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The Economics of the Agricultural Extension Service

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Early reports indicate the existence of an agricultural extension service in India in the thirteenth century.[1] Today the service is found in almost any country, but the intensity of its operation varies even among the more developed ones. (Expenditure on advisory work per person actively employed in agriculture ranged in 15 OECD countries, in 1966, from $0.80 in Greece to $54.18 in the U.S., and expenditure on advisory work as percentage of the gross agricultural product at factor cost ranged from 0.114 in Greece to 1.034 in Norway.[2]) This kind of service is newer and the variety is probably larger among the developing countries.

The agricultural extension service is a system that collects, sorts, and sometimes even produces knowledge. The knowledge accumulated by the service is redistributed to farmers. Like the processing and marketing industries which transfer products and factors from producers to buyers, the extension service acquires knowledge from various sources and passes it on, mostly in a new form, to the producers. The accumulation and distribution of knowledge requires substantial expenditures, diverting economic resources from other uses, while the knowledge thus transferred is of economic value as it raises productivity.

Although several empirical economic studies that dealt with extension together with research or education have been reported (some of them will be cited

below), no comprehensive theoretical framework has yet emerged. This work is an attempt to suggest an outline for the economic theory of the extension service.

Some aspects of extension operations have been studied by sociologists. One of the major lines of these studies is the diffusion-of-innovation approach, connected particularly with the name of Rogers.[3] While this approach sheds interesting light on the dynamics of technical progress in agriculture, one of the main themes of the present assay is that the role of extension is much more complex than the mere importation of better ideas, tools and materials into the farming sector.[4]

The public extension service is not the only channel of agricultural knowledge. Oral communication, professional literature, commercial advertizing and schooling are other, not less important, sources of information to the farmer. The present analysis concentrates on the public extension system; the other components of the "farm knowledge industry" will be discussed only to cover their relations with the extension service.

The term "extension service" covers a host of possibilities. In India it is a community-development organization; in Chile there are a dozen or so such agencies;[5] in the U.S., and as a result in many other countries, the service covers 4-H clubs, home economics and lately even urban-nutritional education.[6] The American service is mostly an "extension" of research and educational institutions. In other countries it is often an agricultural advisory department in the ministry of agriculture. The model discussed here is of a single, centrally administrated, government service supplying technical and economic information to the farmers.

The problems involved with its administrative structure and affiliation or with the other functions often undertaken by the service are left to another occasion. The discussion is on the economics of extension work; the social educational and political issues of this subject are not dealt with here. A special effort has been made to limit the use of technical terms and to explain those that had to be introduced. (A technical exposition is relegated to the Appendix). It is therefore hoped that the analysis will be comprehensible to readers who are not economists.

Knowledge

Since knowledge is the "commodity" that the extension service distributes, a proper analysis of the operation of the service should start with the subject of knowledge and its place in agriculture. This brief and somewhat sketchy discussion will follow Arrow, Boulding, Machlup, Nordhaus, Schultz and Welch.[7]

The stock of knowledge is, no doubt, a factor of production--the more of it, the higher the productivity of the other factors. This stock grows--additional knowledge accumulates through deliberate and unintentional investment. Like other stocks of capital, knowledge is subject to attrition, deterioration and obsolescence. Part of the knowledge is simply forgotten, part is lost through retirement, death or out-migration. Obsolescence occurs to those parts of the stock of knowledge whose importance declines or vanishes with changes in the methods of production.

The stock of knowledge is a very particular form of capital. There is no direct wear or tear of knowledge through use. It can and is bought, sold and transferred from one party to another. Unlike a machine or a piece of

land, however, the use of knowledge by one person does not exclude it from being used by another. The transferor of knowledge may lose his position as an exclusive owner but not the ability to continue to make use of the knowledge he transferred. (In a limited number of cases, such as patents sale, legal restrictions are imposed. These are not, however, restrictions on the use of knowledge as such, but rather on the lines of activity to which the knowledge can be put.)

The stock of knowledge of the individual is a complex phenomenon. (In his fascinating analysis, Boulding preferred the image which the individual has of the world to the narrower term stock of knowledge.) This stock includes facts (the grass is green) and consequential inferences (irrigation increases corn yield) and it includes the ability to analyze new hypothetical situations and events. There is a subjective quality dimension to the components of this stock--the individual is certain about parts of it and is more vague about others--and this dimension is part of his stock; he knows that he is uncertain about some aspects of his knowledge. The stock of knowledge is modified by information gathered from experience or through the social channels of communication. Part of this stock is the mechanism which judges incoming information. A message is judged as relevant or unimportant. Depending on its source, intensity and agreement with previous knowledge, a message is assessed as a more or a less accurate description of the real world. Messages compatible with previous knowledge will substantiate it and increase subjective confidence (decrease uncertainty). Other messages will operate in the opposite direction.

