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Production planning and the management of information on fish farms: results of a UK survey

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Abstract. In order to assess the attitudes of fish farmers towards data management, and discover the major sources of influence upon planning production, a postal survey among 293 salmon and trout farmers was conducted in the summer of 1987. The degree of microcomputer use and the uptake of automation were examined in this perspective.

Salmon and trout farmers collected production records which, in most cases, were unsuitable for planning. Microcomputers were used mainly for accounting and word processing. Software was commonly purchased 'off-the-shelf'. Computerization when rejected was primarily on grounds of excessive costs and time requirements. Other automation comprised feeding systems and to a lesser extent water parameter monitoring. For decision-making, directors and owners relied heavily on their site managers and foremen to provide feedback. When farms were members of marketing cooperatives or owned by larger firms the latter directed their production and outlets. Accountants were employed part-time to draw the financial accounts, and the proportion of fish farms hiring experts and computer consultants was small. The findings showed that information technology is not a priority among fish farm managers.

Introduction

Despite much interest in fish production techniques and marketing there has been no attempt to quantify the effort and attention paid by management in collecting and processing information for planning and production control nor is there any indication of the contribution of staff. Yet there is recognition of the necessity for timely information and the economic benefits of being in a position to adjust feeding and growth, especially when profit margins tighten (Bregnbale 1986; Blake 1989; Varvarigos 1990). Do farm managers delegate planning responsibilities? To what extent are computers entrusted by fish farmers as tools for not only accounting or word processing but also stock control, record keeping and planning production? Automation and computerized systems have started to gain acceptance by the industry (Balchen 1986; Varvarigos & Horne 1986), but there is no quantifiable evidence of the degree of this technology uptake.

The findings presented here resulted from a UK survey which was carried out privately by the author in the summer of 1987 in order to address these issues. Fish farmers responded keenly to the postal questionnaire* despite the fact that reminders could not be mailed due to constrained resources.

*A transcript of the questionnaire is available from the author on request.

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Materials and methods

In order to identify most of the UK salmon and trout farming population, fish farmers' organizations and feed manufacturers were contacted. A total of 293 fish farm addresses in the UK were obtained from the Scottish Salmon Growers Association (SSGA), the British Trout Association (BTA), the Highlands and Islands Development Board, and the National Farmers Union for Scotland. Questionnaires were sent to all these addresses, requesting wide-ranging information on ownership status, production systems, regular and part-time labour, the role of staff in planning, accounting, record-keeping, and the use of on-farm automation. A separate, blank section was intended for comments. Despite its considerable length, 169 questionnaire forms were properly filled and returned, an overall 57·7% response. Results of this sample are shown here.

In the mail list there were 128 salmon farms, 150 trout farms, and 15 farms producing both salmon and trout, hereafter referred to as 'mixed' farms. The achieved sample consisted of 72 salmon returns (56·3% salmon farm response), 86 trout (57·3% response) and 11 returns from 'mixed' farms (73·3% response). It accounted for 10 100 tons of table salmon and 5500 tons of table trout; 80% and 40% of the total table salmon and trout production for 1987 respectively (SSGA, BTA, personal communications). The sample was stratified into 'salmon', 'trout' and 'mixed' farms, which were subgrouped further according to production type as shown in Table 1.

Observed weights were used to calculate means and standard errors. The sample accounted for more than 10% of the actual fish farm population; however, since the latter was not known with accuracy, standard error calculations did not allow for the 'finite population correction', hence standard errors might be overestimated (Snedecor & Cochran 1967).

The findings are presented in tabular form showing mean proportions with their standard errors in parentheses. Most farmers returned complete questionnaires. Those who did not respond to the question for any particular attribute have been excluded from the respective analysis. The proportions do not always total 100 because farmers did not supply unique answers.

Results

The survey revealed that in 1987 the industry was geared towards expansion, with most companies operating on more than one site. The results are shown in Table 2. Not only salmon farmers, two-thirds of whom operated multiple sites, but also a third of the trout producers operated on more than a single site. Both replied positively to the question of whether they planned to expand further in the next 2 years.

Production and marketing were decided most frequently by owners or the farm directors. To a lesser extent, when farms were offshoots of larger concerns and/or members of cooperatives, plans were imposed by the latter. A very small minority of fish farmers delegated production planning to professional consultants. Accounts, on the other hand, were mostly the responsibility of professional accountants, but managers were partly involved sometimes. It appeared that on small holdings the manager felt confident to draw the farm accounts alone. The role of parent companies and cooperatives was again strong. Findings are summarized in Table 3. The proportions of farms owned by larger companies and those being cooperative members are shown on the third part of the table.

