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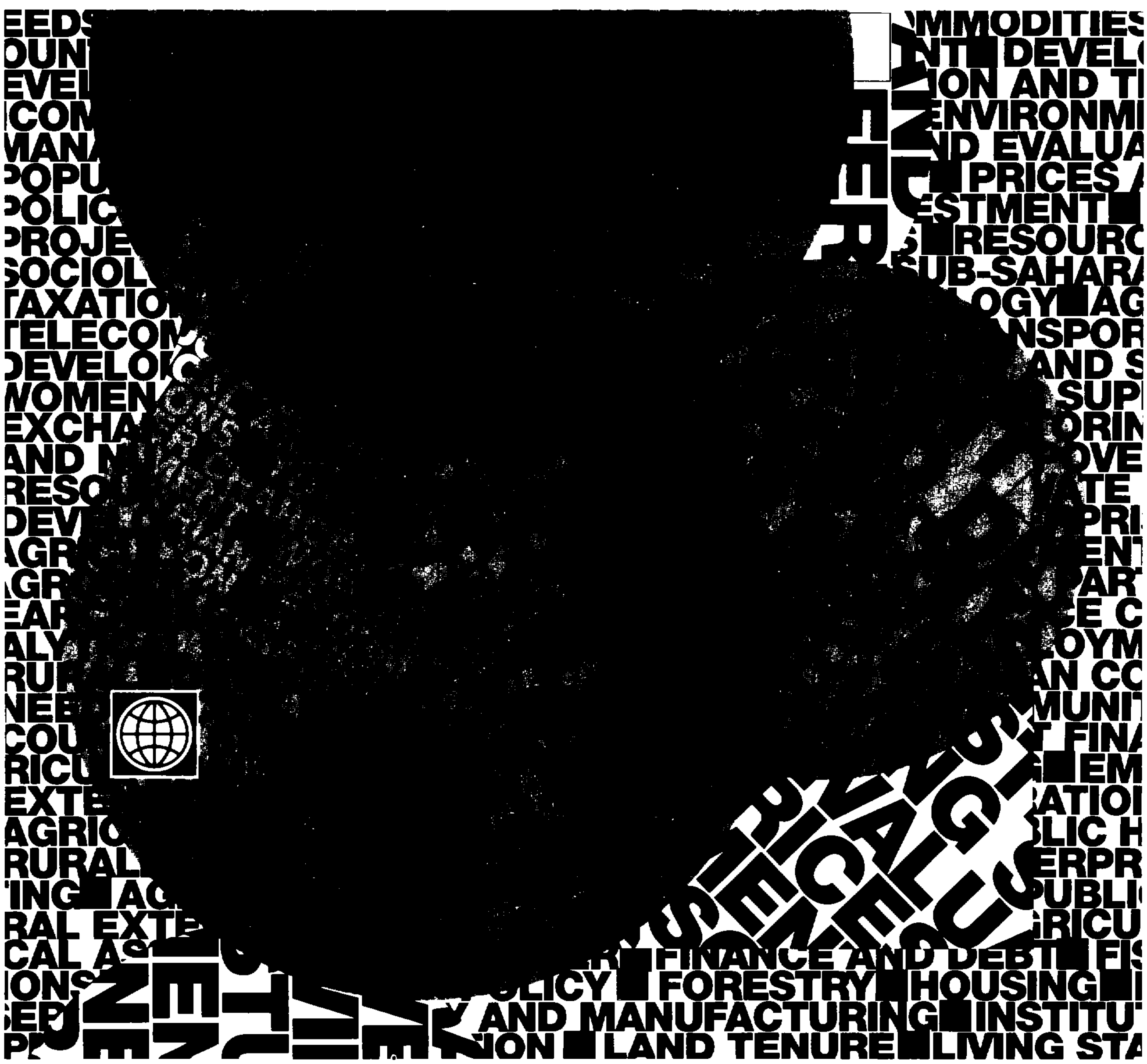
Getting Ready for the Twenty-First Century

Technical Change and Institutional Modernization in Agriculture

Charles H. Antholt



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Technical Change and Institutional Modernization in Agriculture

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FOREWORD

Agricultural technology and its transfer have been important features of Asian agricultural progress for centuries. A thousand years ago during the Sung Dynasty, owners of large and progressive Chinese farms were publishing books on agricultural technology so that smaller farmers might improve their agricultural practices (and, hence, their incomes). It was in Asia during the 1970s that the World Bank initiated a major effort to improve extension services using the Training and Visit system. In this respect, we should acknowledge Daniel Benor's great contribution in initiating and sustaining that effort. Although T&V did not realize all its objectives, and, as recorded in this paper, there were some questions as to the extent of its achievements in some countries, it was very instrumental in bringing a new and different focus to the importance of professional services and the need for the creation of well- trained and -managed extension services.

In the rapidly-changing world of today, there is a need to look for less costly, more responsive and more pluralistic transfer systems that can reach a wider clientele; many farmers never will take advantage of government extension services, but they may be serviced by expanding NGO extension systems, or they may obtain information through the media, publications, or "over the fence" advice from their neighbors.

One other important point is that, in a rapidly-changing world, farmers have to adapt their age-old systems to a new environment that increasingly will force most farmers to more intensive farming systems (together with the attendant environmental issues). New techniques will have to be developed and put in place in order to assure sustainability. These techniques have special importance in the areas of soil and soil moisture conservation, soil fertility, crop protection, and the management of new varieties of crops - thus the need for more aggressive and innovative research linked to more effective dissemination system.

Charles Antholt, the author of this paper, has had many years of experience as a working agriculturist in South Asian countries. He is not slow to challenge the past and is active and aggressive in promoting the future. His paper provides a challenge to those of us working with the future of agricultural technology.

Daniel Ritchie
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ABSTRACT

Agricultural development is related closely to increasing factor productivity. Consequently the productivity and performance of agricultural research and extension are of central, strategic concern in the process of agricultural development. The World Bank, in its concern for economic development, and for agricultural development in particular, will need to continue to be concerned about the availability, generation, and diffusion of new agricultural technology in Asia.

This paper reviews the performance of agricultural research and extension in Asia. Given the increasing pressures for performance and technological innovation at the farm level, a faster-moving, more interdependent world, and a time when governments increasingly are strapped for resources, institutional modernization needs to begin now to deal with the issues of relevance, responsiveness and cost-effectiveness of research and extension.

Imperative reactions to these issues include client ownership and responsibility to gain accountability; competition within the public sector and between the public and private sectors; pluralism, not single dimension solutions, in delivery approaches to research and extension needs. Beneficiaries should be expected to support, in part if not in whole, research and extension services. Downsizing must take place in public sector institutions to husband public resources for those activities the private sector clearly will not do. Lastly, public research and extension personnel will need to have personal stakes in how farmers view their performance.

"Technology is like a lever
that uses mechanical advantage
to multiply force and raises
the economy to higher levels
of productivity and wealth
(Mokyr, 1991)."

INTRODUCTION

The importance of technical change on economic growth has been understood since Adam Smith (1776). Indeed, for agriculture, increasing factor productivity is a hallmark of agricultural development. The green revolution in Asian rice and wheat production is the best known contemporary example of the power of technological change. Central to increasing the productivity of resources used in agriculture are the institutions and arrangements by which more productive germplasm, inputs and/or practices are identified, developed, and ultimately acquired and used by farmers. Therein lies the importance of our concern with the performance of agricultural research and extension organizations.[1] These institutions, especially the national agricultural research systems (NARSs), were able to utilize and adapt the new high-yield rice and wheat varieties, and have been particularly important to the green revolution in Asia. Not unexpectedly, these institutions have, by and large, been in the public sector, centrally-managed and with limited accountability to farmers for their performance. Farmers seldom were expected to have responsibility, even partial, for supporting these institutions, resulting in minimal linkage and often-absent institutional accountability.