Society's stock of knowledge is some average of the individuals' stocks. The frequently used term "frontiers of knowledge" is not at all an unambiguous one, but can serve well to describe the best, most sophisticated and accurate parts of society's technical knowledge. In a dynamic and progressive world, the frontiers expand through research, borrowing, innovation and experience. Interchange of ideas, schooling, extension, consultation and common experience operate to transmit messages among individuals and close the gaps between the individual and the social stock (of relevant) knowledge. As the frontiers of knowledge expand, and since the dissemination of information is not instantaneous, most individuals find themselves constantly modifying and increasing their knowledge but are always behind the best parts of society's stock. Being experienced, the individual is aware of the relative gaps in his knowledge and uncertain about its accuracy. In a technically stagnant society, on the other hand, most messages confirm previous experience, most knowledge is commonly shared and confidence in it is high.

Not only is the individual aware of the content and credibility of the messages he receives--collects will sometimes be a better term--he is also not indifferent to their form. It is probably almost effortless to absorb new information in a casual chat; but such a conversation is a very extensive mode of communication, loaded with a substantial "noise" component of personal opinions. Reading research reports--news from the frontiers of knowledge--requires a concentrated intellectual effort, but the prize is objective observations on up-to-date problems. As schooling,

income and alternative cost of time rise, individuals seek condensed, trustworthy sources of information--they may turn to professional literature, for example.

Knowledge in Agriculture

Much of the new agricultural knowledge is created in laboratories and experimental stations; some of it in the public sector, the other part in private business. Broadly speaking, the farmer makes use of two kinds of knowledge--both affecting his productivity. The first is, in general, not part of his own personal stock of knowledge but is embodied in the inputs and capital goods he employs. This category includes the engineering knowledge embodied in the tractor, the genetics in the hybrid seeds and the chemistry in the fertilizers. The second class is farming knowledge proper: how to cultivate a field, to grow corn or to market the products.

The boundary lines between the classes of knowledge are not at all clear cut. There is a whole spectrum ranging from information vital to farming (corn is not planted in the winter, to take a vulgar example) to knowledge that has no direct relevance to farming what-so-ever (the optic of the microscope in the research station). This is not a division between the so-called applied and scientific knowledge; purely academic information to the farmer can be applied in the production of farm inputs. The demarkation lines between the classes are further blurred by the fact that an important component of farming knowledge is the ability to choose the right combination of inputs and outputs, and in this choice the farmer has to take into account the economic and technical features of inputs and capital goods that embody seemingly irrelevant knowledge.

A very similar, but not always identical, distinction can be made between factual and perceptive knowledge. The first term applies to knowledge about the observable fact, such as flowers bloom in the spring, and the second to theoretical, behind the scene knowledge (blooming is determined by length of day). Factual knowledge may suffice for operational purposes but it is perceptive knowledge which is required to make decisions when confronted with new, hitherto unexperienced, situations.

In the division between the producer's stock of knowledge and that embodied in inputs, agriculture does not differ from manufacturing or services. In another important respect agriculture is unique. Agriculture, probably much more than any other line of production, is characterized by extremely diversified production conditions (soil, climate, topography--to name the obvious). Moreover, agriculture is a struggle against Nature and in this struggle Nature turns out to be a very flexible fighter, reacting often unexpectedly and vigorously to man's innovations and upsetting Her balance (new strains of diseases and insects as a reaction to resistant varieties and chemicals). As a result, agricultural knowledge is created in the field--on the production line--to a much larger extent than in manufacturing. Of course, agriculture also moves toward production in controlled environments--eggs are produced in almost factory-like conditions, vegetables are grown in hot-houses. But crops, fruits and forages are still grown in the open fields and will continue to be so for some time to come.

Because of the extremely diversified production conditions, the first task of the agricultural research is the exploration of these conditions.

Historically, one can see a great share of agricultural research as charting maps of production conditions. Soil and climatological classifications come immediately in mind, but varieties and stock studies are explorations of a similar general nature. As agricultural science progressed, borrowing from the other advancing branches of science, the explorations and the mappings became more sophisticated and grew in dimensions. Today much is known on the production conditions in agriculture--for some areas, needless to say, more than for others--and a great part of the advanced agricultural research slowly moves towards exploring and mapping "production conditions" in the very basic areas of production--plant and animal physiology, the genetic code, the bio-chemistry of virues. The knowledge accumulated here has, in most cases, no specific locality features.

