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POLICIES, PLANNING  
AND MANAGEMENT  
FOR AGRICULTURAL DEVELOPMENT

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## SPECIAL GROUP P

*Chairman:* W. L. Eishel U.S.A.

*Rapporteur:* W. L. Eishel U.S.A.

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### *The Economic Evaluation of Research in the Agricultural Sciences and of Extension Work*

JAN DE VEER

*Agricultural Economics Research Institute  
The Hague - Netherlands*

#### *The nature of economic evaluation*

Economic evaluation of research and extension means evaluation from the viewpoint of scarcity. It involves a balancing of inputs of scarce goods which have to be withdrawn from alternative uses against the outputs in the form of creation and diffusion of new knowledge, technology and information.

Economic evaluation is not necessarily restricted to the effect on satisfaction of material needs or to goods and services which are exchanged on markets.

It is, however, restricted to values which can be expressed in exchangeables. We cannot count the costs without counting (Boulding (2)) either the benefits.

This counting requires a common value denominator. This does not have to prevent us however from taking into account effects of research and extension of which the value is not reflected by market prices or can be calculated objectively from market prices, but which nevertheless can be appraised in terms of money e.g. on basis of revealed preferences. In practice however we tend to concentrate heavily on exchange. The conventional yardstick for measuring the increase of human welfare over time is the increase of real income per head of the population. This is the sum of the deflated market values of produced goods after deduction of the sum of deflated market values of produced goods sacrificed in intermediate states of production.

In most studies economic evaluation of research and extension is derived from their effect on this statistic or on some concept of human welfare similar in scope.

Before making some further comments on the scope of economic evaluation we shall pay attention to a major problem; the evaluation of the output of research and extension.

#### *Outputs of research and extension are social goods*

Particularly in agriculture output of most research is a social good which spreads through society without having to pass market barriers. The homo-

generality of agricultural products and the nature of inventions make it difficult for individual persons or firms to capture the benefits of their research. Only rarely is it possible to recover the costs of research from the market on basis of patent licenses or devices like product registration, brand marks, isolation of genetic parent stock and service industries. And even then the market will not reflect completely the economic value of the research output from the viewpoint of society. Extension is in about the same position. Nearly all farms are too small not only to support their own specialized research, but also to maintain a staff of specialists or to engage external advisory firms to provide them all with specialized know how and information needed for rational farm planning and efficient performance.

Although an increasing amount of highly specialized extension work is performed by private or cooperative industries in conjunction with buying and selling, often in the framework of vertical integration, there is still a big field, which can be covered only by extension work on a collective basis by the government or other non-profit organizations. The output of this type of extension work like most research output can be considered as a social good which works not only in the interest of the farmer but also, or even more, in the interest of the general consumer.

### *Problems of output determination*

The primary products of research and extension consequently cannot be evaluated directly on basis of their market price. The benefits arise from the application of knowledge, technology and information created by research and/or diffused by extension. These benefits take the form of a reduction of resources needed to produce a given output of goods and services or an expansion of total demand for available resources as a consequence e.g. of quality improvements in consumer goods or introduction of new consumption goods.

Approximations to measuring these social benefits can be based on the consumer/producer surplus which under certain premises can be taken to measure the aggregate benefit arising from a given market situation as an excess of total utility over resource costs<sup>1</sup>. The increase of consumer/producer surplus which can be attributed to research or extension on basis of their effect on demand supply relations is in this concept a measure for their social benefits.

The most straightforward method is to determine increase of consumer/producer surplus due to a particular research project (e.g. Griliches (6) for hybrid corn).

Direct observation of the increase of consumer/producer surplus due to a specific research project is however practically impossible. The effect of technological change arises from a multitude of innovations in various stages of adoption which moreover are often complementary. Estimation of the effect of a single innovation therefore in practice has to be based on technical

1 Consumer/producer surplus is the graphical area between supply and demand curves to the left of the equilibrium intersection.

assumptions concerning its effect on input output relations and data about the time pattern of its adoption. The practical opportunities for case studies on benefits of terminated research projects are therefore scarce and as must be feared, restricted to success stories of conspicuous innovations with a marked influence on input output relations and a good record to the adoption process. Approximations of benefits arising from demand expansion are even more difficult. Because of income and substitution effects these cannot be based on demand supply relations for single products but should be based on shifts in aggregate demand. The more research and production are aggregated the less we have to bother about these difficulties. Most studies on economic evaluation of research and extension are based on an aggregate approach relating aggregate research inputs to aggregate supply and demand of agriculture or agricultural sectors. Such an aggregate approach of course is not of much help for economic evaluation of alternative research programs or research projects as a basis for decision making. It will only provide a general view on the benefits of past research as a basis for comparing its rate of return or benefit cost ratio with other investment opportunities or with a social interest rate.

