing rural estates	42	69
Planning the future use	40	66
None of these	2	3

The next question established the *status quo* - which tools and resources were being used and is reported in

Table 3. To some extent this met with expectations - high use of personal judgement (95% - though numbers using only judgement were not recorded) and low use of DSS (3%). The use of computer-based tools was significant with spread-sheets and GIS represented at 44 and 34%. This would seem to back up McCown (2002) observation that software that is controlled by the decision maker is more popular than software that requires any degree of ceding of control. The use of external services at 34% was interesting since in nearly all cases the services were from specialist consultants, from which it was concluded that there was a market for the advice but that it was a niche already filled.

Table 3. Tools and resources being used.

Tool/Resource	Resp	%
Personal judgement	58	95
Crop yield information	27	44
Livestock yield information	23	37
Other information	25	41
Spreadsheets	27	44
Geographical Information Systems	21	34
Decision Support Software	3	5
Other Software	10	16
External Services	21	34
None of these	1	2
Other	7	12

The next question asked for the degree of satisfaction with current tools and resources. The responses (in Table 4) indicated that the vast majority of decision makers were either fairly or very satisfied with current tools and resources. This was interpreted by the market research company as meaning that any venture would face significant competition and would have to demonstrate added-value. The subsidiary question on the likelihood of reviewing tools and resources revealed that 40% would review within 1-3 years, indicating that there was perhaps more fluidity in the market than the satisfaction results alone would suggest.

Table 4. Degree of satisfaction.

Degree of Satisfaction	Resp	%
Very satisfied	10	16
Fairly satisfied	46	75
Fairly dissatisfied	2	3
Very dissatisfied	0	0
Dissatisfied with certain aspects	6	10

The questionnaire then offered a range of features to assess what would be desirable to decision makers. The most desirable feature was the visualisation of scenarios, explaining the success of computer-based mapping software, the desirability of this feature in a DSS and justifying the efforts in integrating the

³www.systems-insight.com

DSS and GIS software. Beyond this there was an interesting tie - between multi-criteria assessment (a feature particularly associated with DSS) and single source information provision (that perhaps explains the success of web portals, such as LaMIS⁴ providing single source spatial data.

Table 5. Desirability of features.

Feature	Resp	%
To visualise land use scenarios as computer based maps	42	69
Faster decision making due to all information in a single source	37	60
Account for social, economic or environmental criteria	37	60
Quick and easy production of alternative scenarios	36	59
Increased objectivity of assessment	24	39
Greater confidence in accuracy of assessments	24	39
Appraise a wide variety of crop and livestock options	22	36
Less fragmented decision making, due to use of single tool	20	32
Improved credibility of decisions	19	31
Other	4	7
None of these	2	3

Going beyond these general categories of improvement the questionnaire sought responses to particular capabilities some of which were under consideration for inclusion within LADSS, shown in Table 6. What is striking is that the capabilities most desired by the respondents are those, that while found in DSS, did not represent what we supposed was the *added value* of DSS - analysis tools. The top three are all information products or presentations of information. The desirability of conservation/bio-diversity may again reinforce the case that DSS inhabit than same niche as consultants, with ecological knowledge seemingly less easily available within organisations yet still often important for many land use decisions. The poor showing conventional single-objective optimisation (21%) may reflect either antipathy to support tools in general (despite the use of an example of profit maximisation), or just to the concept of optimisation per se (since trade-off analysis is nearly twice as desirable (39%). More generally SI commented that the desirability ratings for all the capabilities were such that they would not have recommended dropping any from the overall projects, but in prioritising the key features. Within the team, however, the ranking of the capabilities conflicted with an innovation led science programme.

Beyond the capabilities the survey then asked about the likely reactions to claims that a DSS could deliver

⁴www.lamis.org.uk

Table 6. Proposed capabilities.