Given the magnitude of the future demands that will be placed on Asian agriculture, and the nature of those demands, the current institutional relationships are no longer sufficient. Hence, farmer organizations, associations, NGOs, and private firms can be - indeed must be - expected to take on greater responsibility for the direction as well as support of those institutions involved with agricultural technology identification, generation, and dissemination in Asia.

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1 Agricultural research and extension defined in the broadest sense, not limited to "public sector" institutions, but the spectrum of institutions associated with technological change in agriculture.

BACKGROUND

Concern by the "developed" countries of the "West" for the agriculture of the developing world is not much more than 40 years old. In the early 1950s, the problems facing agriculture in developing countries largely were defined on the basis of a set of rather uninformed assumptions, some of which remain today, about the behavior of people in low-income countries. For example, Lerner (1958) said, "They don't do what, on any rational course of behavior, they should do. They want consumption, but they don't worry about saving and think little about productive investment. Instead of limiting their families ... they produce population explosion ... its people problems."

Early plans for agricultural development were conceptualized in the view that traditional agricultural systems were static or, at the most, very slow to change. In the 1950s, there also was a high degree of confidence in the ability of Western agricultural technology to solve the needs of the "hungry, poor and ignorant" in the developing world (Britan, 1985). Consequently, the problem of developing agriculture was seen as one of accelerating the rate of growth of agricultural output and productivity via what came to be known as the "diffusion model" of agricultural development (Rogers, 1962). In that model the process was conceived as a hierarchical, unidirectional process providing new technology, usually from the West, to traditional agricultures, which then were *delivered to* farmers by departments of agriculture (Kearl, 1991).

From results of village-level research in the 1950s and early 1960s, which documented that peasant farmers were "poor but efficient," and were indeed "innovators" when it was in their interest to be, the above irrational paradigm concerning farmers in developing countries began to break down. In short, while third world farmers may be poor and illiterate, they can count (Antholt, 1991). Furthermore, they also are able to allocate their resources fairly efficiently in response to the dynamics of the physical and economic environments surrounding them (Tax, 1953; de Schlippe, 1958; Schultz, 1964).

The adoption of the new wheat varieties in Pakistan in the late 1960s (Lowdermilk, 1972) the spread of Mashuri rice over most of Eastern India (in the Terai of Nepal, the variety was known as Masuli and in Bangladesh as Pajam) in the late 1970s and early 1980s the widespread adoption of Bikaner Lerma cotton in Western and Northern India (Maurya, 1989) and the rapid and widespread adoption of the new rice varieties in Indonesia in the second half of the 1960s (Hakim and Nataatmadja, 1980) are some of the better known examples of the willingness and ability of small farmers in the developing world to adopt new technology and do so very rapidly. These experiences, plus work by Ruttan, Evenson, and others that documented very high returns to investments in agricultural research, gave rise to a better understanding of the relative importance of "getting the technology right" in the first instance, as well as the importance of technology generation, as opposed to the earlier emphasis on "extension." This shift was bolstered further by work in Latin America and India that revealed the failures of agricultural extension (Rice, 1971; Brown, 1972).

Unfortunately, both of these legacies (i.e., the diffusion approach and "getting the technology right") generally reinforced the limited, linear, and sequential view of how information and knowledge need to be developed and made accessible to farmers -- that is, from basic science to applied science to technological innovations to farmer recommendations. Consequently, this model obscures the fact that farmers are innovators, not just passive receptacles of information (Chambers and Jiggens, 1986). Consequently, there has been a failure to use a systems perspective in diagnosing farmer problems in the development of systems to identify and develop new technology. This perception of what the process of technological transformation in agriculture is and how it works continues to limit the ability of extension and research institutions to be "farm- and farmer-orientated (Roling, 1991)." Perhaps equally important has been this model's failure to promote adequately farmers' involvement in determining the agendas of the very institutions established to service their needs for more productive technology, in evaluating the performance of these institutions, and in financially supporting them.

THE SETTING

Without a question, agricultural gains realized in Asia since the 1950s have been impressive. In 1952, India produced 52 million tons of foodgrains. Today it produces around 175 million tons of foodgrains. Indonesia produced 35 million tons of rice in 1989. Twenty years ago its production was 18 million tons (Crosson and Anderson, 1992). Bangladesh produced 9.6 million tons of rice in 1961. By 1990 Bangladesh rice production rose to 18.5 million tons (World Bank, 1992 a). China's grain production in 1960 was 126 million tons whereas in 1988 is was 343 million tons (World Bank, 1991 a).

Since so many of Asia's poor live in rural areas, are dependent primarily on agriculture for employment, and spend a high proportion of their incomes on food, an increase in their productivity through the provision of more productive agricultural technology is of central importance in alleviating poverty and ensuring future growth. In southern India, for example, the introduction of modern rice varieties and practices has benefited small paddy farmers and landless laborers greatly and has provided the means by which they have been able to double their real incomes in about ten years. This, in turn, has had extremely powerful second- and third-round effects on the demand for non-agricultural products, and, thus has further fueled overall economic growth (Hazell and Ramasamy, 1991). We note, however, that while strong agricultural growth is important in attacking poverty and supporting economic growth, it is not enough. China, even with its agriculture booming over the last fifteen years, still has a per capita income of about $350 per year. In Pakistan, India, Bangladesh, and Nepal, per capita incomes remain low, at about $370, $340, $180, and $180 respectively in 1989 (World Bank, 1991 e).

Through the 1950s agricultural growth in Asia was related closely to increases in cultivated area. Today, Asia has about 343 million hectares in cropland. There remains little potential for expanding this area -- another two million hectares at most. More recent sources of agricultural growth in Asia have been related much more closely to expansion of irrigated area, increased use of fertilizer, and, in spite of the institutional problems noted above, the adoption of the new, high-yielding rice/wheat varieties, and hybrid rice in China. Indeed, it was these latter technological innovations, used in conjunction with irrigation, that fueled the green revolution in Asia.

Even with the promises of biotechnology, future agricultural growth is not expected to be as spectacular as the green revolution, nor as relatively straightforward. Inevitably, biotechnology, through genetic manipulation and gene engineering, should make significant contributions to agriculture, although significant economic impacts are not expected before 2000 (Persley, 1991). As an aside, Ruttan (1990) notes that the promise of biotechnology seems to remain out in front at a constant 5-to-10 years. Byerlee (1989) and Pingali (1990) suggest that the best we can expect from plant breeding in rice and wheat, for example, are increases of about one percent per year in "potential" yields in favorable areas, and about one half of that in unfavorable environments. In short, given the limits on land and irrigation, and likely breakthroughs in technology, future increases are apt to be more incremental and come from technological improvements derived from identifying, developing, and applying more efficient practices (Byerlee, 1991). Such practices include better plant stands, minimum tillage, improved weed control, better land and water conservation, IPM, improved soil fertility management, better use of irrigation, and/or switching to crops or livestock options which take better advantage of emerging new effective sources of demand and the natural resource base.

There are a number of realities that will condition how agriculture should, and indeed will, evolve over the next two decades. These realities will challenge Asian agriculture significantly and must be taken into consideration. Fortunately, these realities also offer opportunities for those who can take advantage of them and meet the competition.

- First is the reality of a world increasingly interdependent through trade, modern information systems, and linked financial systems. For example, worldwide trade of agricultural products grew about six times between 1962/64 and 1983/85 (Timms and Shane, 1987). During that period, total agricultural imports grew nine times for developing countries, while their exports grew about five times. Now, for the first time, agriculture figures prominently in the Uruguay Round of the GATT. While GATT negotiations have been extremely protracted and disappointing, ultimately they should lead to increased support for trade in agricultural products.