Aggregate approaches based on estimation of the increase of consumer/producer surplus of agriculture or of an agricultural sector (e.g. poultry; Peterson (10)) have to deal with the problem: Which part of the increase can be rightfully imputed to research? The assertion that the whole increase is to be attributed to research is rather impertinent but a basis for allocation to research and other sources will generally have to be arbitrary.

In another line of approach this difficulty is overcome by taking research as an input in an aggregate production function in order to establish with help of regression analysis, which part of the growth of aggregate product may be attributed to research (Evenson (4); Griliches (7)).

A general problem in aggregate approaches is formed by the various time lags between research and the ultimate application in production. Disregarding these time lags and relating research inputs to technological changes occurring in the same period does not of course expose the true relationships and will result generally in an underestimation of the benefits.

An estimation of the mean time lag may be based on a distributed lag model (c.f. Evenson (4)).

For separate sectors or geographical areas this will however, be difficult to perform because of lack of data. Studies on basis of aggregate production functions are generally based on a cross section of nations or otherwise defined geographical areas. The main premise for this is that there is a relationship between the research undertaken inside an area and the effect of research on production in the same area. This seems in contradiction to the general experience that the flow of research results by publications and personal contacts or embodied in new capital items is not much hampered by frontiers or geographical distances. The contribution of research does not consist only, however, of new knowledge or technology which is readily applicable under all conditions of physical (climate, soil), economic and social environment. A considerable part of research is devoted to further develop-

ment of general principles involving adaptation to local production circumstances. The presence of own research institutes moreover probably will involve a better communication with research centres in other parts of the world and a faster diffusion of new knowledge and technology. Nevertheless we may expect a considerable spill over. Latimer and Paarlberg (9) concluded from their investigation on basis of a cross section in the USA that a single state could curtail its outlay for research and education without substantial injury to the level of farm income in that state provided that the other states and the federal government would continue their research programs. This did not prevent Evenson (4) and Griliches (7) from estimating an important research effect also on basis of a cross section of states in the USA. This will, however, probably not reflect the whole contribution of research to social welfare.

A question may be raised about the nature and direction of the relationships between inputs for research and extension at national or regional levels and technological development.

In a study on allocation of research, teaching and extension personnel in the USA, Peterson (10) found that state income, both farm and non-farm, was the important variable for explaining experiment station support, non-farm income becoming more important in the latter years. It looks like inputs for research and extension depend heavily on non-farm income which may be suspected to have itself a considerable influence on agricultural development. It must be feared therefore that the production function approach is liable to single equation bias and that the correlation between research expenditures and agricultural productivity does not rest only on the effect of research on agricultural input output relations.

The relations between extension and technological change are still more complicated and vague than for research.

Its contribution of course lies partly in a speeding up of the adoption of innovations. Research after all does not produce innovations but only inventions and information. Its effect on production comes from the practical application at which extension plays a role. Extension personnel act as change agents attempting to influence adoption decisions in a direction they feel desirable. Their contribution seems to be more important in the latter stages of adoption where practical application of new ideas, which are already known, are considered and tried (Rogers (11)). Their efforts may as well be directed to promotion of recommended innovations as to the prevention of non-recommended innovations and they may be more effective in prevention than in promotion (c.f. Rogers (11) pp. 254/255).

Extension, at least if non commercial, is not much specialized and it is therefore difficult to associate extension with specific innovations or particular products or fields of technology. Economic evaluation therefore will only be possible on an aggregate basis, whereas it is hardly possible to trace the separate effects of extension on technological change. In studies on basis of aggregate production functions a distinct contribution of extension however, did not come out clearly until now (c.f. Evenson (4)).

We must be aware however, that increases in technological knowledge not

only involve research activity but also production experience (learning by doing). By not identifying production experience as a separate source of technological change we may be inclined to forget about it. The extension service not only contributes to technological change by diffusion of innovations but also by gathering and diffusing production experience. In production function approach the attention is moreover focused on neutral shifts of the production function. It should however not be forgotten as pointed out recently by Atkinson and Stiglitz (1) that the different points of a production curve may represent different processes of production, as we know from linear programming. Movements along the production function e.g. as induced by changes in price relations as a consequence of overall economic growth, generally require complex and drastic changes in farm outfit, farm scales and farming methods and reallocation of resources. In aggregate analysis by which changes in input output relations are measured at constant prices, the economic significance of these adaptations is only partly brought forward.