Innovations, whether they come from the scientific, mostly publicly financed, research or from the commercial R & D laboratories, are conceived and prepared in research institutions under controlled enviroments. It is the knowledge which has already been accumulated about the field that permits direct application of laboratory results to the farm, but the ultimate technological and economic test is still in the field and has still to be carried out separately for different localities.

Parts of agricultural knowledge are hardly appropritable, no single individual can successfully establish ownership of this knowledge. These parts form cases of public goods which, for maximum efficiency, should be supplied by the government. Other parts are more efficiently dealt with

by the private sector. What should be the area taken by the public research and what should be left to private R & D depends on the nature of the knowledge and its use on the farm. It seems that private industry has a clear advantage over the public sector in engineering. An interesting example from the biological fields is that of the development of hybrids of wheat and maize.[8] Regularly harvested grains can be used as wheat seeds for the next season. Thus, once released by the developer, hybrid varieties can spread by farmers who will multiply their stock, and the developer cannot hope to cover his cost through the market. Hybrid maize seeds, on the other hand, have to be produced each year anew; the farmer has to buy them from the producer and he cannot use last year's grains. It would be very inefficient to leave the development of new wheat varieties to private business while business handles well the development of hybrid corn (though usually supported by supply of new lines from public research).

Operation of the Extension Service

The extension service employs agricultural experts, most of them with advanced professional training, and runs special refresher courses and retraining programs. On their visits to farms, extension agents witness successful and unsuccessful production techniques. This experience is analyzed by the service and the conclusions are, in turn, redistributed to the farmers. New knowledge is supplied to the service by research institutions and universities. To some extent, the service produces knowledge through field experiments. That produces and distributes

knowledge in agriculture. The multitude of the channels of agricultural information is not a mere accident, rather it is a demonstration of the operation of the division of labor principle, although probably not always to the maximum effficiency. Schooling provides concentrated, basic knowledge. The outflow of information from scientific institutions is mostly in the form of research reports which are penetrating but narrow in coverage. The extension service (a) transmits raw research results into forms absorbable by the farmers; (b) selects the information relevant to locality and farming conditions; (c) feeds back information from the field to the researcher and producer.

In commercialized agriculture, the transmission of knowledge is also tied-in with the sale of farm inputs. The seller has to convince the farmer of the superiority of his product, and it is in his interest the experience with it will not be disappointing. He therefore supplies recipes for use along with his product and often augments them with personal instruction. Competition forces him to be accurate in his advice. As commercialization grows (the share of purchased inputs to farm income rose in the U.S., for example, from .320 in 1924 to .491 in 1967),[9] the share of new knowledge supplied through these channels is increased.

Thus, private, commercial information is a substitute for the service supplied by the public extension system; it will be argued below that there exists also an element of complementarity between the two kinds of information, as between other sources of information and extension.

The extension service incurs various kinds of expenses. The service pays for the knowledge it obtains from educational institutions through wages and salaries. Connections with research institutions, retraining of field workers and similar activities also have their price tag. The knowledge collected on the farms is partly a by-product of the extension and distribution operations. Processing the accumulated information, selecting the correct and important from the inaccurate and trivial, and preparing new knowledge for distribution all require costly efforts.

This aspect of the operation of the extension system is generally simple and its structure can be estimated easily. A well-organized extension service will keep records in which one can recognize most of the items mentioned. Estimating the cost of collecting knowledge on the farms is particularly difficult and this item does not usually appear separately in the service accounts.

The cost of the knowledge collected by the system varies from source to source. The system pays the whole cost of knowledge produced in the service. If farmers are willing to cooperate, they, of course, share the costs. The system pays wages, as previously mentioned, for the knowledge acquired by extension workers as students. The knowledge produced--at cost--in research institutions is obtainable free; the only cost to the service is the absorption of this knowledge, just as the only cost incurred by a housewife receiving free goods is the cost of going to the market.

The Contribution of the Extension Service

The contribution of the extension service on the farm is multi-dimensional. It increases farmer's awareness of new factors and products, deepens his understanding of agricultural processes and techniques, guides in the application of new methods, and assists in making decisions and choices. In terms of the previous discussion, the service adds to the farmer's stock of knowledge and increases his judgement ability and his confidence in his knowledge. The rise in the farmer's knowledge and understanding increases the farm's productivity both in terms of a higher product from a given set of inputs and in terms of a better allocation of inputs and outputs.[10]

Farmers in a dynamic agriculture are aware of their relative position behind the frontiers of knowledge and are uncertain about parts of their knowledge. They will, therefore, actively seek information and will hedge against subjective uncertainty (postpone the use of new seeds, for example, or over-apply chemicals), thus paying a premium in terms of actual outlay or income foregone (not to be confused with premium against objective risks, for example weather).

