Making use of technology diffusion

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ABSTRACT

Diffusion is the process by which the adoption of new technologies spreads over time throughout the members of a social system. Many science institutions target their extension efforts at adoption leaders in a population, and rely upon a trickle down of the technology to spread it to the general population.

Diffusion is described as resulting from the effects of farmer characteristics, technology characteristics, farming systems, and communication networks available for diffusion.

The process of diffusion is enhanced by extension activities, and much can be done by scientists to improve the value of their technology to intended recipients. In order to do this, farmers should be involved during the development of technologies to identify the characteristics most important to them and their farming systems. New technologies should be evaluated for their effects upon the whole farm system and upon farmer perceptions.

Sufficient information is needed by potential adopters for them to successfully implement new technology. The information they value most is provided by other farmers with scientific support for the essential principles they should apply.

Keywords: extension; diffusion; communication.

INTRODUCTION

Many speakers at agricultural conferences (eg: McDonald, 1975; Macmillan, 1980a) over the past 30 years have expressed concern at the lack of uptake within the agricultural industry of new technology developed by research institutions in New Zealand. Concern centres particularly on hill country production of meat and wool, in which output has been conservatively estimated to be capable of a 50% increase (Parker *et al.*, 1977). The non-application of technology has been considered a matter of "national concern" (Macmillan, 1980a).

These concerns reflect a pro-innovation bias that is the basis of traditional diffusion models. In these, the value of new technology to its intended users is assumed to be worthwhile for all farmers; and if farmers have not adopted the technology, then someone should be blamed and held responsible.

The conference speakers have considered that new technologies were not diffusing adequately through farming communities and that both extension agents and farmers should move to remedy the problem. To improve diffusion rates the factors affecting them need to be addressed. Previous research has described these factors as characteristics of: farmers, the technologies themselves, production systems, and communication channels. Each of these will be addressed below.

1. Characteristics of Farmers

Personal characteristics of farmers have been used to define at what stage (early, middle, or late) in the diffusion process a group of farmers were likely to adopt new technology. Most research in this area suggests that early adopters tend to have higher income, higher education, greater mobility between social groups, more favourable attitudes towards risk, greater social participation, and are younger than the majority but later adopting farmers.

Early adopters have been thought to pass information on new technology to their neighbours and friends by personal influence and word-of-mouth (e.g. Milne, 1990). In a similar manner, management techniques adopted by members of discussion groups have been presumed to "spill over" to non-members through personal contact (McKenzie, 1980); continuing differences in management techniques and production between group members and non-group members implies that "spill over" effects are sometimes very limited (Johnson, 1993). The effectiveness of a "trickle down" approach from early adopting farmers is itself disputed (Röling 1988) and many New Zealand technologies have not diffused very widely in this manner e.g. the mating of yearling beef heifers (New Zealand Beef Council 1989).

One reason for this lack of "trickle down" from innovative group members to their neighbours is that they are too heterophilous - too different, in terms of their access to resources, production objectives, and opportunities (Röling, 1988). Groups that are homophilous with regards to these are likely to have similar technology needs. Introduced technologies will diffuse through the groups until reaching social or system barriers. Within a homogeneous group, a desirable innovation will diffuse regardless of any intervention (such as an extension effort) (Röling, 1988). However extension programmes can speed up rates of diffusion and assist technologies cross heterophilous barriers. Perhaps the more desirable a new technology is perceived to be by the farming community, the less of a problem heterophilous barriers will be (Macmillan, 1980b; Elworthy, 1976).

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2. Characteristics of New Technology

Some researchers have studied the perceived characteristics of new technology as an effective predictor of adoption levels (e.g. Fliegel *et al.*, 1968; Kivlin and Fliegel, 1968). The perceived characteristics found to be positively related to adoption have been: the relative advantage it has over existing technologies, the level of compatibility it has with the existing operation and existing values and beliefs; the trialability of the new technology; and the observability of the technology in application.

Perceived characteristics that may be negatively related to adoption are the apparent complexity of a new technology, and the level of risk associated with it.

Research by Parminter and Greaves (1993) compared farmer characteristics, farmer enterprise beliefs, farm system variables, and technology characteristics, as predictors of adoption of three beef breeding cow technologies. Technology characteristics, as perceived by the farmers surveyed, provided a better predictor set than any combination of the other variables.

3. Characteristics of the System

A number of researchers have incorporated system effects in recent studies, recognising that farmers who know about an innovation suitable for their farming operation, and who are willing to adopt it, cannot do so because of the institutional environment, lack of skills, or lack of resources (Galjart, 1971; Ashby, 1985; Hooks *et al.*, 1983). Limiting resources may include suitable labour, credit and material prerequisites.

