Adoption and Diffusion of Technology: an Overview

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Abstract

There is a vast literature on innovation adoption and diffusion, and no attempt is made in the paper to provide an exhaustive review of this. Instead, a simple conceptual framework of the innovation adoption process based on recent research in this area is developed. The model is then used to classify and critically assess the different types of adoption and diffusion studies, many of which contain apparently conflicting results. However, a much clearer picture of the constraints to adoption and of the determinants of rate of innovation diffusion emerges from a selective review of the empirical literature using the conceptual model to filter out misleading findings. The primary consideration is that the technology be appropriate to the potential adopter, in the sense that adopting the innovation is in his/her best self-interest. If this critical precondition is not met, then any initial adoption will be ephemeral. On the other hand, given fulfilment of this condition, there are some prospects for speeding up the rate of diffusion by attention to factors such as innovation testability, and to communication channels for information about innovation productivity.

THE study of technological change is important for a number of reasons, including notably the pivotal role that it plays in the process of economic growth. Technological change involves two subprocesses. The first is the generation of new technologies. The second is the adoption of such technologies by producers, etc. Although innovation development is a necessary condition for adoption, the potential benefits from development of new technologies can only be realised once they are adopted. Furthermore, the rate of return to society on the development of new technologies depends, among other things, on how quickly such benefits are realised. Hence, the rate at which adoption of innovations diffuses through the population of potential adopters is an important determinant of economic growth.

This paper focuses on the phenomena of adoption and diffusion of new production techniques (sometimes called *process* innovations). The term adoption will be used to denote the process whereby an individual producer decides whether or not to use the new production technique, while the term diffusion will be reserved to describe the cumulative spread of such adoption decisions over time and through space.

The literature on innovation adoption and diffusion is vast and growing. An insight into the explosion of research on this topic is provided by Rogers and Shoemaker (1971). In the preface to their book entitled 'Communication of Innovations — A Cross-Cultural Approach', they note that Rogers (1962) was able to base the previous edition on only 405 reports, which were kept in a cardboard box. By the time of the second edition eight years later, the number of publications had trebled, and the authors found that they needed to develop a computerised database to keep track of all the publications. Since 1971, the literature has continued to grow, and no one now claims to be aware of all publications on the topic, let alone to have read them all.

Worse still, any attempt to present a comprehensive review of this literature here would not be enlightening. On almost any issue relating to information adoption and diffusion, it is possible to find studies which reach contradictory conclusions. There are a number of reasons for this unsatisfactory state of affairs, some of which will be discussed in the selective review of empirical studies in the third section of this paper. The different types of research are put into perspective

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there, so that readers will be better able to judge the relative merits of individual publications. Before doing so, a model of the innovation adoption process is described in the next section. The conceptual framework so developed is quite simple and serves as a useful reference point for the subsequent literature review. Like any attempt to simplify, however, it has its limitations. In the fourth section of the paper, some of the deceptively simple concepts are discussed in more detail to provide some appreciation of the diversity encountered in the adoption and diffusion of actual innovations.

The Modern Theory of Innovation Adoption and Diffusion

Adoption is essentially a simple process despite the diversity in type of innovations, characteristics of potential adopters, patterns of innovation diffusion, and time taken by different individuals to decide to adopt/reject any particular innovation. Basically it involves just two universal components, namely risky choice and the acquisition of knowledge (i.e., learning).

At any point in time when a potential adopter has to decide whether to adopt or not, he/she will be uncertain about the consequences of this choice. The choice is risky in the sense that uncertainty exists about whether the decision-maker will be made better off or worse off by adopting the innovation. Some of the complexities involved in the concept of 'best self-interest' (or 'own welfare' or being 'better off') are discussed later. For the time being, it is sufficient for the decision-makers' best self-interest to be defined by the action each would choose if they had complete, but not necessarily perfect, knowledge.

Since the choice of technique decision is contingent on the uncertain state of knowledge, it must be based on subjective beliefs incorporating currently available information. Even though the decision-maker might be uncertain about the outcome of several uncertain future events which impinge on this decision, basically there are only two possibilities (or STATES of the 'world'):

STATE I: The innovation is *in fact* 'GOOD' for the potential adopter in the sense that it would be adopted given complete knowledge.

STATE II: The innovation is *in fact* 'BAD' for the potential adopter in the sense that it would be rejected given complete knowlege.