- A second reality is the phenomenon of economic growth in non-agricultural sectors and associated urbanization -- a trend closely associated with a growing and more- concentrated demand for higher-value agricultural products, e.g., vegetables, meat, oils and fat, and dairy products. Many of these products can be produced efficiently on small farms and are labor-intensive. Therefore, increases in demand from domestic growth, or through trade, can be particularly important in getting at root causes of rural poverty as well as enhancing shifts in land use to more sustainable practices and/or efficient use of resources. Coupled with the increasing trade opportunities, the structural change on the demand side implies increased diversification, more sophisticated marketing requirements, new opportunities for value-added processing, and, in general, increasingly commercial agriculture.

- The third reality is the finite and fragile nature of the natural resource base. The issue of sustainability today is more obvious and urgent than ever. A little over forty years ago Alan Paton, in *Cry the Beloved Country*, wrote, "The rich green hills break down...they grow red and bare, they cannot hold the rain...the streams are dry...too many cattle feed upon the grass...the earth has torn like flesh...the soil cannot keep them anymore (Khan, 1989)." For vast areas this description remains true. Soil erosion, increasing urbanization, and salinity/alkalinity problems continue to make inroads on the existing cropland.

- Fourth, not only have the cropland frontiers been reached in Asia, there is evidence that the irrigation frontiers are being reached as well. The demand for urban drinking water and industrialization requirements, once insignificant vis-a-vis total water availability, increasingly are priority claimants on water resources. In some areas, water use is a looming issue of major importance and possibly conflict. In the state of Tamil Nadu in India, for example, there is essentially no available water with which to expand irrigated area. In other parts of Asia some potential remains, as in China, but those areas tend to be more problematic and significantly more costly to develop.

- Fifth, many governments in Asia, if not most, seem to be reaching the limits of their financial ability to sustain large cadres of civil servants (the cost-effectiveness of whom is questioned increasingly). Public sector agricultural research and extension are no exception. Given the inability of, or at least the great difficulty for, public sector institutions to downsize, what budget resources are available go first to salaries, leaving little for complementary operational funds, i.e., the funds to carry out research or conduct field demonstrations. In Rajasthan, India, for example, the scientists at the State Agricultural University have had, on the average, about $107 per annum with which to work for the last few years. And this is the principal institution responsible for generation of new agricultural technology in the state. In Tamil Nadu, 88% of the state's approximately $10 million 1990-91 extension budget was used for staff salaries, allowances, etc., but only .04 percent (roughly $4,000, or a little less than one dollar per extension agent) was budgeted for "materials and supplies," i.e., materials for demonstrations (Macklin, 1991). Over the past few years, Nepal's budget for extension has declined by 40% in real terms (World Bank, 1992 b).

- Lastly, besides the issue of financial sustainability, there is an increasing concern about the limits and diseconomies of scale for governments with respect to centrally-managed, manpower-intensive, location-specific services like agricultural research and extension. In a country such as Indonesia, for example, which is spread over 4,000 miles, with 13,000 plus inhabited islands and an extension cadre of 33,000, sustainability is almost impossible (Pusat Pengembangan Agribisnis, 1989). Similar views, particularly from finance and planning officials, are articulated increasingly in the Philippines, Nepal, Sri Lanka, Pakistan, and in a number of states in India.

These realities, along with agriculture's central position in meeting the strategic issues of growth, sustainability, and poverty, underline more than ever the importance of increasing agricultural productivity while maintaining the inherent productivity of the resource base. In looking ahead, it is clear we have to agree with Mellor (1990) that broad-based agricultural development, driven by cost-reducing, productivity-enhancing technological change, has to be of paramount strategic importance. Indeed it should be even more important than in the past. For example, in China, as the growth fostered by the institutional reforms of the 1980s becomes exhausted and the constraint on arable land asserts itself, additional growth will have to come from new technologies, techniques, and know-how based on agricultural research (Fan and Pardey, 1992).

While future agricultural growth may be more incremental, it also will be increasingly complex, location-specific, market- driven, and science-based/knowledge-intensive. Herein lies the importance and concern for the institutions that must be in place and effectively working in identifying, developing, and disseminating agricultural technology.

AGRICULTURAL RESEARCH

The Bank has supported agricultural research since 1972 (Pritchard, 1991). Bank willingness to support agricultural research was, in part, due to the increased understanding of the importance of technical change, and, thus, the importance of agricultural research. Griliches (1957), in his seminal work on hybrid maize in the U.S., was the first of a number of scholars who documented the economics of technical change. By the late 1960s, the extremely high return that could be realized from investments in technology generation in agriculture was well documented. Also, by the late 1960s the green revolution was sweeping Asia. It was clear early on that those countries with stronger agricultural research systems were the ones that most rapidly assimilated and adapted the new, exotic germplasm to the needs of their farmers and, in turn, were quickest to realize significant increases in foodgrain production. The work of Evenson and Kislev (1975) confirmed that strong NARSs were the key to a country's capacity to screen, borrow, and adapt scientific knowledge and technology.

The Bank's strategy concerning the support for agricultural research was developed in 1981. In short, the policy paper calls for increased lending for agricultural research (at the expense of extension). The policy is broad and comprehensive, giving emphasis to applied and adaptive research concerning food and commodities for low-income consumers, cash and export crops, farming systems, and environmentally-sound production practices. Bank support for more basic research was to be restricted to the International Agricultural Research Centers (IARCs) and a few of the stronger NARSs. Projects were to insure linkages between research and extension, address personnel management problems, and address research quality (World Bank, 1981).

Throughout 1991 some 352 projects in 77 countries received Bank support for agricultural research -- 107 of these projects were in Asia. Pritchard (1991) estimates that since 1980 Bank support for agricultural research has come to about $2.3 billion, with about $1.6 billion in "free-standing" projects. The balance represented components of various other agricultural or rural development projects. While the bulk of Bank support was through loans or credits to borrowers, the Bank also supported the Consultative Group on International Agricultural Research's (CGIAR) IARC system with grant funds. By 1991, total Bank support for the IARCs was $315 million with the 1991 support level at $37.1 million.

Experience with Agricultural Research

Within the World Bank, the Agricultural Division of the Asia Region's Technical Department reported on agricultural technology generation, management, and dissemination for the region in the 1989 ARIS (World Bank, 1989). More recently, Purcell (1991), Pritchard (1991), and Tamboli (1991) also reviewed Bank experience with agricultural research. The following are highlights from those reviews.

- Coordination of research resources remains a major problem. In countries with centralized systems, as in **Indonesia**, **India**, **Philippines**, **Bangladesh**, **Pakistan**, and **China**, mechanisms exist, e.g., national agricultural research councils, aimed at facilitating better planning and coordination. While issues of concern since the early 1970s, planning and coordination remain problem areas. For example, in China, coordination in planning between various institutes remains a critical issue.[2] In India, Sri Lanka, Pakistan, and possibly in Indonesia, increased political decentralization makes it even more difficult to integrate and coordinate agricultural research efforts. In Nepal, Sri Lanka, and Bangladesh, the national research councils exist in little more than name. But even in large, strong systems such as those in Pakistan and India, the national councils have become so overly-centralized and preoccupied with "administering" that the effectiveness of their coordination is arguable.

- The social sciences are poorly-integrated and used in most of the Asian NARSs. **Thailand** has very few economists in its NARS. Where they exist, they tend to be isolated, neither doing necessary supportive analysis for the more traditional agronomic sciences nor undertaking policy-relevant research useful for planners.

- Overall "management" is generally poor in most of the NARSs. Management of the research agenda, personnel, and finances are all very problematic. The

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[2] Remarks by Dr. Gary Toenniessen, Rockefeller Foundation, at World Bank Workshop on "Technical Innovation in Agriculture: New ways of doing business - The Bank and BioTechnology, June 11, 1991.