Knowledge diffuses. The information brought by the extension agent will reach the farmer through other channels with a delay of days or months (or perhaps years in a less progressive agriculture). Considering a single bit of information such as an innovation, the contribution of the extension service is in the advancement of benefits from this information item by a certain period of time. In a dynamic, progressive

agriculture with constantly expanding frontiers of knowledge, extension puts the farmer in a (moving) position closer to the frontiers. A steady state may evolve in which the contribution of the extension service will be the constant difference in productivity brought by its operation.

Knowledge being a stock, the effect of extension is to increase the rate of its accumulation. If a steady state develops--with a constant rate of extension and a steadily improved position of the farmer--the contribution of the service can be measured in flow (annual) terms of increased productivity against the (annual) cost of the flow of services. Otherwise, particularly with the introduction of the service to new areas, the contribution has to be assessed from the time profile of productivity increases due to the extension operation.[11]

The extension service operates on a large number of farms in the agricultural sector and its influence reaches many of the producers who are not directly reached. If the system were to operate on only a few farms, its effect would be to raise the productivity of those farms; the additional small quantities supplied to the markets will not affect prices. However, as the service operates through the whole sector, the quantities reaching the markets increase substantially or, more exactly, the supply of agricultural products increases. This causes a fall in prices.

When yields are increased, the farmer's income rises, but when the overall supply of agricultural products increases, the reduction in prices can be so severe as to even reduce farmers' incomes. Raising productivity increases efficiency and expands production--a blessing from the point of view of the

national economy. The additional welfare stemming from this added product is divided between the producers and the consumers of agricultural products. The latter receive larger quantities at lower prices, the former increase their income. However, it might happen--and definitely not only in theory--that farmers' incomes will even decline. In these cases, not only are the fruits of the additional knowledge shared by consumers and producers, but the new knowledge will cause a redistribution of income away from farmers and to consumers. This can be put slightly differently: had the prices of agricultural products not been affected at all, the only ones to gain would have been the farmers; since prices decline, there is a process of redistribution of income. A graphical analysis of these points is given in the Appendix.

From this, one would conclude that it may not be in the interest of the farm sector to expand the creation and distribution of knowledge. In some cases, this sector may even want to limit it. Such suggestions have been made particularly in the United States and with respect to research.[12] In many respects, the arguments for contracting the creation of knowledge apply also to its distribution. There is, however, one additional welfare aspect of extension work: extension can (it not alway does) reduce income inequalities within the agricultural sector by spreading the best methods throughout the whole sector.

The Demand for Extension Service

It is convenient to view the operation of extension as being conducted in a market for this service. In this market the supply is determined by the extension service and, more generally, by the public agencies financing it, while the demand is a function of the willingness and desire on the part of farmers to absorb new knowledge through this channel of communication.

The extension service passes on information to the agricultural producers by visits, by issuing pamphlets, by radio broadcasts and by other means. The absorption of new knowledge is not effortless. The farmer has to spend time talking to the field worker, listening to the radio, reading the instruction, or going to model farms. The adoption of a new method which sometimes requires "unlearning" probably also demands special psychological efforts. Since field workers collect information on the farms, the farmer benefits from the service only if he contributes to the general pool, sometimes without seeing any direct or immediate benefit. The lower the cost, in terms of effort and time of absorbing knowledge, the more inclined the farmer will be to acquire new knowledge.

An important aspect of the quality of the extension service is the probability that the information it distributes--the messages it transmits--is trustworthy. An additional aspect of the quality is the amount of information that the service can transmit per action--the intensity of the message-- roughly speaking, it is the amount the farmer receives per hour's visit by an extension worker, per five minutes of viewing television, etc.

The higher the quality of the extension service, the higher the demand for it. However, the demand also depends on the farmer himself.