For this simple situation, it is possible to classify decisions into one of only four possible categories illustrated in Figure 1. The possiblity that the decision-maker will make an *incorrect* decision is represented by cases 2 and 3 in Figure 1. Using the terminology of statistical hypothesis testing, these two cases of incorrect (wrong) adoption and incorrect (wrong) rejection involve type 2 and type 1 errors, respectively, if the null hypothesis is that the innovation is 'good'. Clearly, cases 1 and 4, which represent correct adoption and correct rejection, respectively, involve no error on the part of the decision-maker.

The likelihood of making a correct, or incorrect, decision clearly depends on the decision-maker's knowledge of the relevant parameters. In particular, the greater the potential adopter's level of knowledge about the performance characteristics of the innovation, the less likely it is that an incorrect choice of adoption decision will be made. However, as noted above, adoption is above all else a dynamic learning process. Analytically, this learning process can be treated as comprising two further sub-processes: the first is the acquisition of information; the second is the incorporation of this information into the potential adopter's PRIOR beliefs to form revised, or POSTERIOR beliefs about innovation performance. Because these beliefs are likely to change over time as the potential adopter acquires more information about how the innovation can contribute to his own welfare, the choice of technique decision is likely to be reviewed periodically. Hence, an individual may well change a previous adoption decision, and thus move from one to another of the classifications in Figure 1. In particular, a subsequent adoption by the majority of potential adopters who initially reject an innovation represents a movement from case 3 to case 4 in Figure 1, thereby eliminating type 1 error. By the same token, some adopters of an innovation might subsequently decide that their first choice was a mistake, and reverse this decision. This subsequent rejection is depicted in Figure 1 by a reclassification from case 2 to case 1, thus eliminating type 2 error.

To summarise, the adoption process can be characterised as a sequence of risky choices. Initially, the potential adopter knows less about the innovation than about the alternative technology,

		States - actual value of the innovation (i.e., with complete knowledge)	
		Innovation good	Innovation bad
Subjective beliefs (i.e., with incomplete knowledge)	Adoption (increases welfare)	Case 1 Adoption correct (no error)	Case II Adoption incorrect (type 2 error*)
	Rejection (increases welfare)	Case III Rejection incorrect (type 1 error*)	Case IV Rejection correct (no error)

Fig. 1. A classification of four possible types of innovation usage decision given incomplete knowledge.

but this information asymmetry is progressively eliminated. Immediate adopters learn from trial use of the innovation, while immediate rejecters are forced to learn by oberservation. The adoption process terminates when the potential adopter is equally well, or poorly, informed both about the traditional technique and the innovation, and on this basis makes a final choice between adoption and rejection.

Equivalently, diffusion of an innovation amongst a population of potential adopters essentially involves a transition over time and space from a situation of incomplete knowledge to one of complete knowledge. Many individuals, through ignorance, initially make adoption decisions which are not in their own best interest, but progressively such errors are corrected through the accumulation of knowledge. The diffusion process is complete when all those who could benefit from adoption have done so, and when all those who would not benefit from it no longer use the innovation.

The Empirical Record — Warnings

The conceptual model outlined above has its roots in the insights of Schultz (1975), who depicted adoption and diffusion as processes of adjustment to a state of disequilibrium created by the development of new technology. From this perspective, there are clearly two fundamental questions which need to be addressed by empirical research.

The first concerns the determinants of the ultimate adoption decision, which is essentially a static issue. In other words, once the adjustment process is complete, what determines whether a particular producer adopts or rejects a given innovation? In more aggregate terms, what determines the proportion of the potential adopter group to ultimately adopt the innovation?

The second question concerns the determinants of the adjustment process. In contrast to the first question, this is a dynamic issue. For innovation adoption, this question translates into: what determines the length of the time lag from development of the innovation to its adoption by the individual producer? With respect to the diffusion process, the equivalent question is: what determines the time lag between adoption of the innovation by the first and last members of the potential adopter group to do so.

Any attempt to deduce unequivocal conclusions about either of the above issues from the vast amount of empirical research on this topic invites frustration because of the diversity of findings. This confusion of results can be ascribed largely to poor methodology. To provide the basis for a more selective and discriminating assessment of the reported results of empirical studies, this section is devoted to a discussion of methodological problems before returning to the substantive questions in the next section.