The contribution of extension work in a developing economy lies particularly in creating an understanding of the necessity of change, in the support of these adaptations and in the gathering and diffusion of production experience, which has to be built up for the new production processes introduced in the adaptation process.

Economic evaluation of extension in my opinion therefore has to start with a renewed reflection on the nature of technological change and the implications of economic development for agriculture. The role of the extension services and its contribution to social welfare have to be placed in this context.

#### *Some problems of economic evaluation*

Real income per head of the population, factor productivity or consumer/producer surplus as basis for the measurement of human welfare and social benefits imply a narrow concept of value which disregards many aspects of human wellbeing and preferences. Not all utilities or disutilities are adequately expressed by the market price or, if so, are captured by the concepts and methods used in actual measurements of social product. Increase of spare time, lighter and more pleasant work e.g. are not or only partially taken into account by these measures. Damage to natural environment and resources, changes in personal and regional income distribution, hard consequences of reallocation of human resources necessitated by technological change and economic growth are ignored, although they affect human wellbeing and costly actions are taken to redress these evil consequences.

If these external economies and diseconomies can be related to technological change produced by research or extension, they could and should be taken into account. An objective measurement on basis of the synthesis of individual preferences presented by the market is however not possible. Their economic value has to be approximated by estimation of the costs which have to be made or would be acceptable in order to prevent these external

diseconomies or produce the internal economies.

There are some further implications along this line. The major part of the costs of agricultural research and extension is carried by government public bodies or other non-profit organizations, which have to take decisions concerning the allocation of scarce resources to research and extension and among the various disciplines and research projects. Economic evaluation has to serve as a basis for optimal decisions. The objectives of government and other collectivities are however not fully covered by maximization of social product in terms of real income. There will be many additional objectives partly competing with maximization of real income. In the economic field e.g. objectives with regard to income distribution, balance of payments, safeguarding of national food supply, future development etc.

To an increasing extent the government also takes actions and allocates scarce resources to prevention of 'social bads' or production of 'social goods' on basis of collective preferences, which are not expressed adequately by the price mechanism.

If economic evaluation of agricultural research and extension is to serve as a basis for optimal decisions about the allocations of scarce resources, this implies that it has to be based on optimization of the whole set of objectives which the decision taker considers. This means that the decision taker has to show which are his objectives and how they have to be weighed, so that they can be synthesized into an economic value.

It might be that the government wishes to direct research partly to objectives of agricultural policy like avoidance of surpluses, income parity etc. (c.f. Cochrane (3) p.p. 130–131), which would influence the evaluation of alternative research projects and extension programs. An increasing part of agricultural research particularly if we include the social sciences, is moreover orientated to the actions and policies of government concerning agriculture.

This research can only be evaluated from the viewpoint of the objectives of the government. In the practice of evaluation of current or future research projects it is therefore useful to distinguish into production research and policy research. Only for the first category relating to research orientated to technological change, economic evaluation on basis of increase of social product taking into account external economics and diseconomies, is an appropriate approach.

Another problem is formed by the prices on which the economic evaluation should be based. Taking into account the time lags, evaluation of current or future research and extension programs should be based on price relations to be expected in the future.

There is still another issue on prices. The question is to be raised if national price levels for agricultural products are a sound basis for the evaluation of the impact of technological change on national income. Price levels in most countries are regulated in order to achieve a fair remuneration of the immobile factors of production in agriculture. As a consequence they do not reflect the marginal values on basis of existing demand supply relations.



Changes in agricultural output of the main products of agriculture induce changes in imports or exports or other outlets of agricultural surpluses at prices which are much below the national price level. Economic evaluation on basis of the internal prices therefore leads to an overestimation of the economic value to be attached to changes in output from the social point of view.

Investigations in Japan and the USA indicate that in recent years yield technology (production per acre) and mechanization (acres per man) contributed in nearly equal parts to the rise in labour productivity (Kaneda and Auer (8)). Adaptation of the calculation prices to marginal values would have as a consequence a relatively lower evaluation of technological change leading to saving or substitution of land and agricultural inputs and relatively higher evaluation of saving or substitution of labour and industrial inputs.

If on this basis higher priorities would be given to research projects in the latter category this would certainly be in the national interest, at least in the short run.