Table 1. Details of the fish farm sample, stratified by types and level of production

		Salmon	Trout	Smolts	Trout fry	Salmon ova	Trout ova	Restocking (*)	
	Returns	(thousand t)		(million)				(thousand t)	(million)
Salmon producers									
Table salmon	37	5·6	—	0	—	0	—	—	—
Table and hatchery	17	4·0	—	3·3	—	12	—	—	—
Hatchery only	8	0	—	1·3	—	0·4	—	—	—
Unquantified production	10	—	—	—	—	—	—	—	—
Salmon subtotals	72	9·6	—	4·6	—	12·4	—	—	—
Trout producers									
Table trout	57	—	4·4	—	0	—	0	0	0
Table, hatchery and/or restocking	14	—	0·5	—	6·1	—	7·0	1·2	0·03
Hatchery and/or restocking	9	—	0	—	13·5	—	0	0·3	0·05
Unquantified production	6	—	—	—	—	—	—	—	—
Trout subtotals	86	—	4·9	—	19·6	—	7·0	1·5	0·08
Mixed (salmon and trout)									
All mixed farms	11	0·5	0·7	0·4	4·7	3·0	44·0	0	0
All fish farms	169	10·0	5·5	5·0	24·3	15·4	51·0	1·5	0·08 (*)

(*) The restocking columns must be considered together, because some fish farmers measured their production for restocking in numbers of fish while others in weight without indicating mean harvest weights.

Table 2. Farm sites and expansion plans of UK fish farms
(a) Mean proportions of farms operating one or more than one sites

	Salmon (%)	Trout (%)	Mixed (%)
Multiple sites	62·0	33·3	63·6
	(5·4)	(5·1)	(14·4)
Single site	38·0	66·7	36·4
	(5·4)	(5·1)	(14·5)

(b) Farms planning expansion between 1987 and 1989

	Salmon (%)	Trout (%)	Mixed (%)
Mean proportions	85·8	69·0	90·9
	(4·1)	(4·6)	(8·7)

Table 3. Decision-making responsibilities on fish farms
(a) Decision-maker of production plans and marketing policy

	Director (%)	Owner (%)	Parent Company Cooperative (%)	Consultant (%)
Salmon	74·6	22·5	14·1	1·4
	(5·0)	(4·8)	(4·1)	(1·3)
Trout	69·0	32·1	8·3	1·2
	(4·8)	(5·0)	(3·0)	(1·1)
Mixed	72·7	27·3	—	9·1
	(13·4)	(13·4)	—	(8·7)

(b) Responsible for the financial accounts

	Director (%)	Owner–Family (%)	Parent Company Cooperative (%)	Accountant (%)
Salmon	13·9	11·1	8·3	79·2
	(4·1)	(3·7)	(3·2)	(4·7)
Trout	15·3	15·3	9·4	72·9
	(3·9)	(3·9)	(3·1)	(4·8)
Mixed	18·2	—	—	90·9
	(11·6)	—	—	(8·7)

(c) Farm busines status

	Independent (%)	Subsidiary (%)	Cooperative member (%)
Salmon	84·6	12·5	2·9
	(4·3)	(3·8)	(2·0)
Trout	89·0	7·3	8·5
	(4·0)	(2·8)	(3·0)
Mixed	100·0	—	—
	—	—	—

Table 4 shows the proportion of the regular fish farm workforce that consisted of professionals, and the proportions of the surveyed farmers who employed part-time professional staff. Whereas technical and management consultants, engineers, pathologists, biologists, marketing experts, solicitors, etc. were occasionally part of the regular farm staff, accountants and computer experts were only employed part time.

Table 5 shows that a substantial proportion of the total 1090 full-time employees in the sample contributed somewhat to production management. They included, apart from company directors, site managers and supervisors as well as farm owners. The degree of participation of middle management — site managers and foremen — in setting production targets was significant. Only a minority of replies indicated a solely day-to-day supervisory role for them. Further, it was revealed that the eventual decision makers — company directors or otherwise — frequently met and discussed production matters with their staff. The majority did so on a daily basis, indicating regular presence on their farms. Most of the remainder held weekly or at least monthly consultation sessions. Overall, an important input of middle managers and their influence in formulating the final decisions was apparent.