The bulk of empirical studies which address one or other of the two fundamental questions outlined above can be classified into one of the following categories.

A. Adoption Studies (concerned principally with adopter characteristics)
  1. Cross-sectional (i.e, why do some producers adopt an innovation, while others reject it?)
  2. Temporal (i.e., why are some producers early adopters, while others are laggards?)

B. Diffusion Studies (concerned principally with innovation characteristics)
  1. Cross-sectional (i.e., why are some innovations widely adopted, while others are not?)
  2. Temporal (i.e., why do some innovations diffuse more quickly than others?)

Cross-sectional adoption studies account for a significant proportion of empirical studies on innovation diffusion and adoption, but have contributed very little to understanding these processes. In most of these studies, an attempt is usually made to identify differences between those farmers who adopt, and those who do not. An almost exhaustive list of 'explanatory variables' has been investigated in these, albeit not all in the same study. The following examples taken from literature reviews by Jones (1967), Rogers (1983) and Feder et al. (1985) are only illustrative.

(a) Personal attributes of decision-makers as suggested by rural sociology theory (e.g., IQ, social status, attitudes to progress, cosmopolitism, level of income or wealth, etc.), and/or by economists' expected utility theory and human capital theory (e.g., level of general and/or vocational education, attitudes to risk, etc.);

(b) Attributes of the firm, such as firm size, degree of diversification, form of business organisation, distance to markets, etc.;

(c) Attributes of the social system constraining adoption, such as social mores, inadequate communication channels, etc.;

(d) Attributes of the economic system constraining adoption, such as unsuitable tenurial arrangements, lack of credit, labour supply problems, etc.

Collectively, the results from such studies are distinguished first by generally low levels of overall explanatory power, and second by mutually contradictory findings concerning the importance of any given explanatory variable. While the diversity of human behaviour is notoriously difficult to explain, there are other methodological reasons for these poor results.

One problem which is not specific to this class of studies is poor model specification. Many of the early studies used only univariate analysis, and most of those which used multivariate analysis included only a small subset of the explanatory variables required for a fully specific model. Consequently, the results are likely to suffer from omitted variable bias.

Another problem is the use of a binary dependent variable. Classifying a population of potential adopters into just two groups of those who have or have not adopted at a particular time, discards much of the information potentially available on the diversity of adoptive behaviour, thereby markedly reducing the power of any statistical tests. As noted below, this is solved in the following class of temporal adoption studies.

The most serious problem, though, is a conceptual failure by most authors to appreciate the significance of the dynamic learning process underpinning innovation adoption. At any stage during the diffusion of an innovation, much of the observed differences in adoptive behaviour will be due to different perceptions, based on different levels of knowledge at that moment, about the utility to be derived from adoption. Consequently, attempts to relate possible explanatory variables to individual adoption decisions before the diffusion process is complete are almost guaranteed to produce misleading results. Surprisingly, studies which commit this form of fallacy continue to be published, as is evident from the recent exchange between Braden and Eales (1986) and Rahm and Huffman (1986).

The problem can be avoided in one of two ways. One is to elicit subjective beliefs about innovation productivity, and to relate adoption decisions to these beliefs instead of, or as well as, to other more objective variables. To date, very few empirical studies have followed the pioneering work of this type by O'Mara (1971). More such studies are needed to better understand the determinants of inter-firm differences in the adoption decision time lag, and of the associated dynamic learning process.

The other approach involves avoiding the problem of differential knowledge levels by waiting until the diffusion process is complete. Analysis of the adoption/rejection decision can then proceed on the basis that all producers are fully and hence equally well informed. Two examples of this approach which are further discussed later in the paper are the studies by Perrin and Winkelmann (1976) and Gladwin (1979). Note that, in contrast to the first approach, these studies provide insights into the first fundamental, but static, question of what ultimately determines innovation adoption.

The impetus for the second category of temporal adoption studies can be traced back to the findings of sociologists such as Ryan and Gross (1943) and Beal and Rogers (1960) that substantial time lags typically occur between availability of an innovation and awareness of its existence by potential adopters, and from time of awareness to time of adoption. Again, the aim of these studies is to contribute to a better understanding of the dynamic learning process by accounting for differences in adoption time lags.