### *Systems for economic evaluation of research projects*

Planning of research is a problem of choice involving the establishment of total amount of resources to be dedicated to research and the allocation of these resources to various disciplines and projects. As a consequence of the increasing volume of resources allocated to research, the growing complexity and specialization, and the increased necessity of interdisciplinary approaches, scientists and research directors are less able to overlook the consequences of different research alternatives and to determine priorities. There is a growing need of economic evaluation of research projects as a guidance for decision making. In the economic evaluation of research alternatives the following factors have to be taken into account:

- costs of research*
- benefits* to be expected from the application of new knowledge and technology resulting in case of success
- realization time*—elapse of time before benefits will be realized
- deterioration* replacement by new knowledge and technology not built on the same line of research
- probability of success*

Economic evaluation requires a sound administration of the costs of different research projects in the first place. Further on there is a need of economic classification schemes which can be used as a tool for research managers and decision makers for establishing priorities. In the U.S. Department of Agriculture a scheme for research evaluation has been developed (Fedkiw and Hjort (5))

In the Netherlands a scheme for evaluation of agricultural research has been proposed, of which some of the characteristics are as follows:<sup>2</sup>

The scheme is based on logarithmic scales in which all factors mentioned above are synthesized and which can be applied by simple detraction of scale

2 The principles of this scheme have been developed by A. Eriks and G. Hamming of the Agricultural Economics Research Institute in the Netherlands.

coefficients.

In the proposed form it is a benefit cost approach, flows of income being transposed to present value on basis of a predetermined interest rate, but the system can be adapted to the internal rate of returns approach.

Scale	Recent value	Annual benefits (x 1000 guilders)	Realization after . . . . years	Deterioration application during . . . . years	Probability of success (%)	Total costs of research project
0			0-7	> 16	60-100	
1	25-40		8-14	9-15	40-60	45-40
2	40-60		> 15	5-8	25-40	40-60
3	60-100			3.4	15-25	60-100
4	100-150			2	10-15	100-150
5	150-250			1	6-10	150-250
6	250-400				4-6	etc.
7	400-600	25-40			< 4	
8	600-1000	40-60				
9	1000-1500	60-100				
10	1500-2500	100-150				
11	2500-4000	150-250				
	etc.	etc.				

The probable net benefits can be approximated by simple detractions of scale coefficients. A project costing 100,000 guilders and estimated annual benefits of 125,000 guilders to be realized after 10 years with an application period of 5-8 years and a probability of 50% is evaluated as 2 (11-1-2-1-5).

The scale is constructed by dividing the factor 10 over 5 classes. Because of addition of 5 scales the total rounding up error of these estimates will be about twice ( $\sqrt{5}$ ) as much than that of single scales, which seemed reasonable.

This system can of course be expanded by adding criteria and perfected by taking closer intervals. It can also be adapted quite simply to calculation of benefit cost ratios or internal rates of return.

Benefit cost ratios can be calculated by dividing the present value of benefits after correction for realization, deterioration and probability, by the costs.

The internal rate of interest can be derived from the distance between the scale coefficient of research costs (in the example 5) and of the corrected benefits (in the example 7 (= 11-1-2-1)).

The scale table is based on an interest rate of 6½%. A difference 1 means an internal rate of return of ± 10%, 2 means ± 16%, 3 ± 25% and 4 ± 40% as can be deduced from the table.

The advantage of this system is that it does not involve complicated calculations.

## References

- 1 Atkinson A. B. and Stiglitz J. E. 'A new view on technological change' *The Ec. Journal* 79:315 : 573-579, Sept. 1969.
- 2 Boulding, K. 'Economics as a moral science' *The American Economic Review*, March 1969, 1-12.
- 3 Cochrane, W. *The cityman's guide to the farm problem* Minneapolis, 1965.
- 4 Evenson, R. 'Contribution of research to production' *J. of Farm Economics* 49.5: 1415-1425, Dec. 1967.

5 Fedkiw J. and Hjort W. 'Approach to research evaluation' *J. of Farm Economics* 49.5: 1426-1434, Dec. 1967.

6 Griliches, Zvi. 'Research costs and Social returns: Hybrid corn and related innovations'. *J. Pol. Economy*, 66: 414-431, Oct. 1958.

7 Griliches, Zvi. 'Research Expenditures Education and the aggregate production function' *American Economic Review* 54: 961-974, Dec. 1964.

8 Kaneda H. 'The source and rates of productivity gains in Japanese agriculture as compared with the U.S. experience'; discussed by Auer, *J. of Farm Economics* 49.5: 1443-1455, Dec. 1967.

9 Latimer R. and Paarlberg D. 'Geographic distribution of research costs and benefits' *J. of Farm Economics* 47.2: 234-242, May 1965.