A well-schooled and knowledgeable farmer may find that only seldom the information in the extension service pamphlets is new and that there is little to learn from field workers. The time of such a farmer is also usually more expensive than that of his less knowledgeable colleagues; therefore, he may view an extension organization as supplying a low quality service at high cost, while his colleagues judge the service more favorably. Thus, the greater the knowledge of the farmer, the less his demand for the service--unless the quality is improved. In other words, to keep the demand for its service, the extension system has to up-grade its service--probably through better extension personnel--as the knowledge of the farmers increases.[13]

Perhaps the most important factor in the demand for extension service is the rate of expansion of agricultural knowledge. The higher this rate is, the faster the change will be in the environment in which the farmer operates and the more he realizes his need for help in aquiring knowledge and assisting in the interpretation of the messages which he receives. Ordinarily, the better-schooled and knowledgeable farmers are also the most dynamic; this factor sometimes outweighs the negative effect that schooling has on the demand for extension. The contribution of the extension service should be viewed, at least partly, as an investment since it raises productivity in future periods. From the point of view of the receiving farmer, this is an investment in his own human capital. It follows, and experience verifies, that younger farmers will show a greater demand for extension and new knowledge than will their elder neighbors.

The reduction in prices due to the higher productivity in the agricultural sector affects most of those farmers who lag behind in acquiring new knowledge and in increasing the efficiency of their operations. To reduce the harm to his income, such a farmer must then acquire the new knowledge, improving his relative position while contributing to a still further reduction in prices. Since an individual farmer has a negligible effect on the market, ignoring new knowledge means immediate and sometimes severe harm. One should not expect that farmers will voluntarily reduce their demand for new knowledge.

Cooperation of the Producer with the Extension Service

Farmers' experience is an important source of information to the extension system. The knowledge created within the service is usually created in cooperation with farmers who allow and participate in experiments made on their land. There are two reasons why a farmer would attempt to limit the amount of information that he supplies to the service: (a) cooperation may be costly and bothersome; (b) by supplying information he worsens his relative position in the industry. On the other hand, the supplier of knowledge acquires social status, something for which people are generally willing to forego income. There is, of course, also an understanding of the principle of cooperation. Often the farmer sells his information in exchange for a visit by the field worker.

Things are very different in the industrial sector where the number of producers is substantially smaller and the weight of the

individual producer is much larger. A great part of the knowledge is specific to the industrial producer, and he avoids cooperation so as not to contribute to the strength of his competitors. One often hears of the spirit of cooperation in the rural community. This, together with the fact that public agencies often favor agriculture, may perhaps be accepted as an explanation for the prevalance of extension in agriculture and its absence in manufacturing. Yet, the economic factors which inhibit cooperation may dominate all other reasons for the present industrial distribution of extension activities.

The Creation of Knowledge and the Connection with the Research System.

The extension service does not only distribute knowledge but also contributes to its creation (15% of the advisory service personnel in the United Kingdom are engaged in research,[14] in Israel the extension agent will usually spend one day a week conducting field trial in farms). This raises the question of the optimum allocation of efforts between creation and transmission of knowledge and of the division of labor between the extension and research organizations.

The creation of knowledge is a costly operation, but it increases the field worker's comprehension of the problems he faces, his status and his satisfaction with his job. The extension service is closer to the field, to its diversity of conditions and everyday problems, than is the research institution. The cooperation of the farmers enables immediate experimentation to tackle minor but important problems without the necessity for comprehensive research programs as may be the case in research institutions.

The research organization, on the other hand, is better equipped with instruments and knowledge. It is also likely that the knowledge from this system is more reliable than that created on the farm, which may be biased by specific local conditions.

While the service meets the full cost of knowledge created in the extension system, the knowledge it receives from the research organization is free. This may be one of the reasons for conflict between the two organizations.

Moreover, the research organizations are part of the international system producing and distributing knowledge which has developed its own standards, according to which the work of a researcher is judged by his contribution to the knowledge of the profession, mostly via publication in international journals. This method, being operated by human beings, isnot perfect but there is no better indication of the scientific value of a man's work. Hence, promotion in research organizations is generally based on the amount and quality of published work. This situation creates a genuine conflict of interests between the extension worker, looking for answers to problems raised in the field today and sometimes not recognizing the potential long-run contribution of more basic research, and the research worker trying to make scientific discoveries which may seem to be rather remote from practical agriculture. This conflict is only intensified if both receive their salary from the same public coffers.[15]

In fact, it seems that there are kinds of knowledge in whose creation the extension service holds a relative advantage and others in which the

superiority of the research organization is unchallenged. The difficulties lie, as usual in the no-man's land where neither system has an obvious advantage. Perhaps charging the extension service for knowledge that it now receives free from the research organizations will smooth relations between the two organizations. Government agencies purchase knowledge from engineering and academic institutions and there is no a priori reason why such an arrangement should not be successful in agriculture.