Agriculture Research Management Project in **Indonesia**, the National Agriculture Research Project in **Thailand**, and the Agricultural Research Project in **Sri Lanka** are designed to address specifically overall management issues.

- Striking a balance in the allocation of research resources between high-potential areas and resource-poor areas remains problematic. **Indonesia**, **Thailand**, and **India** have found this particularly difficult, but the issue is also of major concern in all Asian countries.

- The green revolution gave tremendous stature to "plant breeding." That legacy has led to some NARSs, particularly in **India** and **Pakistan**, having too many breeders in comparison to other disciplines.

- Autonomy from the tyranny of the usual civil service "rules and regulations" is an important characteristic of modern, productive science institutions. Limited success has been obtained on this issue, either in conjunction with projects or adjustment operations. Closely related to this is the importance of insulation from "capricious" political interference.

- Little has been done to integrate forestry and agricultural research needs, although very modest starts have been made in **India** and **Pakistan**. Even less has been done to develop capacity for adequate work on resource conservation issues.

- Little, if any, integration of livestock and pasture/forage research has been achieved in **India**, **Nepal**, **Bangladesh**, **Pakistan**, and **Sri Lanka**. This is usually a result of agriculture and livestock being viewed as two separate areas, often with separate ministries. Forage and pasture work particularly has been neglected as a result.

- The relevance of research continues to be a central issue in all Asian NARSs. **Bangladesh**, **Thailand**, and **Pakistan** have responded by organizing a Farming Systems Research (FSR) approach/capacity. In some cases, such as **Nepal**, this has led to the establishment of FSR units at stations. However, these do nothing in terms of better acquainting firsthand "mainline" scientists with farm problems. **India's** response has been a massive investment to define 127 agro-ecological zones and develop appropriate research station facilities to ensure more relevant research work. Extension services might be expected to play a more important role with respect to this problem, particularly in diagnosing farm-level constraints. Nevertheless, none of the national extension services has the capacity to do this.

- Research and extension linkages remain weak in **Bangladesh**, **Pakistan**, **Indonesia**, **Nepal**, **Sri Lanka**, and **India**.[3] It is recognized widely and agreed that research and extension are part of the same continuum. Nevertheless, these areas still tend to be under separate bureaucratic entities and supported by separate funding mechanisms, including, frequently, from donors.

- Under-funding of operational expenses is a chronic, across-the-region problem. In 1989, **India** had a normative figure of about $400 per scientist per year, although in reality few scientists ever had that much with which to carry out research. Tamboli (1991) notes that the same sort of problem exists with **Indonesia**. Pritchard (1991) suggests that a ratio of one-third to two-thirds for operational funds to salaries should be the norm.

- While the importance of private-sector research is recognized, no direct effort has been initiated to "actively" encourage public sector research organizations to turn particular areas of research over to the private sector.

There are seven additional comments about agricultural research systems in Asia that need to be made.

- First is that the legacy of the green revolution is a proud one to which many of the NARSs contributed significantly. Sri Lankan, Indian, Pakistani, Bangladeshi, Indonesian, and Chinese rice and wheat breeders can take considerable pride in their role in using exotic germplasm to develop varieties that fit the particular needs of their countries at that time. That legacy gave rise to the recognition of the value of technological innovations in agriculture, as well as the need for strong agricultural research systems. This, in turn, led to support for significant expansion of NARSs throughout Asia, not an inconsiderable accomplishment considering all the other investment needs at the time.

  However, the legacy also has left too many Asian NARSs complacent with resources over-committed to foodgrains. Over-manning is a problem in many systems, if not all.[4] At the same time, these same NARSs are undermanned in areas for which there is emerging demand and significant opportunity for diversification, policy analysis, or better use of the natural resource base. Increasingly, NARSs no longer are taken for granted and are being

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3 Indeed, Haryana State Agricultural University Vice Chancellor Dr. A.L. Chowdhri recently reported (May, 1992) that it was his view that research/extension linkages have gotten weaker in general despite more opportunities for closer collaboration and explicit policy pronouncements supporting increased research and extension cooperation.

4 In briefing the World Bank agricultural research review team in May 1989, the then-Secretary of Agriculture, Government of India, listed over-manning as one of the principal issues facing India's agricultural research system.

questioned more frequently as to their usefulness. Unfortunately, however, these questions are not being asked by the NARSs themselves but by those in government who have to make hard choices with respect to increasingly scarce budget resources. Lastly, too many NARSs tend to want to hang on to all the responsibilities they have had for the past two decades. They seem unwilling to look for ways to spin off research areas to or develop collaborative partnerships with the the private sector. India is a classic example in which the private seed industry has a clear, comparative advantage in producing hybrids, yet the NARSs continues to commit major resources to work on hybrids.

- Secondly, while all of the Asian NARSs have grown significantly in size, (for example, India has about 30,000 scientists), this expansion too often has disregarded the qualitative needs of agricultural science. Of particular concern is the presumption of nearly all the systems that it is possible to do serious agricultural research without scientists. This surfaced in a World Bank review (1989) of the Indian Council of Agricultural Research (ICAR) and previously was raised by Ruttan (1986). Throughout the Asian NARSs it is not uncommon to see "scientist" positions filled with B.Sc. or non-research Masters' degree graduates. Even the stronger systems, like those in India, have relatively few scientists with solid Ph.D.-level training. This problem is further compounded by inbreeding in many Asian universities. Consequently, new scientists entering the systems may have advanced degrees, but degrees that may be depreciated seriously in terms of value or the potential skill level of the holder. This poses a serious, long-term dilemma for contemporary NARS because most systems have very limited ability to retrench scientists once they are recruited and remain on board for three or more decades of service). While Asian agriculture may be developing, the problems and opportunities facing Asian agriculture are no less complex and sophisticated than those in the developed world. Consequently, if the NARSs are to be productive, scientists with the requisite education and skill levels are required. That does not necessarily mean all research can be done only by holders of a Ph.D. Far from it. But serious questions have to be asked about the real capabilities of scientists who have neither the education nor training, and furthermore work in an environment that does not reward for performance.

- The third comment is that, in most of the NARSs, the performance of scientists has little effect on recognition, reward, and promotion. The bottom line for career enhancement still tends to be related to length of service. This is exacerbated further by outdated personnel management systems that may be suitable for general civil service but that restrict promotions to a pyramidal arrangement in which advancement is not possible unless a higher post is created or vacated. This in effect means that, no matter how good the work of a scientist is, a promotion is not possible until a vacancy above exists or is created. This does two things. At best it encourages excessive expansion and/or continues fragmentation of research groups, sometimes at the cost of a critical mass of scientists, in order to open up more promotion possibilities. At the worst, however, this situation adds to the frustration levels of scientists, particularly the best and brightest, and in effect encourages them to market their abilities outside their own countries. In the fast-moving world of science and technology, and the increasing importance of market forces and market interdependence, there is a premium on excellence, entrepreneurship, creativity, and agility in a scientist's performance (and that of science organizations for that matter). Outdated, and indeed perverse, incentive systems for scientists are as big a problem as any facing Asian NARSs.

- Fourth, as mentioned above, the nature of technological change in agriculture is likely to be more complex and incremental -- and more knowledge-intensive. Asian NARSs will need to devise ways that promote increased collaborative working relationships with extension and a multi-disciplinary approach to problem solving. Institutional structures and incentive systems in existence today do not foster these relationships, contemporary rhetoric aside. Bureaucratic rigidities represent formidable boundaries, but the essentially mono-disciplinary approach in which most research is carried out now simply is not good enough for the future.