Indeed, some of the foundations for the central role assigned to learning in modern models of the adoption process can be traced back to the group of early sociological studies which classified adopters into categories according to time of adoption. These studies represented an improvement over cross-sectional adoption studies by discarding a binary classification (adopt/not adopt) in favour of a multi-category classification (e.g., adopt early/mid/late/laggard). Unfortunately, most of these early temporal adoption studies still employed unsophisticated analytical techniques and, like the cross-sectional studies, suffered from the problems previously discussed of specification error and omitted variable bias. In a recent empirical investigation of the adoption of trace element fertilisers, Lindner et al. (1982) demonstrated that, notwithstanding conventional wisdom, it is possible to account for most of the variation in individual adoptive behaviour measured by the continuously variable time lag to adoption if analysis is based on a fully specified adoption model.

There are fewer examples of the third category of cross-sectional diffusion studies. Potentially, they also are subject to much the same sorts of problems arising from changing knowledge levels as are cross-sectional adoption studies. Both types of research can generate findings that relate mainly to the static issue of ultimate adoption levels, rather than the dynamic issue of the rate of diffusion, but only if the data are collected AFTER the diffusion process is complete. One difference between them, however, is the continuously variable nature of the dependent variable, compared with the binary adopt/reject variable for adoption studies. On the other hand, many more data are needed for this type of study, which helps explain why there are fewer of them.

The most powerful category of empirical research is the last. Temporal diffusion studies can be used to address both the static issue of ultimate adoption levels as well as the determinants of the dynamic rate of adjustment to this new equilibrium state.

The methodology which Griliches (1957) developed in his pioneering study of the diffusion of hybrid corn set the standard for this type of work, and has been imitated in almost all intertemporal analyses of the spread of innovations. By fitting logistic functions to data on cumulative adoption level by year, he was able to estimate three parameters which adequately summarise the classic S-shaped diffusion curves for each state and crop reporting district. The three essential features of these diffusion curves and Griliches' corresponding measure of them were:

(a) the origin of the diffusion process (empirically calculated as the time when estimated cumulative adoption reached 10% of the ceiling level);

(b) the *rate of adoption* (a standardised measure of the average slope of the cumulative adoption curve);

(c) the *ceiling* level of adoption (estimated maximum cumulative level of adoption as a percentage of total potential adoption level).

There are no serious conceptual problems with this approach, and the only real limitations involve the difficulty of obtaining the required data and of measuring relevant variables. Note, however, that it is not possible to investigate the reasons for interpersonal variation in adoptive behaviour with this type of approach. Hence, further temporal adoption studies also are needed to improve extension strategies.

The Empirical Record — Conclusions

Ultimate Adoption/Rejection Decisions

The view that individuals make irrational choices is widely held, and especially so with regard to adoption decisions. For instance, after reviewing many early studies of innovation adoption, the eminent rural sociologist, E.M. Rogers concluded (Rogers 1969):

> Available evidence seems to indicate that peasant behaviour is far from fully oriented toward rational . . . considerations. Undoubtedly, however, the degree to which peasants are efficiency minded and economically rational depends in large part on their level of modernisation.

At least from the publication in 1964 of T.W. Schultz's seminal work, 'Transforming Traditional Agriculture', the prevailing view amongst economists is that, while potential adopters may make incorrect decisions out of ignorance, they generally are not irrational in the sense of making decisions contrary to their own best-interest. Many other social scientists now share this view. For instance, Rickson (1985) states that 'when technology is specifically designed to cater for the specific needs of small farmers, it was adopted very rapidy by those that would otherwise be classified as laggards'.

As long as the findings of methodologically flawed studies are ignored, there is compelling empirical support for this emerging consensus that the final decision to adopt or reject is consistent with the producer's self-interest. The analysis by Griliches (1957) of the diffusion of hybrid corn was the first empirical study to provide convincing evidence of the importance of so-called economic variables in determining the ultimate adoption/rejection decision. To address this question, he investigated reasons for regional differences in the equilibrium, or ceiling level of adoption of hybrid corn, and concluded (Griliches 1960:279) that:

> . . . variation in these ceilings across the country can be explained in good part by the same two measures of profitability: the average absolute superiority of hybrids and the average number of acres per farm planted to corn.