Efficiency of the Extension System as a Public Service

Efficiency has many aspects. The management of the extension system will mostly be bothered by the technical aspects of efficiency: optimal size of extension work force, optimal spatial distribution, allocation of efforts and funds between advice, experimenting and collection of information, model farm and demonstration against visits to farms, etc. Though administratively not simple at all, these questions will be put aside. Another set of issues is directly connected to the public nature of extension. It was pointed out above that much of the knowledge in agriculture should (for maximal efficiency) be treated as a public good. A separate question is whether the service distributing this knowledge should also be a "public good."

It is not necessary that extension be public and run by the government. It could conceivably be a private, profit-motivated organization collecting payments from the receivers of the service. The profits of such an enterprise will be maximized when the marginal revenue gained by employing an additional field worker equals the marginal cost entailed in his employment.

The extension organization will collect payment only from the farmers who are in direct contact with the service, in spite of the fact that the new knowledge spreads to others too. Problems of social justice and distribution aside, a private profit-oriented organization will be too small from the point of view of economic efficiency; its size will be determined by the revenue it can collect while the benefits of its operation will be greater than indicated by this criterion to the extent that knowledge diffuses to farmers not in direct contact with the service.

The question of private against public organization is strongly connected with the issue of the optimal scale in the extension service. It is not necessary for the service to be a single economic and administrative unit, and a large scale of operation has its shortcomings. The extension service could operate in a manner similar to rural medicine or veterinary which are usually run by individuals and not by large organizations. The question is whether the scale economies outweigh the diseconomies. The strongest argument for a large-scale organization is the importance of practical experience in ever creating, testing and modifying the stock of knowledge in agriculture. The extension service operates here as a clearing house. Practical experience is most important in the biological aspects of the agricultural knowledge. It may be optimal to have a large-scale public extension organization that will concentrate mostly on the biological aspects of agricultural production along with private advisory firms specializing in engineering.

A separate issue is that of the burden of finance in the service.

Because the beneficiaries of extension cannot always be identified, collecting payments from the receivers of the advice will limit the effectiveness of the service by reducing farmers' demand, on the one hand, and their willingness to share their knowledge with their neighbors, on the other.

A public service could also be financed by taxes levied on the farm sector as a whole in a manner unrelated to the amount of service received by the farmer. The level of the tax can be determined so that it will be exactly sufficient to cover the cost of a service of optimum size. However, to the extent that the main beneficiaries from the new knowledge are the consumers and not the farmers (apart from their role as consumers), it does not seem just to require that the farmers alone should shoulder the burden of the service.

Development

Having discussed various aspects of the operation of the agricultural extension service with only incidental references to the stages of development of the agricultural sector, it will now be worthwhile to recapitulate the previous analysis in a discussion focused on the changing role of the extension service as development proceeds.

In a traditional agriculture with a stagnant technology, the farmer, though mostly illiterate, is well acquainted with the production condition in his environment. Generations accumulated knowledge through experience and observations and transferred this knowledge in an oral, established tradition. Uncertainty with respect to this knowledge is very low; the range of alternative inputs or outputs to choose from is limited and decision-making is simple. Farming is mostly of a subsistence level and commercialization is virtually nil.

So long as farming stays within the range of the traditional sets of inputs and outputs, extension has little to offer. There is no need to transfer knowledge from one farmer to another; the stock of knowledge is well spread and commonly shared. The farmer has a good factual and operational knowledge of farming but his real understanding is almost nil--his "theoretical" basis is superficial or utterly wrong. The farmer has however no use for better, scientific knowledge. What difference will it make to him if he knew how the plant roots absorb minerals or how the cow's four stomachs digest cellulose? An extension service trying to spread this kind of information in a traditional setting is likely to be met with polite indifference at best.

The picture changes drastically the moment new inputs appear. Equipped with no perceptive knowledge, ignorant about the biological, chemical or physical nature of the agricultural production processes, the farmer is at a total loss when he has to make decisions about factors with which he has no prior experience. He cannot predict the outcomes, in hypothetical cases, of the introduction of these new factors. As great as his confidence in the traditional knowledge may be, his uncertainty with respect to the new knowledge is enormous. Once the new factors start spreading, the farmer recognizes strongly the need for advice and assistance in decision-making. This rise in the demand for extension is further augmented by the fact that most agricultural innovations come, at the early stages of development, in "packages"--a new variety, for example, will often be profitable to adopt only if accompanied by the use of chemical

fertilizers or irrigation. The contribution of a trained extension agent, capable of applying knowledge from outside of traditional agriculture, then becomes very important.