- Fifth, it is agreed that poor management is a serious problem in all of the Asian NARSs. However, almost all interventions to improve management from the installation of management information systems (MIS) to the development of "national research plans," tend to further centralize and concentrate the locus of power. While this does not have to be problematic per se, somehow in Asia these kind of initiatives too often end up reinforcing traditional administrative control/management procedures that net out to be overly-centralized authorization processes which nonethelss (paradoxically) allow too much operational decentralization (Hobbs, 1990). Consequently, over time, large hierarchical organizational structures like ICAR have developed. Initially these organizational arrangements were to coordinate, bring focus, reduce duplication, etc. Instead they have become structures that dampen creativity, reduce the independence of the scientist, and at the same time detach responsibility for performance from career advancement. In other words, these structures have violated most of the principles identified to manage successfully for innovation (Williams and Antholt, 1992) and are certainly incompatible with the location-specific nature of agricultural research.

- Sixth, none of the Asian NARSs has been able (or rather tried) to develop a constituency for support outside the governmental bureaucracy, or in many cases, donors. Indeed, in some instances research organizations have more of a constituency among donors than within their own government or the intended beneficiaries of their research. This problem is related closely to the relevancy and responsiveness of agricultural research, but also is at the core of the long-term financial sustainability issue.

- Finally there is the issue of isolation. Few of the NARSs have up-to-date libraries, and what facilities exist may not be very accessible by the majority of the scientists in the system. Furthermore, few of the systems have provided the capital necessary to invest in modern telecommunication and information systems that could -- relatively cheaply -- link scientists to colleagues, libraries and/or database anywhere in the world. Somehow it seems to be assumed that once a scientist has a degree he or she is equipped for life. This is particularly tragic when the degree itself may signify less than what it should be. Besides the under-investment in libraries and information systems, there is also under- investment in appropriate opportunities for scientists to meet and work with professional peers. These kinds of activities (sabbaticals, seminars, conferences, etc.) too often are viewed as current expenditures, sometimes luxury expenditures at that, instead of what they are -- investments in the building and maintenance of the systems's human capital.

AGRICULTURAL EXTENSION

In the early 1970s there came about a better understanding of the importance of technological innovation in the process of agricultural development. At the same time, there also developed a sense, in some quarters, that there was a backlog of technology yet to be moved to farmers. This perception stemmed in part from the desire to maintain the rapid progress in food grain production that was experienced in the first flush of the green revolution. Also, it stemmed in part from an over-estimation of the robustness of existing technology under conditions faced by farmers, particularly small farmers in resource-poor areas. The problem then was assumed to be (in retrospect incorrectly) one of passing the technology on to farmers (Sims and Leonard, 1990). Most important, however, is the fact that this view was consistent with the linear, sequential, center-periphery view of agricultural technology development and dissemination. It therefore followed that increasing the intervention capacity of extension through more staff, more training, more buildings, more motorcycles, etc., was necessary (Roling, 1991).

Not unexpected was the conclusion that to move this backlog of technology out to farmers would require increased discipline in managing extension personnel. In response, the T&V approach to extension management evolved which was to energize extension and turn a cadre of poorly-supervised, -motivated, and -trained field agents into effective agricultural extension agents (Hulme, 1991). While the Bank had supported agricultural extension since 1964, it was in the mid-1970s that Bank support for extension took off, with some 356 projects being approved that supported agricultural extension. By 1988 the Bank, through 512 projects, had disbursed about $2 billion, primarily using the T&V model (or a somewhat modified T&V model) for reformation and strengthening of agricultural extension (Hayward, 1990).

Experience with T&V

There can be no question that T&V has had considerable influence on extension services in Asia despite the controversy and the debate about it (Roberts, 1989; Peberdy, 1990; Howell, 1988). Perhaps the most useful result of the debate concerning T&V has been the bringing to bear of attention on the more systemic problems of extension, not just the organization and management arrangements used (Hulme, 1991). Although somewhat late perhaps, it seems that Axinn's (1988 a) clarion call to scholars "of extension" has been heeded indeed.

The difficulties of evaluating extension (Baxter et al, 1989) notwithstanding, Feder, et al's work in particular has to be considered. This field research was carried out in India in contiguously similar areas, the Karnal district in Haryana and the Muzaffarnager district in Uttar Pradesh. The study was a rigorous, in-depth review of T&V at the field level. The main feature of the study was an analysis of productivity differentials between the two areas in wheat and rice. The results with rice did not prove to be significant statistically. With respect to wheat, the study assumed constant returns to scale and estimated a production function for farmers with no irrigation problems. The analysis estimated that an internal rate of return to the incremental cost of establishing T&V in Karnal district was (with a 90% probability) at least 15% over the life of the project and 18% using the concept of "efficient project life" (Feder et al, 1987). Not an unimpressive return on investment, although returns to agricultural research generally are higher.

Nevertheless, there is widespread dissatisfaction with T&V and extension in general, in Asia. In reviewing the literature it is clear that a number of observers, researchers, and evaluations have reached conclusions that need to be "put on the table" in order to provide the foundation for moving ahead with extension. Some of the more important findings are:

- In **Pakistan** T&V had no impact in the Punjab province (Khan et al, 1984). T&V focused too much on process and not enough on "increasing the relevance of technology messages and different methods of transferring them to farmers" (Bartlett, 1987).

- In **Indonesia** T&V was unable to make an impact in non-rice, dryland, multi-system crops (Pusat Pengembangan Agribisnis, 1989).

- In rainfed and less well-endowed areas of Andhra Pradesh, **India**, T&V was found to have no effect on agricultural productivity (Sanghi, 1989). In comparing the relative growth in wheat yields and agricultural gross domestic product for Haryana, which used T&V, with Punjab, a non-T&V state, it cannot be concluded that T&V made a difference in spite of the attention, additional investment, and new life that T&V brought to extension in the Haryana (Antholt, 1990). A recent review of West Bengal, Bihar, Kerala, Maharashtra, and Tamil Nadu in India could not identify a clear causal connection between incremental productivity and incremental investment in establishing the T&V system. This is true in spite of ten years of effort and the provision of relatively intensive extension services to farmers in three of the states -- Maharashtra, Kerala, and Tamil Nadu (World Bank, 1991 b).

- After ten years, T&V in the Terai of **Nepal** was found to have had no impact on changing wheat yields, the principal winter season thrust area for extension (World Bank, 1992 b).

- **Thailand** moved to a "participatory farmer planning" approach after trying T&V for five years in the early 1980s (Chumsri, 1992). While rice yields increased by 1-to-1.7% per year in the ten years since introduction of T&V

in 1980, and crop diversification and cropping intensity also increased, these changes could not be linked reliably to the investments in extension (World Bank, 1991 d).

- In **Bangladesh** T&V was not successful in achieving a positive difference in the "orientation of extension to clients," a major objective when it was introduced. Nor were any qualitative improvements observed in supervision, communication and leadership (Hassanullah, 1989).

- In 1984, **Malaysia** decided T&V was not a workable model, and changed to a market-driven, commercial approach linked to groups (Abas, 1992).

There are two additional, general observations about T&V that also need to be made:

- First, T&V projects almost universally have been associated with large increases in government staff. In the Indian state of Tamil Nadu, for example, village extension officers went from 1,730, to 4,000; in Madhya Pradesh they increased from 6,932 to 14,525; and so on (Axinn, 1988 b). For extension departments that historically have had problems providing sufficient operational funds for travel, demonstrations, etc., expanding staff makes this problem even more acute. Lack of operational funds tends to perpetuate itself because it severely limits extension's ability to be responsive to client needs. Under those circumstances, extension is unable to establish the political base necessary to ensure long-term financial support above what is necessary to meet salary needs.