The analytical methods developed by Griliches have been imitated many times,[1] and in almost all cases substantially the same results have been obtained. Much the same picture emerges from the very extensive modern literature on innovation adoption in less developed countries. Ruttan (1977) reviewed the large number of studies of the spread of the package of innovations forming the basis of the Green Revolution, and from this review drew seven generalisations, including the following relating to adoption of high yielding varieties (HYVs): 'The new HYVs were adopted at exceptionally rapid rates in those areas where they were technically and economically superior to local varieties'. He could have added that ceiling levels of adoption of the HYVs in these areas also were found to be very high, but negligible or low in other areas. By contrast, Ruttan concluded that neither farm size nor tenure had constrained long-run adoption levels, although there is some evidence that smaller farmers and tenants were slower to adopt.

While innovation profitability is unquestionably an important, and perhaps even the single most important determinant of the final choice to adopt or not, the concept defined above of the potential adopter's best self-interest is much broader than just net financial returns. For instance, non-economists often overlook the fact that non-market inputs (such as family labour) have an opportunity cost determined by the foregone utility from alternative uses (such as leisure activities). A good exposition of other factors beside profit which also contribute to producer welfare is provided by Perrin et al. (1979).

One such factor which deserves special mention in the context of innovation adoption is risk. In a recent comprehensive literature review, Feder et al. (1985) note that 'empirical studies have very rarely

[1] For instances, see Mansfield (1961, 1969), Romeo (1975), Pardey (1978), and Jarvis (1982).

treated this factor, because it is difficult to measure'. Nevertheless, there is limited direct evidence as well as some indirect evidence that risk is an important consideration in choice of technique decisions. For instance, in a study of variety choice by Sri Lankan rice farmers, Herath et al. (1982) elicited subjective beliefs about yields as well as attitudes to risk, and concluded that choice criteria incorporating risk considerations performed much better than expected profit maximisation. Circumstantial evidence supporting this result is provided by Cutie (1976) who found location-specific dummy variables associated with different climatic areas to be significant. More generally, Newbery and Stiglitz (1981) have reviewed the large body of literature investigating the effect of risk on all aspects of farming, including tenurial arrangements, insurance, etc. Furthermore, given the demonstrated effect of tenure conditions on the distribution of risk between tenants and landowners, the 'tenurial obstacles to innovation' demonstrated by Newbery (1975) also support the view that perceptions and attitudes to risk influence innovation adoption decisions.

This notion that the decision to adopt or reject an innovation ultimately depends on what is in the producer's best-interest is deceptively simple. Some insight into the complexity actually underlying such a choice can be gleaned from the study by Gladwin (1979), who dissects in detail the reasons why a sample of farmers did not adopt a set of agronomic recommendations. For instance, it is easy to overlook differences between firms in resource endowments (e.g., equity capital, own labour, managerial skills, etc.) as well as personal preferences, etc., which influence the utility of innovation adoption.

For agriculture, the situation is further complicated by the location-specificity of many innovations. Paradoxically, this fact often seems to be overlooked by biological scientists. Just how subtle these location-specific effects can be is highlighted in a paper by Perrin and Winkelmann (1976), who reviewed a group of international studies, sponsored by the International Maize and Wheat Improvement Centre (CIMMYT), of the adoption of new crop varieties, and of fertiliser use. They concluded (Perrin and Winkelmann 1976: 891–892) that:

> . . . productivity factors — agroclimatic zone and topography — are the most consistent in explaining why some farmers adopt new varieties, and others do not . . . we are convinced that much more of farmers' adoption behavior could have been explained by productivity considerations had more accurate measurement of agroclimatic factors as related to productivity been possible. This became clear in retrospect . . . within a small geographic area, we had observed three villages ostensibly similar, with markedly different patterns of adoption: no adopters in one village, nearly all adopters in a second, and a mixed pattern of adoption in a third. Yet with better insight into agroclimatic factors affecting the production of new varieties versus old, this pattern of behaviour was understandable apart from considerations of information, prices, and risks . . . These experiences force the recognition that within any farming area, there exists a wide range of expected yield increments from a given new technology. The differences can be the result of gradients in soil depth, texture, or other characteristics, differences in night-time low or daytime high temperatures in certain seasons, differences in disease incidence related to these factors, and so on.

Notwithstanding the overwhelming evidence that the ultimate decision of potential adopters to adopt or reject an innovation will be consistent with their own best-interest, it cannot be assumed that such private choices based on self-interest will automatically serve the broader social interest. The perception that there might be failure with respect to innovation adoption has resulted in a shift in emphasis in recent economic studies to focus on the so-called constraints to adoption.