Moreover, new factors of production are conceived in the laboratory or introduced into traditional agriculture from the outside. Agricultural production conditions are variable; factors which perform excellently in one fashion in one place fail altogether or require a different mode of application in another. The source for another aspect of the contribution of an extension service lies in accompanying the introduction of new factors, carefully observing outcomes and constantly spreading knowledge accumulated in experience.

Usually, the development of the agricultural sector is accompanied by development of agricultural institutions, and--what is relevant for this discussion--of an agricultural research organization. This introduces another aspect for the contribution of the extension service in several ways: (a) transmitting knowledge from the research personnel to the farmers; (b) bringing feedback from the field to the researcher; (c) dividing the labor--undertaking the more simple field trial, experiments and follow-ups by the extension personnel leaving for the researchers the more basic and sophisticated inquiries.

The introduction of new inputs into traditional agriculture implies the start of commercialization. It is in the interest of private business that farmers' awareness to the existence of modern knowledge will be aroused and that their understanding of how to apply these methods on their land

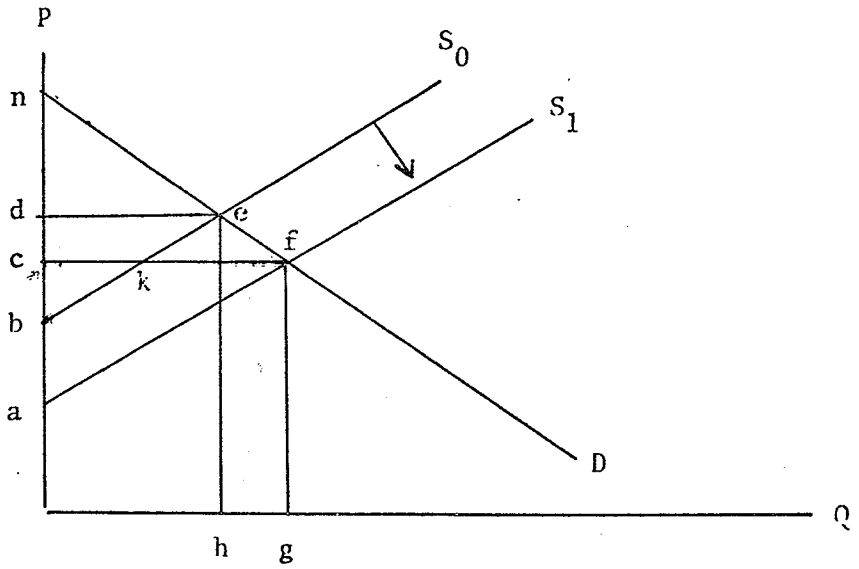
be developed. It is, therefore, in the interest of private business, so it seems, to go to areas of traditional agriculture and to undertake all the research, extension and education needed to modernize this sector with its future potential purchasing power. But this knowledge is not appropriatable. Much of the fruits of the effort of an enterprizing businessman will be harvested by his competitors. Here lies the justification for a publicly financed extension service at the early stages of development.

Perhaps the most important role of an extension service at the early stages of development is to ignite the development engine and to regulate its first phases of work through the introduction and careful assistance in the adoption of new factors. (Of course, a precondition for success is the availability of such factors.) When development becomes a self-sustained process, when new generations of schooled, outward-looking and change-oriented farmers take over, and when purchased inputs grow in numbers and quantities, business finds it profitable to advertize and to promote its products--that is, to spread knowledge on new inputs. The extension service can now assist farmers, and in the long-run business too, by testing and assessing competing brands. Competition and the watching eyes of the extension service--sometimes with the help of regulatory agencies--will then force business to be more elaborate and accurate in specifying its products. At the same time, the share of the extension service in the information flow into the farming sector declines.

One conclusion of this discussion is clear; for the extension service to successfully fulfill its functions, it must grow in knowledge and capacity to tackle problems as the agricultural sector develops. This is not easy at all. First, farmers grow fast in schooling, specialization and sophistication. Second, the public extension agent is often in an inferior position in compared with the expert representing the producer of farm inputs. The last has access to the inside information of the development and production of the products, and chances are that initially he will know more about the chemical, physical and biological properties of a new product than the extension agent. With the short length of life of many of the products, this is a long lasting disadvantage of the public agent.