- Secondly, T&V projects have tended to further institutionalize hierarchical tendencies already existing for top-down, centralized management, despite clear aims to the contrary. Bureaucrats appreciated the T&V approach because it was a new means by which to hold staff accountable (Sims and Leonard, 1990). Similarly, research in Pakistan found that "...the patterns of internal communication in the Department of Agriculture is asymmetric (geared to control rather than to create an understanding) and top to bottom" (Nayman, 1988). Observers in Indonesia noted that the top-down flow of information, which stemmed from national planning objectives, did not necessarily reflect the objectives of farmers (Drysdale and Shute, 1989), and, because of the limitations inherent in a centrally-controlled and managed extension service, extension was unable to deal effectively with the site-specific needs of farmer problems and opportunities (Fisher, 1988; Manwan, et al., 1988). Given the seasonality of work loads, the heterogeneity of agro-ecological systems, changing market conditions, and the difficulties of travel, extension services must be decentralized and made more flexible, and timely (Moris, 1988; Antholt, 1991).

Despite its high visibility and controversial reviews, Kearl (1991) found that T&V no longer is at the center of discussion. He suggested that this is due to T&V being too narrow a model for most situations and therefore of limited utility, particularly under circumstances of considerable farm level heterogeneity.

Kearl did not go far enough. Not only is the model too narrow, but T&V's management response to the problems of extension simply failed to address adequately the underlying systemic problems confounding extension (Antholt, 1991). Indeed, it is those underlying problems, e.g., lack of relevant technology, poorly-trained and -motivated staff, insufficient operational resources, etc. -- not so much the principles of T&V per se -- that underlies the continued disappointment with T&V and most Asian extension systems. In that context the criticism of T&V needs to be redirected at the underlying systemic problems facing extension (though T&V clearly can be faulted for the attention and resources it absorbed when one views the nature of the agricultural development process, the role of extension and what needed to be done with extension). With no little consequence, there has been a considerable delay in the recognition and confrontation of the more fundamental issues facing extension.

Further debate concerning T&V is not likely to be very fruitful. T&V needs to be put behind and attention turned to developing extension efforts (public and private) -- services that are relevant, responsive and cost-effective with respect to enhancing the knowledge base of farmers. Antholt (1991) charts the course by opening up conceptual horizons with respect to extension. Using his rural information management approach to extension, Zijp (1992) develops a pragmatic set of tactics for enhancement of extension. Ameur (forthcoming) usefully notes that the evolution of modern agriculture necessitates an even faster evolution of extension and the need to redefine conventional thinking and approaches to extension, particularly with respect to increasing the role of the private sector.

FURTHER COMMENTS AND TAKING STOCK

The reasons for the uncertainties about the effectiveness of agricultural research and extension do not all lie with the institutions charged with carrying out these functions. Indeed, it sometimes can be traced to policy environments that discriminate against agriculture, poorly-developed infrastructure, non-existent or under-developed markets, or lack of the unavailability of appropriate technology. Too often it has been assumed that technological performance of farmers was sub-optimal and that the exotic technology available only had to be extended to them (Sims and Leonard, 1990). In reality the much more important issues were changes in policy, investments in rural transportation infrastructure, and the capacity for technological innovation through research and acquisition of technology. These should have been dealt with first. When they were not addressed, investments in extension in particular turned out to be little more than surface treatments of deeper, more crucial problems (Cernea et al., 1984; Antholt, 1991; Birkhaeuser et al., 1991). But investments in agricultural research also have been disappointing. Sometimes this is due to macro economic policy reasons, as Hayami and Ruttan (1985) point out. More often it is because of inattention to the underlying systemic issues, such as the lack of accountability to the clients for performance, and the detachment of career advancement/status and performance of scientists, to name two major issue areas.

Agricultural research and extension cannot be viewed as implementing arms of a national planning and production process. Under central planning, this would make some conceptual sense, despite the fact that it is impractical. Nevertheless, extension in particular continues to be burdened by the view that it is a means to get farmers to meet national "production objectives" articulated by planners. In the end, extension only can bring to farmers new knowledge that farmers will use only because they think it will be good for them.

Experience in Asia adequately demonstrated that communication systems, outside and beyond those of formal extension systems, work incredibly well. Somehow this seems to be inadequately appreciated. Lowdermilk (1972) notes how the "word got out" about the new wheat varieties in Pakistan, where there was a "tidal wave" of change, i.e., within four years 100% of the farmers in the Khanewal area were using the new varieties. Other examples from India and Java were mentioned previously. There is also the well known history of the introduction and widespread and rapid adoption of Pajam rice in Bangladesh -- without approval or support of government. Nayman's (1988) research in Pakistan on information-seeking by farmers underscores that traditional systems of communication offer attractive, cost-effective opportunities for modern extension services. However, in all of these cases the technology was "right" as defined by farmers.

Ministries of agriculture have been allowed to monopolize technology generation and diffusion functions too long. This is not to say that public-sector research and extension will not remain important. Indeed, it needs to be understood that public-sector agricultural research should be viewed as an "input" for private-sector entities involved in technology generation and dissemination, and that under-investment in public-sector research will be a brake on private-sector investment in technology generation (de Janvry and Dethier, 1985). Therefore, it is timely to introduce the notion of "institutional pluralism" when looking ahead at how technological change in agriculture has to be generated and spread (and the processes for doing so fostered). NGOs, seed companies, implement dealers, fertilizer distributors, TV and radio systems, farmer associations, youth groups, local communities, and primary school systems all can have important and complementary roles in this regard.

Pluralism often has been dodged in the name of avoiding duplication, which is equated with waste, and sometimes the mistaken belief that it is government's responsibility to do everything. What is sacrificed, however, is the flexibility that alternatives can provide, and the innovative and more cost-effective initiatives that can flow from competition. This fact needs to be recognized and harvested. Many examples testify to its success. In central India, grape growers are banding together to hire their own professional agronomists. In Bihar, one of India's most "backward" areas, Pioneer Seed Company, more or less on its own, developed and pushed a variety of maize that transformed maize production in the region from summer to winter with substantial increases in yields and farm income. In Mindanao, Philippines, the sloping-lands technology was developed and disseminated by an NGO. Women's groups in central India hire their own extension aides to help with their sericulture operations.

One of the major challenges ahead for Asian research and extension systems is the need to shift away from a supply side approach of "pushing technology out like sausages," to paraphrase Biscoe's (1991) comments on extension. To accomplish this, mechanisms to establish meaningful accountability between the clients and research/extension services must be found. Axinn (1991) suggests this may be the single biggest challenge facing extension, especially for Asian public sector research organizations. Promoting "tight" and improved management systems in extension has been one attempt to make extension services more demand-driven. In research, a great deal of attention has gone into the farming systems and coming up with better research plans. Clearly, utilizing better management, farming systems research methodology, and research planning are useful. But if scientists and front line agents are looking over their shoulders at headquarters, as well as depending on seniority for transfers and promotions, it is unrealistic to expect that their first loyalty will rest with their clients, particularly the small, marginal farmers.

Increased "participation" is often called for to obtain more demand-driven, client-oriented research and extension services. Participation is cited as fundamental to the sustainability of extension systems (World Bank, 1990 a). However, we are reminded that the bullocks pulling the farmer's plow are participating with the farmer -- but only the farmer is in control (Axinn, 1990). It is not enough just "letting" or "allowing" farmers to participate, e.g., to come to meetings or to allow a few of their representatives to sit on committees. The bottom line is to empower farmers so they have meaningful roles in defining research agendas and extension programs, as well as judging performance (and that judgment should make a difference in the lives of scientists and extension personnel). This amounts to, in effect, a "sea change" in the incentive system facing research and extension staff and their respective institutions. Indeed, it is the difference between trying to push a string and trying to pull one.

The flip-side of the above is developing mechanisms in which farmers and/or industry assume some of the responsibility for supporting research and extension. There are a number of ways to do this. A cess, such as the one used by the Australian meat industry to fund applied research, is one way (Monteith, 1992). China has a system for the delivery of many of their agricultural services, in which "those who benefit -- pay" (Grimshaw, personal communication). Often experienced farmers and/or farm groups provide their "advisory" serivces for fees to other farmers and/or groups. China also encourages research institutions, universities/colleges, scientists and teachers to sign contracts to advise farmers or rural groups (Delman, 1988).