Capability	Resp	%
Public designations	41	67
Land use plans on O.S./photo-maps	40	65
UK/EU grant options	39	63
Conservation/bio-diversity values	37	60
Statutory legal implications	35	57
Sustainability	33	54
Impacts on water quality	32	52
Profit and loss accounting	30	49
Profitability: land uses	30	49
3-D visualisation over time	28	46
Taxation implications	26	42
Investment scheduling	24	39
Productivity: land uses	24	39
Trade-offs between objectives	24	39
Waste management planning	22	36
Labour profiling	21	34
Suitability: land uses	20	32
Optimisation (single objective)	13	21
Other	10	16

against these capabilities, with the reactions shown in Table 7. From this table it is clear that while the DSS capabilities are attractive the reality was that decision makers while interested to find out more (36%) were skeptical (31%) and would need previous success stories to convince them (29%). This would seem to chime with Carberry et al. (2002) experience in FARMSCAPE with interest but an initial credibility gap to be overcome. Those interested were predominantly from the agri-businesses and land-agents categories, perhaps seeking a competitive advantage. There was a significant proportion of respondents for which the DSS was not considered relevant but since there was no opportunity to say why it is difficult to interpret this result. Lastly it was interesting to note that there were a small number of respondents that had adopted DSS, and of those none had abandoned then.

Table 7. Likely responses to DSS.

Responses to DSS	Resp	%
Find out more	22	36
Want to see relevant success stories	18	29
Sceptical	19	31
Tools already developing this way	3	5
Not relevant	13	21
Already adopted	4	7
Tried but abandoned	0	0
Other	2	3

As a sub-question to the above the options for service delivery were queried, with software product preferred by 36%, an Internet based service by 13% and an external consultancy by 10%. The results of this question again emphasised the desire for control, in

this case over the software tool itself. This preference was a serious issue for commercialisation potential since it would have involved a major commitment of resources to build and support a software package rather than delivery via the existing consultancy arm of the research institute. Whether web-based tools would now be more acceptable in 2005 would be worth investigating.

The final aspect of the survey explored the possible barriers to using the proposed DSS. The options and the responses are set out in Table 8. Here as might have been expected, cost-benefits are the key barrier, with an upper limit of £5000 and more typical values of £500 to £1000 quoted. While these values are consistent with PC software prices, they are not, other than at the upper end, consistent with the charge out rates for consultants providing professional services. This confirmed that while DSS may be seen as alternatives to consultants they crucially lack the credibility to be valued as such. The other significant barriers are the a priori knowledge that the benefits would not be significant enough (at 30%) and that the decision maker simply does not have a budget for DSS or like software (37%)

Table 8. Barriers to adoption.

Barriers	Resp	%
None - but cost-benefit decision	26	43
Lack of appropriate budget	23	37
Benefits not significant enough	18	30
Traditional methods preferred	8	13
Needs too specialised	8	13
System should be developed in-house	5	8
Decisions based on external advice	5	8
Other	4	7
Negative previous experience	3	5
No reason	2	3
Staff resistance	0	0
Already have a preferred system	0	0

The conclusions from SI were that the DSS as specified had many desirable features and little direct competition, however, indirect competition was significant, there was a high degree of satisfaction with current methods and there was a good deal of skepticism that would have to be overcome. The figures for likely income from such a venture (given the low price per unit) and the preference for software rather than services (raising the investment of development and deployment and support) combined to mean that as a commercial venture there was little reason to proceed further.

6. REACTIONS - THE POST-DSS PERIOD?

Subsequent reevaluation of the direction of the DSS research returned to their potential role in *post-hoc* and *ex ante* policy assessment one of the core roles of the Institute and one with increasing importance since the establishment of regional government in the form the Scottish Executive. Agricultural land managers while still a key stakeholder group since 70% of land in Scotland is under agricultural management were no longer the only stakeholders that had to be considered. The policy agenda for land use was increasingly concerned with environmental protection and sustainable rural development and was thus geared to multi-functional (if not post-productivist) land use. These developments emphasised the need to be able to explore the trade-offs between multiple, non-commensurable objectives, including financial, social and environmental.