Feder et al. (1985) provide the most recent review of this work, and note (p.255) the conventional wisdom that:

> . . . constraints to the rapid adoption of innovations involve factors such as the lack of credit, limited access to information, aversion to risk, inadequate farm size, inadequate incentives associated with farm tenure arrangements, insufficient human capital, absence of equipment to relieve labor shortages . . . chaotic supply of complementary inputs . . . and inappropriate transport infrastructure.

Many of these constraints impede the rate rather than the ultimate level of adoption. Nevertheless, they cite considerable empirical evidence of suboptimal adoption levels even in the long-run when labour, credit, and/or other complementary inputs are not freely available in the market-place.

This form of market failure is one example of the broader problem created by complementarities in the adoption process. Obstacles to the socially desirable level of adoption can arise whenever the private benefits of adoption may be depressed by the decisions of others. Other instances include inappropriate tenure conditions, and inadequate investment in infrastructure such as transport and communication facilities. Imperfections in the marketing system that inhibit prices from signalling new opportunities to benefit from technological progress is another possible cause of suboptimal adoption which may be particularly important with respect to postharvest grain handling. In fact, as long as information can flow freely, the problems of non-adoption are, in the long run, synonymous with those of economic development in general.

Rate of Diffusion

As noted in the introduction, the prospects for economic growth depend not only on whether new technologies developed by research are eventually adopted, but also on how quickly the diffusion of any adoption decision takes place. Once again, temporal diffusion studies such as that of Griliches (1957) provide some of the most convincing evidence on this issue.

Specifically, Griliches (1957), together with almost all of the dependent cohort studies, found that the rate of adoption (i.e., the rate at which the economic system adjusted to the new equilibrium) depended primarily on the *actual* extent to which the innovation was beneficial to potential adopters. Recent theoretical research by Lindner et al. (1979), Feder and O'Mara (1982), and Stoneman (1981) has provided an intuitively plausible rationale for this result. The essence of this theory is that innovations which are in fact more beneficial will generate more positive messages about the desirability of adopting than will less beneficial innovations.

The finding that rate of adoption as well as ultimate adoption level are determined primarily by the actual benefits of adoption to the potential adopters is by far and away the most important result to be culled from the empirical literature on adoption and diffusion. The inescapable implication from this result is that the overriding concern in the design and development of new technologies should be to ensure that any innovations are 'appropriate' to the potential adopters, in the sense that adoption will in fact be beneficial to them. Hence, there is a coincidence of interest in achieving speedy adoption as well as high levels of adoption.

Apart from the actual benefits to be derived from adopting the innovation, other factors which have been found to influence the rate of adoption include proxies for the cost of acquiring information (e.g., education level, distance to nearest adopter, availability of extension services, etc.), and proxies for the incentive to acquire information (e.g., farm size). Lindner et al. (1982) have shown that a great deal of individual adoptive behaviour can be explained if the estimation model is correctly specified to include such 'informational' variables.

Evidence from a number of other studies reviewed by Feder et al. (1985) is also consistent with the conclusion that constraints to the learning process slow down the rate of diffusion, but are not obstacles to the ultimate adoption of innovations. For instance, small farm size reduces the return to information gathering activities, and has often been found to be associated with laggardly behaviour. However, except for those cases where a scale bias is embodied in the new technology, ultimate adoption levels have been found to be scale independent. Similarily, large fixed adoption costs and/or low levels of managerial education have also been found to inhibit rapid adoption, also no doubt because they are impediments to the learning process. By the same token, the speed of innovation diffusion will be faster, other things being equal, the more readily the innovation can be partially adopted, and/or the lower the costs of trial use for other reasons.

A final point: while empirical validation is difficult, recent theoretical research suggests that improving the quality of innovation-specific information is more important for rapid diffusion than increasing its quantity. This raises the possibility that efficacy of extension expenditure could be improved considerably by facilitating self-learning activities rather than attempting to substitute for them by bombarding potential adopters with so-called facts.

In conclusion, technology design rather than technology transfer should be the primary consideration because, if the former is successful, the latter will by and large follow automatically. However, it is in the social interest for technology transfer to be as rapid as possible, and policies which promote self-learning by potential adopters will help achieve this goal.

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Editors: **B.R. Champ, E. Highley and J.V. Remenyi**

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