Britain has transformed its Agricultural Development Advisory Service to a system that charges for services of direct benefit to the client, but does not for services which spread benefits across society, such as those relating to soil conservation. The service hopes to cover 50% of its costs by 1993-94 (Ingram, 1992). In Malaysia, scientists have teamed up (part-time) with the plantation industry, which supplies equipment, laboratory facilities, etc., to work on applied/adaptive soil and water conservation. In Norway, farmer circles select extension/research agronomists, whose salaries are paid for by the government -- but the farmer circles are responsible for all of the operational research and outreach expenses of the agronomist. This works out to be a 50:50 cost-sharing arrangement (Haug, 1990). Mexico is in the process of shifting to farmer groups in irrigated areas at least half the cost of extension services (Wilson, 1991). Chile actively encourages its NARS to contract its research services out to farmer groups, but to industry and government entities as well (Venezian, 1992). In France the "Chambers of Agriculture" are funded from land taxes, fees for consultation provided to farmers, and a number of other sources (Ameur, 1992).

There are numerous models to follow and any number of cost-sharing ratios for dividing the burden of support among beneficiaries and between government and communities/farmer groups. There is no one best option. Arrangements that fit the needs of situations, the characteristics of beneficiaries, and are politically acceptable need to be worked out on a case-by- case basis. However, a major and critically-important feature of the particular option eventually worked out is that the clients have both responsibility for and ownership of (and therefore "drawing rights" on) the service.

One of the legacies of the U.S. country agent model that is inappropriate, unrealistic, and not financially sustainable for most developing countries is the notion that a low client/extension agent ratio is desirable and perhaps even necessary. We have seen how in numerous cases in Asia, e.g., in India and Bangladesh, widespread and rapid technological innovations often were picked up by farmers regardless of the formal extension services. It is clear that large numbers of extension agents are not essential for an effective extension service -- especially when most field-level staff are recruited with little, if any, real farm experience; are poorly-trained from a practical perspective; and are faced with incentives unrelated to the value of their performance as determined by farmers. Furthermore, large numbers of this kind of staff under those kind of incentive arrangements invite long-term problems because of the diseconomies of scale that arise in large government bureaucracies, to say nothing of the financial sustainability issue. In fact, it appears that in relatively better-off, more homogeneous areas, extension personnel might be reduced substantially if the green revolution has any lessons to offer (Lowdermilk, 1972; Brown, 1972; Bernsten, et al., 1982).

In the poorer, more marginal areas, staffing density requirements for extension agents are more problematic. The heterogeneous nature of these areas, as well as the usually under-developed infrastructure, might call for higher staff densities because opportunities to pack new knowledge into products, like the HYV rice and wheat, are not likely to be as readily available (Mueller, personal communication). Indeed, as suggested above, agricultural improvements in these areas most likely will come from improved, albeit incremental, management practices. But if technology is not available for less well-endowed areas, investment in extension is questionable and should not be confused with welfare concerns for poor people living in resource-poor areas. Under these circumstances it is more important to create the capacity to find, develop and/or adopt more productive technologies to fit those conditions.

Given the values and practices of many communities in Asia, male extension workers have great difficulty communicating effectively with rural women in agriculture. This is a matter of considerable concern since research demonstrates that women do a large amount, if not the lion's share, of farm work. For example, in India, more than 70% of the farm work is done by women. Yet the Ministry of Agriculture reports that in 1988 only about .54% of all extension officers were women (including Kerala, where 25% of the extension officers are women; Axinn, 1991). Gabriel (1987) reports that only .07% of Asian extension agents are women. This is not to say men cannot communicate effectively with women farmers; rather, that it is not easy and cannot be counted on. Neither can it be assumed that husbands will transfer new agricultural knowledge to their wives, and if they do, that they transfer it effectively (World Bank, 1991 c). The long-run answer lies in the recruitment, even if it must be at the expense of new male recruits, of more women extension professionals, and the sooner the better (Saito and Weideman, 1990).

The linear, center-periphery, transfer of technology (ToT) model of technology generation and dissemination lingers on. The tyranny of this reductionist approach to the development of agricultural innovations is widespread, deeply ingrained, and has been difficult to dislodge. Yet, if that is not done, research and extension organizations will continue to be blind to the importance and power of a systems approach to identifying options for farmers, particularly those based on local knowledge (Warren, 1991). Clearly, there are times when seed-based, green revolution technologies come along. But innovations of this sort are rare and can often more or less sell themselves provided they are appropriate. In looking ahead, research and extension can be relevant and responsive to farmers' needs (and therefore, important to them) only by being able to recognize and accept improvements and ideas from anywhere, including from farmers themselves.

CONSIDERATIONS, POLICY ISSUES AND INVESTMENT IMPERATIVES

Governments and donors have been reasonably generous in supporting research and extension since the 1960s. Given the strategic importance of technical change in agriculture, it is important to be concerned about the continuation of support for these areas. Nevertheless, with increasing frequency there is a level of frustration and fatigue expressed at the seemingly never-ending discussions about, and projects for, research and extension. The frustration and fatigue is acknowledged. But given the lack of alternatives to science-based, knowledge-intensive paths for further agriculture development, it is argued that these anxieties must not detract from future support by donors and host countries. The following section will identify some of the policy issue areas and investment options that will be important in developing programs or projects aimed at enhancing the rate and effectiveness with which better, more productive technology are delivered to Asian farmers.

Before going on, however, it is useful to be reminded again of the importance of getting the technology "right" in the first instance, whether it is evolved over time by farmers themselves, borrowed directly from other parts of the world, or borrowed and then appropriately adapted. Indeed, this and the need to have competent, first-rate capacity to seek out, develop and/or adapt technology, are strategic needs for most countries that are dependent significantly on their agricultural sectors. That is not to say other factors -- such as macroeconomic policies, commodity price polices, infrastructure development, input availabilities -- can be ignored. But given the state of Asia's resource base, the current and future demands on agriculture, and the realities of global integration, there is no alternative but to use Moky's "technology lever" which was referred to at the beginning of this paper. To do so requires institutions, public and private, that are creative, foster excellence, and are entrepreneurial and agile in the use of scientific resources to solve old problems or meet new opportunities. And that does not imply business as usual.

Secondly, going back to Cernea, Coulter, and Russell (1984), we need to also be reminded of extension's relative importance, i.e., "extension is only one of a number of factors that contribute to increased farm productivity and that it is not one of the essential ingredients such as the availability of appropriate technology, inputs and attractive markets." This is not to say extension can be ignored, or that new investments in extension are not needed, but it does put a premium on insuring that extension services are as relevant, responsive and cost-effective as possible. In hindsight, it is clear that too much emphasis was given to aspects of extension that should not have had it, particularly in the numbers of staff and centralized management versus staff quality, cost-effectiveness, accountability and financial sustainability dimensions of extension. Consequently there remains much to do, and in some cases to undo, to insure the rapidity with which farmers are better acquainted with better technology, to help them learn important principles and practices, and learn how to organize to help themselves -- and all in an affordable, sustainable manner.

PUBLIC POLICY: ISSUE AND CHOICES

Accountability/Responsibility

Perhaps the most important initiative to take is to shift the primary focus of power and responsibility for research and extension to the clients. To borrow Robert Chamber's phrase, we need to "put the farmer first." We have enough experience about the nature of government employment to know that the "normal" incentive system facing government employees, even under the most enlightened circumstances, puts a premium on not making a mistake, and on length of service but not necessarily on service to clients, particularly small farmers. This not acceptable and does not have to be taken as inevitable. Sims and Leonard (1990) found that the most important determinant of extension success is the strength of farmer organization, and the same holds true for agricultural research.