On the question of whether production records were kept, the replies were overwhelmingly positive, with the majority of fish farmers keeping their data on paper forms. The first part of Table 6 presents the relevant figures. A few, apart from paper sheets, used also microcomputers to store their records, while even fewer relied entirely on a fully computerized system.

Typically, fish were graded at least twice during each production cycle into two or three size groups. Fish batches were thus spread on the farm and their movements were often recorded. Other recorded data comprised stocked numbers in each container, mortalities, sample weights, feeding, stocking densities, and environmental parameters, commonly water flow, temperature, dissolved oxygen and pH. Farmers were keen to report not only the type of data they collected but the frequency with which it was done as well. The analysis of this information showed that only about a third of fish farmers recorded data which could help with their planning. Most recorded facts in an inconsistent way. In order to plan production at all and to have some control over stocks, knowledge of stocked numbers, feeding, temperature and growth is absolutely essential. This yardstick was used to measure recording quality. The low proportions of farmers who collected these data at least on a monthly basis, or more frequently, are shown in the second part of Table 6. Even diaries were not always updated regularly.

Table 7 presents the fish farmers' own evaluation of the production data they kept. Whatever the data-recording system in use, records were thought to have proved their value on the majority of farms with the exception of some frustrated farmers, who thought that their records were useless, and a small proportion who felt uncertain.

A large proportion of fish farmers believed that their records were not utilized fully in the process of decision-making, but had more potential that was not taken advantage of. The second part of Table 7 shows this clearly.

Although a considerable percentage of farmers were already using microcomputers, as Table 8 demonstrates, the great majority of their uses were accounting, pay-roll, and secretarial tasks, mostly word-processing (second part of Table 8). The proportion of computers used also for record-keeping formed a small minority, and as more farmers reported that they used their computers for planning, this indicated a lack of integrated systems where the recording module would feed information directly into the planning

Table 4. Employment of professional experts by fish farms

	Full-time professionals Other* % total workforce	Farms employing professionals part-time*		
		Accountants (%)	Computer experts (%)	Other* (%)
Salmon	1·4	83·9	14·3	32·1
	(0·4)	(4·7)	(4·6)	(5·9)
Trout	0·3	78·9	9·9	15·5
	(0·3)	(4·8)	(3·5)	(4·2)
Mixed	4·2	90·9	18·2	9·1
	(2·4)	(8·7)	(11·6)	(8·7)

*'Other' comprises professionals other than accountants or computer experts.

Table 5. Contribution to management by fish farm staff

(a) Proportions of employees contributing to management

	Salmon	Trout	Mixed
Total full-time staff	645	373	72
Contributors to management*	21·4%	29·0%	29·2%
	(1·5%)	(2·3%)	(5·4%)

*includes directors, owners, site managers, foremen.

(b) Involvement of middle management* in production decisions

	Participate (%)	Only supervise day--to-day operations (%)	Both (%)
Salmon	14·3	38·8	46·9
	(4·8)	(6·3)	(6·7)
Trout	20·8	35·4	43·8
	(5·6)	(6·7)	(6·8)
Mixed	11·1	55·6	33·3
	(10·5)	(16·6)	(15·7)

*includes site managers, foremen

(c) Frequency of consultations of directors/owners with middle management*

	Daily (%)	Weekly (%)	Fortnightly (%)	Monthly (%)	Occasionally or never (%)
Salmon	59·3	28·8	6·8	8·5	5·1
	(6·4)	(5·7)	(3·1)	(3·6)	(2·8)
Trout	69·2	16·9	7·7	6·2	9·2
	(5·7)	(4·6)	(3·3)	(2·9)	(3·6)
Mixed	62·5	50·0	—	37·5	—
	(17·1)	(17·7)	—	(17·1)	—

*includes site managers, foremen.