The question, therefore, arises as to whether, at the advanced stages of development, public extension's contribution does not fade away and vanish altogether. The answer should be given on empirical grounds. A priori, the service should continue to operate so long as there exist a stock of knowledge whose distribution could be regarded as a public good. A precondition for its existence in a dynamic agriculture is a highly skilled, specialized and sophisticated personnel equipped with technical facilities to perform rapid and accurate testing and with access to the best research results. Whether these conditions exist in any of the developed countries and whether the contribution of extension then outweighs the cost is an interesting and important question to which no answer has yet been given.

Appendix: The distribution of the effect of additional knowledge



ben - total surplus, consumers' plus producers', before the distribution of knowledge;

afn - total surplus after the distribution of knowledge;

abef - surplus added by knowledge;

cdef - surplus added to consumers;

acf - bde - surplus added to producers (may be negative);

cked - transfer of income from farm to consumer sector;

kef - addition to consumer surplus due to increase in efficiency.

Footnotes

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[1]Dorris D. Brown, Agricultural Development in India's Districts (Cambridge: Harvard University Press, 1971), p. 2.

[2]Organization for Economic Cooperation and Development, Agricultural Advisory Services, No. 90 of Documentation in Agriculture and Food (Paris: OECD, 1968), p. 73.

[3]Everett M. Rogers, Diffusion of Innovations (New York: The Free Press of Glencoe, 1962).

[4]Compare to Rogers' statement: "The thesis of the present report is that the problem of persuading peasants to adopt innovations can profitably be approached as a communication problem. The content of the message exists. We know what is to be communicated to the peasant, but we do not know how to do so most effectively." (Everett M. Rogers, Joseph R. Ascroft and Hiels G. Roling, Diffusion of Innovation in Brazil, Nigeria and India, Diffusion of Innovation Research Report 24 [East Lansing:

Footnote 4 continued:

Michigan State University,Department of Communication, 1970], 1-2).

[5]Marion R. Brown, "Agricultural 'Extension' in Chile: A Study of Institutional Transplantation," The Journal of Developing Areas, 4 (January, 1970).

[6]Ken D. Duft, "The Team Approach and Extension Economics," The American Journal of Agricultural Economics, 53 (February, 1971).

[7]Kenneth J. Arrow, "Economic Welfare and the Allocation of Resources for Invention," in The Rate and Direction of Inventive Activity, ed. by Richard R. Nelson (Princeton: Princeton University Press, 1962).

Kenneth E. Boulding, The Image (Ann Arbor: The University of Michigan Press, 1956).

Fritz Machlup, The Production and Distribution of Knowledge in the United States (Princeton: Princeton University Press, 1962).

William D. Nordhaus, Invention, Growth and Welfare: A Theoretical Treatment of Technological Change (Cambridge: The M.I.T. Press, 1969).

T. W. Schultz Transforming Traditional Agriculture (New Haven: Yale University Press, 1964).

Finis Welch, "Education in Production," Journal of Political Economy, 78 (January, 1970).

[8]For a case study covering this and other aspects of the development of corn and wheat, see: Delbert T. Myeren, "The Rockefeller Foundation Program in Corn and Wheat in Mexico," in Subsistence Agriculture and Economic Development, ed. by Clifton R. Wharton (Chicago: Aldine, 1969).

[9]Finis Welch, "Some Aspects of Structural Change and The Distributional Effects of Technical Change and Farm Programs," in Benefits and Burdens of Rural Development (Ames: Iowa State University Press), Table 9.1.

[10]Welch, in "Education in Production," stressed the "allocative effect" of schooling and extension, arguing that production function estimates of the contribution of these factors are biased downwards since they include only what he termed the "worker's effect," namely, the contribution of schooling and extension holding all other inputs constant.

For an example of production function estimates see: Zvi Griliches, "Research Expenditures, Education, and the Aggregate Agricultural Production Function," American Economic Review, 54 (December, 1964).

[11]For an example of an estimate of research and extension contribution in stock terms, see: Willis L. Peterson, "Return to Poultry Research in the United States," Journal of Farm Economics, 49 (August, 1967).

[12]Willard W. Cochrane, "Some Further Reflections on Supply Control," Journal of Farm Economics, 41 (November, 1959).

Luther G. Tweeten and Fred H. Tyner, "Toward an Optimum Rate of Technological Change," Journal of Farm Economics, 46 (December, 1964).

[13]This is an unidirectional argument. The sociologist, it seems, will argue both ways in saying that extension is more effective when agents are peers of farmers.

[14]OECD, Agricultural Advisory Services, p. 79.

[15]See for example: R. J. Hildreth, "Tensions Between Research and Extension Workers - Three Hypotheses," Journal of Farm Economics, 47 (August, 1965).