Some New Zealand studies have identified system impediments to the adoption of innovations, for example Kaplan *et al.* (1978), identified low farming profitability and lack of suitable labour as factors preventing the adoption of land development techniques in their survey of a valley near Wanganui.

In their study of King Country breeding beef cow farmers, Parminter *et al.* (1993) described the importance of system effects of breeding cows to the farmers surveyed. These effects included their complementary nature when integrated with a sheep production system, a reduction in total farm labour requirements, more flexible farm cashflow management, and their dependence upon cattle trading trends (table 1). Evaluations of different enterprises and new technologies have often been carried out on a marginal basis not including the value of the system effects described above. Some of the papers presented at this conference are exceptions to that (e.g. Lowe, 1994, Webby & Thomson, 1994).

The farmers surveyed in the King Country study were very aware of the effects they perceived new technologies would have upon their farming systems. The most common reason given for their rejection of crossbred cows and terminal sire technologies were their incompatibility with existing farm operations.

System effects are best identified as a result of involving the targeted users of research (e.g. farmers) themselves (Chambers *et al.* 1989). To be able to control the system effects scientists require an understanding of how characteristics of new technology are likely to impact upon the existing system; and how the results of such changes will affect the attitudes of users towards adoption (Saunders and Townsley, 1991). Compatibility of new technology with existing farm systems, improves its diffusion rate as described earlier.

TABLE 1: Farmers' beliefs about the benefits of their cattle breeding enterprise.

Beliefs	Proportion (%) of Farmers with Belief
Breeding cows are good for *pasture improvement* and weed control. They improve pastures from year to year.	45
Breeding cows provide *complementary grazing*. They control surplus summer growth, conditioning pasture for other stock classes. They are especially good at preparing feed for lambs to be finished.	74
Breeding cows have a *feed demand that matches* feed supply. They are easier than finishing animals to winter, and their nutritional needs are flexible if feed is short in winter.	15
Breeding cows are *self replacing*, reducing the risks of having poor quality replacement (breeding and/or finishing) stock.	47
Breeding cows are good for *capital management*, building up a relatively liquid asset that can be drawn upon for income stabilisation or for alternative investments.	11
Breeding cows are *more profitable* and less risky than other enterprise options. They have lower costs than other enterprises. They diversify a farm's income source. They increase a farm's flexibility as calves can be sold or reared a further one to three years.	34
Breeding cows *improve cashflow* management within a season.	6
Breeding cows are *less work* than other enterprise options. They enable more time to be spent on the farm rather than at sale yards buying replacement cattle. Farming breeding cows builds on existing management skills.	20
Breeding cows are an *easy-care* enterprise. They have better footing and better foraging ability than bulls or large steers. It is easier to shift cows with dogs than it is for them to move bulls. They have less health problems than other livestock options.	21
Breeding cows are more *compatible* with limiting topography or farm practices. Breeding cows are able to graze areas inaccessible to other livestock classes, particularly steep land not suitable for steers.	
Breeding cows are suited to organic farming.	7

Communication Networks for Diffusion

Communication channels need to exist between individuals in a social group to transfer information about new technologies before diffusion can occur (Röling, 1988). A 1993 survey of the Te Anga community (forty five farming households) indicated that their information sources for fertiliser, pasture species, beef breeds, cattle feeding, or beef cattle sale policies varied depending upon who in the community they perceived as being most experienced in those areas. Such people needed to visibly demonstrate their success with new technology before other farmers would try it out.

The adoption of technologies like fertiliser policies and cattle sale policies requiring external (to the community) sources of information as part of rational decision making, were almost always a result of information provided by change agents not living within the community e.g. stock and station agents, and farm consultants. There was very little farmer-to-farmer diffusion of such technologies.

Some New Zealand researchers and farmers have commented that farmers would have a more positive perception of new technologies if they were demonstrated on farmers' properties (Inder, 1990; Pinney, 1978; Macmillan, 1980 (a) and (b)), and farmers' needs and views were incorporated in the research programme (Pinney, 1978). When clients are involved in the design and development of innovations, the results are more likely to be an improvement on the existing production system, more likely to be usable, and more likely to be accepted by the clients (Williams and Gibson, 1990).

CONCLUSIONS

Each type of new agricultural technology will have farmers with favourable production systems able and interested in taking up those technologies. The characteristics of the farmers who do so will depend upon how the new technologies impact upon their farming systems and their farming style. The rate at which new technology diffuses through a population will depend upon how homogeneous the population is with regard to these factors and how dependent successful implementation of the technology is upon external information sources and their availability.

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