10 Peterson, W. L. 'Return to Poultry research in the United States' *J. of Farm Economics* 49.3: 656-669, Aug. 1967.

## SPECIAL GROUP P REPORT

### The Economic Evaluation of Research in the Agricultural Sciences and Extension Work.

The extent of interest in the topic of economic evaluation of research and extension was amply indicated by the more than 130 conference participants who attended this special section meeting and by the number of participants who actively contributed to the discussion. This serious interest as the discussions clearly revealed, concentrates on appraising the worth of quantitative economic evaluation procedures and methodologies as effective, practical aids to the difficult tasks of research planning and administration. In these discussions, theoretical considerations received no attention whatsoever.

About the only agreement on this topic among the discussants was that in practice it is an extremely complicated process to carry out and that it is resplendant with problems. It was not even generally agreed that the economic evaluation of research and extension is an *important* subject. One view would suggest that for the developing countries in particular the differences in rates of pay off among alternatives are probably so large as to be evident by simple observation. Consequently and especially in view of the procedural problems, quantitative research planning would seem to serve little purpose. A contrary view suggests that we may tend to be overly awed with the enormity of the procedural problems and too readily conclude that the effort is not worthwhile. But, in doing so, we are failing to carefully observe the many signs at the micro-level of agricultural production which point to the benefits that specific research has and can contribute to agricultural production and growth. Failure to recognise the existence of such differential effects in planning would be a mistake.

It was emphasised that careful distinction must be made between historical (ex post) evaluations, which only tell us the degree of success attained *after* adoption of some set of innovations has taken place, and forward (ex ante) evaluations, which are concerned with the allocation of resources in the present and future time periods. *Ex post* evaluations depend on good data about costs and returns of research efforts, but how do scientists and

economists propose to provide appropriate data for *ex ante* evaluations of research? This is where most difficulties lie, and it is the area where research administrators require effective guidance. Schemes like J. de Veer's appear to ask the right questions but fail to specify *how* the data is to be obtained.

There was considerable discussion about the relevant levels of aggregation for economic evaluation of research, which was considered in two parts: geographical (local, regional, national and functional (levels of research and extension)). From the standpoint of geographical aggregation there would appear to be a conflict between the problems of specification errors in analysis, particularly with respect to extension activities, on the one hand, and providing meaningful information to research planners which reflects the variability among regions in the effects of technological change on product markets, input markets, structure of agricultural land and credit etc., on the other hand. Functional aggregation raises the question about accounting for joint inputs in technological innovation. This also takes two forms: one is the problem of planning expenditures between *basic* and *applied* research and the second is between research and extension which together make up the whole of the technological delivery system. Evaluation methodologies do not exist at present which would aid planners in deciding what to put in each.

Several other problems encountered in the practical application of quantitative economic evaluative procedures were presented more in search of answers than in attempting to suggest answers. Most of these dwelt on measurement problems such as assigning time variables, judging rates of knowledge adoption and obsolescence, allowing for uncertainty, and others. But, there were questions regarding the ability of such methods to answer the many alternative questions about allocations of resources that must be answered. Some questioned the relevance of evaluative methods developed in the advanced countries to the developing countries; in particular, how does one convert social values to economic variables when the choice is among the efficiency of conducting research in irrigated areas (continuance of the "green revolution") and research to benefit primarily the dry farming poor areas. The critical role of time lag between innovation and adoption was attributed with being a key contributor to the extent and persistence of undernourished areas throughout the world today. The lack of our knowledge about this function is considerable and deserving of much more attention by scientists than it is currently receiving. In addition to these points, many more interesting and important problems were presented and discussed.

An overall summary of the discussion might picture the economic analysts and scientists as reservedly pessimistic about the future of quantitative economic evaluation methods for research and extension. One discussant contended that scientists should stress to decision makers that adequate tools have *not* been developed at present, that there is a role for such quantitative methods in their decision processes, that some progress is being made in the refinement of the methods and procedures, and that such developmental efforts are worth their support and encouragement.

Among the participants in the discussion were:

O. Aresvik *Norway*, S. A. Ilyin *U.S.S.R.*, S. S. Johl *India*, N. I. Zhukovsky

*U.S.S.R.*, D. Moyobuu *Mongolia*, V. G. Krestovsky *U.S.S.R.*, Dr. Natarajan *India*, Mrs. L. V. Ospinnikova *U.S.S.R.*, C. H. Shah *India*, A. I. Stepanov *U.S.S.R.*, Mrs. R. Thamorajakshi *India*, U. A. Tihonov *U.S.S.R.*, R. Johnson *N.Z.*