Table 6. Production data collection methods and quality of records kept
(a) Collection and storage of production records

	Keep records (%)	Record keeping systems: Manual (%)	Computers (%)	Both (%)
Salmon	94·4	67·6	1·5	30·9
	(2·6)	(5·5)	(1·4)	(5·5)
Trout	87·2	81·3	—	18·7
	(3·6)	(4·4)	—	(4·4)
Mixed	90·9	70·0	10·0	20·0
	(8·7)	(14·5)	(9·5)	(12·6)

(b) Quality of records for planning and stock control

	Salmon (%)	Trout (%)	Mixed (%)
Farms recording stock numbers, transfers, mortalities, sample weights, feeding and temperature at least monthly	33·8	30·7	30·0
	(5·5)	(5·2)	(14·5)
Farms updating their diary at least once a month	82·8	77·8	88·9
	(5·9)	(6·8)	(10·5)

Table 7. Fish farmers' evaluation and expectations of their records
(a) Fish farmers' evaluation of their records

	Useful (%)	Uncertain (%)	Useless (%)
Salmon	89·7	5·9	4·4
	(3·5)	(2·7)	(2·4)
Trout	94·7	1·3	4·0
	(2·6)	(1·3)	(2·2)
Mixed	90·0	10·0	—
	(9·5)	(9·5)	—

(b) Fish farmers' expectations of their present records

	Potential (%)	Uncertain (%)	No potential (%)
Salmon	66·2	5·9	27·9
	(5·7)	(2·8)	(5·4)
Trout	70·7	1·3	28·0
	(5·2)	(1·2)	(5·2)
Mixed	77·8	—	22·2
	(13·9)	—	(13·9)

Table 8. Microcomputers on fish farms
(a) Fish farms with microcomputer systems

Salmon (%)	Trout (%)	Mixed (%)
48·6	29·1	36·4
(5·8)	(4·9)	(14·5)

(b) Uses of microcomputers on fish farms

	Accounts & pay-roll (%)	Word processing (%)	Records (%)	Production planning (%)	Envrionmental monitors Auto-feeding (%)
Salmon	85·7	68·6	11·4	54·3	8·6
	(7·4)	(7·6)	(5·1)	(8·3)	(4·5)
Trout	68·0	68·0	12·0	32·0	—
	(7·8)	(8·5)	(6·1)	(8·9)	—
Mixed	100·0	50·0	—	75·0	—
	—	(25·0)	—	(21·7)	—

(c) Sources/types of software

	Package (%)	Bespoke (%)	Consultant (%)	Combination (%)	Self-made (%)
Salmon	46·9	31·3	12·5	21·9	9·4
	(8·2)	(7·9)	(5·7)	(6·3)	(4·6)
Trout	76·2	33·3	4·8	4·8	—
	(8·4)	(9·5)	—	(4·6)	—
Mixed	—	33·3	—	66·7	—
	—	(27·2)	—	(27·2)	—

module. Data were often kept on paper forms and had to be typed manually into the production planning programme.

Lastly, the least popular uses of computers were to control feeding directly and as monitors of environmental parameters. All relevant figures are presented in Table 8.

The third part of Table 8 shows the popularity of the various sources of software programmes among the computer users. It was felt prior to the survey that fish farm consultants would utilize their expertise and take advantage of an 'information revolution' to develop a range of computer programmes and techniques suitable for their industry. However, it was found that most software was purchased 'off-the-shelf' (spreadsheets, data bases) or written by computer programmers for particular clients (bespoke). It appeared that the industry was deprived of the benefits that could flow from a combination of expertise in fish husbandry and programming skills. The lack of specialized software for fish farmers had led a small proportion of managers to develop programmes themselves (Table 8).

The farmers who rejected the use of microcomputers cited lack of time and the costs involved as the most prominent reasons, whereas doubts, fuelled by the fears of complications that surround computer systems in general, deterred another significant proportion. A minority indicated that the small scale of their operations rendered computerization an unnecessary investment. Despite these reservations many producers were planning to

Table 9. Attitudes towards computerization of non-computer users
(a) Reasons of rejecting computerization

	Costs (%)	No time (%)	Doubts Complicated (%)	Small scale Unnecessary (%)
Salmon	62·9	42·9	20·0	20·0
	(6·4)	(7·5)	(6·7)	(6·4)
Trout	48·1	34·6	36·5	30·8
	(6·9)	(6·5)	(6·6)	(6·4)
Mixed	57·1	57·1	85·7	28·6
	(18·7)	(18·7)	(13·2)	(17·1)

(b) Fish farmers intending to install computers

Salmon (%)	Trout (%)	Mixed (%)
45·9	14·8	28·6
(8·0)	(4·5)	(17·1)

(c) Anticipated uses for the new computer installations

	Accounts and pay-roll (%)	Word processing (%)	Records (%)	Production planning (%)	Environmental monitors Auto-feeding (%)
Salmon	52·9	17·6	70·6	11·8	17·6
	(9·8)	(8·9)	(9·6)	(7·3)	(7·0)
Trout	77·8	44·4	55·6	33·3	—
	(13·3)	(16·5)	(16·5)	(14·5)	—
Mixed	50·0	—	50·0	50·0	—
	(35·4)	—	(35·4)	(35·4)	—

acquire a microcomputer in the future. They anticipated accounting to be the major role of their new computer, but appropriately, the other major use mentioned was record-keeping. Table 9 presents the proportions.