The development of the DSS continued with multi-objective land use planning tools (Matthews and Buchan, 2003) but the importance of the social aspects of decision support meant that the team increasingly looked at how the DSS could be embedded within deliberative inclusive processes (DIPs) Matthews et al. (In Press). This approach emphasised application rather than development of the tool. The DIPs involve stakeholders with differing perspectives (for example government, agency and NGO representatives) discussing an issue within a structured workshop programme. They are thus an example of reason-based debate with the aim of better informing researchers, policy makers and stakeholders. While the process may result in empowerment or change in practice this is not the primary intended outcome. The approach is illustrated in Figure 2 and is being applied to CAP reform and climate change topics (Matthews et al., In Press; Rivington et al., In Press).

Figure 2 shows the DSS used as the basis of case study analysis of particular scenarios - usually comparing the *status quo* with another scenario with changed circumstances - typically policy. The definition of the scenarios draws on macro-economic modelling and policy-review to provide a coherent background. Within the workshop process the results from the DSS are presented as the basis for further discussion and analysis by the delegates. Practical planning exercises have been found to be particularly useful in this regard.

The workshop deliberations are structured so as far as possible to capture the aspirations, expectations and adaptations of the delegates to the driver being examined. Less formally but equally importantly the DIPs provide an excellent opportunity to elicit practitioner knowledge - often in the form of

heuristics that can be incorporated into formal analyses (typically restricting the set of alternative options that are considered valid). These outcomes are structured into alternative futures scenarios and serve as the basis for post hoc analysis using the DSS or are used for further macro-scale analysis.

This is less ambitious than PAR approaches but is realistic within the research teams funding structure and directly addresses its primary remit in providing advice to policy makers. This is a good example of where the socio-political circumstances and institutional arrangements mean that even where a successful development path has been demonstrated to be successful it may not be directly transferable.

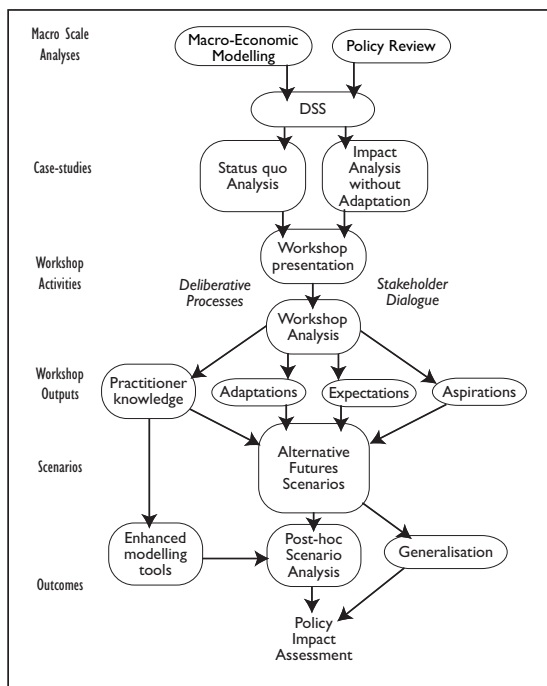


Figure 2. DSS as part of DIPs

7. CONCLUSIONS

From the reviews of DSS implementation, our experiences in developing land-use systems models and applying these in a DSS context and from the market research it is possible to conclude that agricultural DSS are not necessarily heading for extinction since they can be relevant to both practitioners and a wider constituency of stakeholders. For practitioners, PAR based approaches address the key issues of engagement and credibility. The operation of DSS it appears is best undertaken by researchers or consultants but with practitioners. For the wider constituencies particularly where there is debate or conflict over issues then using the DSS (or the DSS as part of a framework of tools operating at a range of scales) as a boundary object within a DIP seems to be promising since it serves both

to elicit stakeholder knowledge and communicate research outcomes. In both cases the limitations on the effectiveness of the DSS may depend less on the technical or theoretical aspects of the tools but more on the institutional and socio-political environment that determines the resources available?

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