The use of automation on fish farms, not only as regards microcomputers, is gaining momentum (Balchen 1986; Zahradnik 1986), and the postal questionnaire included a small section on the types of any automatic or semi-automatic systems operating on the farms. The results are presented in Table 10, and show that apart from automatic feeding systems which, as expected, were the most popular, temperature and oxygen sensors and aerators were quite common as well as alarms, particularly security alarms. Automatic live fish grading and elevation machines were less common.

Discussion

Drawing from the comments supplied with the questionnaires, the spectrum of fish farm managers as information technology users comprised on the one end those who were 'past their time for education', did not believe that computers could do anything but book-keeping, or thought they were distracting, expensive 'toys' which tied up skilled staff for

Table 10. Automation applications other than computers
(a) Fish farmers using automation other than computers

Salmon (%)	Trout (%)	Mixed (%)
69·4 (5·3)	25·3 (2·7)	90·9 (8·7)

(b) Proportions of automatic systems used

	Auto-feeders (%)	Environmental sensors (%)	Aerators (%)	Graders (%)	Alarms (flow, intruder) (%)
Salmon	98·0 (1·9)	32·0 (5·5)	14·0 (4·3)	6·0 (3·0)	16·0 (5·0)
Trout	48·8 (7·5)	46·5 (7·6)	39·5 (7·0)	32·6 (6·9)	30·2 (6·4)
Mixed	70·0 (14·5)	40·0 (15·5)	30·0 (14·5)	20·0 (12·6)	30·0 (14·5)

information input. In the middle were those who had purchased a microcomputer, usually without expert advice and mainly for their secretary to use. These wondered whether their often inadequate machines could be used for tasks such as stock control or feed scheduling. On the other end of the spectrum were the enthusiastic few complaining about the lack of specialized software; they had programmed their computers themselves or had commissioned this work to programmers.

Despite this diversity of opinion, good stockmanship, experience, skill and dedicated husbandry will never be in doubt or replaced by machines, as a few producers feared. Nevertheless, humans cannot remember or handle all facts and the problem of data management remains unresolved on most farms. Despite their nearly unanimous agreement on the need for good records, fish farmers did not fulfil this function well. Neither was automation of environmental monitoring popular. The great burden of secretarial work was often blamed by those who had abandoned record-keeping and by the majority who felt that the potential benefits were not fully realized. Automatic systems to monitor water quality were rejected as either unreliable or unnecessary in most cases.

Consequently, existing and potential suppliers of computerized solutions and automation have to stimulate demand by educating, training and convincing the prospective clients that their equipment or services are economic and reliable. Considering in tandem the time and effort to develop and test specialized computer software, it is understandable why most fish farm consultants have not targeted information technology as a suitable field to deploy their services and expertise.

Nonetheless, the necessary technology is available (Kennedy 1985; Auld 1986; Traynor 1989), and research has identified the opportunity and suggested solutions (Varvarigos & Horne 1986; Varvarigos 1987). It might be that the willingness to consider the potential deployment of information technology is lacking (McGrath 1987).

Even if most fish farm enterprises do not rely on highly controlled production processes, investing in information technology is necessary in order to provide solutions to mounting

information needs. The industry's own spokesmen (Rackham 1987) have envisaged computer-aided growth and grade profile predictions on individual farms in order to supply their producer organizations, such as the SSGA, with information to coordinate production scheduling and hence selling. Substantial economies could be realized if tighter structure and controls of production were introduced. However, only a significant fall in prices might stimulate groups of entrepreneurs to accept the capital outlay, effort and training necessary to install an information network. The individual producer would then be required to supply forecasts and receive directions from the marketing/selling organization.

In fact, trout farmers avoid price pressures by rigorous marketing and careful expansion. The salmon industry, on the other hand, is powerful enough to reverse the recent trend of falling prices by restricting supply. Either way, production efficiency is not the main priority.

If the current, widely publicized, international efforts to restrict production in line with demand succeed, radical changes in attitude will be unlikely. As long as there is no immediate return on the investment, producers will continue to perceive low opportunity costs for the lack of information technology applications.

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