The opposite side of the accountability coin is expecting the beneficiaries of research and extension to be responsible for some of the support, even if it is only a proportion of total costs. This is important for three reasons. First, it gives the beneficiaries ownership and drawing rights on the services. Second, it takes some of the financial pressure off the central government and therefore gets at the issue of financial sustainability. Lastly, if ownership and responsibility resting with clients, the basis for more demand-driven, responsive service is established. A successful example of this is with the National Farmers' Association of Zimbabwe (Amanor and Farrington, 1991).

Another scenario using this approach might be for extension departments to develop cooperative and/or contractual agreements with local bodies, as in China. Under these arrangements local organizations might take responsibility for provision of their own extension services, but the center would reimburse the local entities for some percentage of their costs. Alternatively, as in some areas of China, or in Ecuador (Van Growder, 1991), an arrangement to share in the output of the farming enterprise can be devised.

Another alternative, as mentioned above, is seen in Chile; contracting with private firms or NGOs for the provision of extension services. The government's role is to lay out the ground rules for service, select consultant firms through competitive bidding, evaluate performance, and subsidize the cost of the services. Consultants carry out the technical extension services; farmers contracting with firms of their choice (Venenzian, personal communication). The exact form is not so important, but the bottom line must result in putting farmers in the "driver's seat."

Research in some countries is supported directly through funding from farmer or commodity groups; in others, through a cess levied by a particular industry on itself but collected by the government. The example of the Australian meat industry was mentioned earlier. The Rubber, Tea, and Coconut Research Institutes of Sri Lanka once were funded by private industry and were recognized as outstanding. (Since nationalization, unfortunately, these same institutes have declined markedly.) Pray (1991) comments that the key to the productive U.S. agricultural research system has been the fact there is some farmer control over the research system's budget, keeping the attention of scientists on the needs of farmers. Chinese farmers contract with research organizations and/or individual scientists to undertake specific research. The reverse also is true, i.e., research organizations contract with farmers to do applied research when it is practical.

The exact nature of the accountability and responsibility relationships will vary from country to country. This does not matter. Of central importance is the need to insure that the relevance and responsiveness of agricultural research and extension, as viewed by farmers, clearly and meaningfully affect the welfare of the scientists and extension personnel involved. Furthermore, it needs to be ensured that farmers have some responsibility for support as well. This does not mean each and every scientist is subject to the scrutiny of the crowd, or that a farmer is charged every time extension workers stop by. But it does mean going beyond "putting farmers first," and developing practical, tangible means to do so. The Norwegian example cited above is one way. Perhaps more applicable for Asia, however, is the Chile model, which basically relies on the private advisory services for frontline extension work.

Contemporary research and extension organizations, particularly their leadership, should take the lead in developing the environment necessary to encourage private companies, local communities, NGOs, and groups to assume greater responsibility for these functions. To do this it is important for research and extension leadership to do so to be able to control the pace and shape of this kind of change. Not to do so is to invite others to take the lead. Surely the forces of change stemming from budgetary constraints or the movements toward greater decentralization that are going as in Indonesia, Philippines, Karnataka state in India, and Sri Lanka will dictate these changes. However, given the conservative tendencies and internal interests of ministries of agriculture, the likelihood of this happening is not great without considerable outside encouragement.

Management

Improving management of agricultural public services is an often-stated objective for most governments and is an objective similar to maintenance research; that is, it remains a generic concern over time, but at any given point in time the particular issues and tactics change. For example, in extension, T&V was a management response to problems perceived to be important. However, as Norgueira (1990) notes, a management response such as T&V, which in effect seeks to reinforce centralized management, never really could be a viable response given the multiplicity of participants, the location-specificity of agriculture, the formidable information constraints and the need for high levels of discretionary capability and authority. For these reasons, and the other systemic problems with extension pointed out by Antholt (1991), particularly the availability of technology and the incentive structures facing extension agents in the field, a management response to extension has proved insufficient. Indeed such a response is a mis-diagnosis of the nature of the problems facing extension and a mis-specified solution.

Saying that, however, is not meant to suggest that management issues do not need to be attended. Rather, efforts directed at better management only pay off significantly if the more problematic, systemic issues of extension can be dealt with first. The problem is that, too often, a management response such as T&V or adoption of the form (but not the substance) of the U.S. Land Grant system is thought to be sufficient. Clearly that is not the case.

The size and complexity of almost all Asian public sector NARSs have grown by orders of magnitude since the early 1960s. Unfortunately most of the basic management systems used in the NARSs have been more or less brought forward from even older management systems, and those primarily were concerned with "control." Consequently, over time the management practices of Asian public-sector research organizations have evolved from old operational practices that increasingly reduced flexibility, added to institutional rigidities, and encouraged, albeit unintentionally, isolation. There are, of course, notable exceptions, such as the TATA Institute in biotechnology in India.

Given the importance of technology generation to the future of Asian agriculture, it is not too difficult to conclude that there is a management crisis in Asian public-sector research systems. In China this is underscored by the reluctance of senior administrators to borrow for research that is carried out by scientists and institutions,with little incentive to see that their research leads to results that will enable repayment of a loan (Grimshaw, personal communication, 1992). While perhaps short-sighted, this nevertheless is indicative of the value and utility senior government, albeit non-agricultural, leadership place on their agricultural research infrastructure at the moment.

Because of the discipline of the market, the kind of management crisis referred to above in the public sector is not a concern of private firms involved with technology generation. This is another reason for public policy to look for ways and areas, as appropriate, to involve private firms increasingly in the generation of new agricultural technology.

The management crisis in public sector research is not unrelated to the state of public support for research, the support and facilities available to agricultural sciences and the caliber of scientists in the NARSs. For these kinds of issues, increased budgets can be allocated, new equipment purchased and more fellowships made available -- relatively straightforward, easy issues with which to deal. The management concern in this paper, however, has to do with the process of organizing, supporting, directing and fostering the process of innovation. Williams and Antholt (1992) took the issue of managing for innovation and found that the most interesting literature in this regard was outside agriculture.

Peters and Waterman (1982), for example, identified eight "attributes" of the U.S.'s best run companies which have relevance to our concerns about the management of Asian NARSs. John Nickel (1988), the retired Director General of CIAT, takes the attributes identified by Peters and Waterman and relates their importance to a not-for-profit agricultural research organization. The attributes are: 1) action orientation, 2) being close to the customer (the farmer and the importance of on-farm research), 3) autonomy and entrepreneurship (ever-increasing levels of planning and budget management can stifle agricultural research), 4) productivity through people (the care and feeding of scientists), 5) being hands-on and value driven, 6) sticking to the knitting, 7) simple form, lean staff, and 8) simultaneous, loose-tight properties (firm central direction and maximum individual autonomy). Nickel goes on to add a ninth attribute -- leadership.

Williams and Antholt (1992) single out other important features of organizations that are successful in maintaining innovation over time. They too point out the importance of clear and explicit goals/objectives. Fuzzy, "cover all the bases" kinds of goals will not do. Other important features include:

- Flat organizational structures -- what the ICAR, Nepalese and Bangladesh systems, for example, are not,
- Small, but interdisciplinary teams of researchers,
- Low hurdles, i.e., in trying out new ideas at the early stages of innovation,
- Communication both up and down the organization, as well as with fellow scientists at home and abroad,
- Legitimizing and supporting failure,
- Mentoring or "executive champions," as Peters and Waterman call them, for new ideas and innovative researchers willing to take risks, and
- Rewards based on excellence.

It is true that technological innovation has a degree of serendipity associated with it. However, capturing serendipity is not idle chance: rather it is a matter of thorough preparation and the ability to seize opportunities when they present themselves -- not a commonly-found feature in Asian NARSs. Consequently, in looking ahead at the institutional innovations that are needed to improve management, policy efforts by countries and donors will need to be concerned with how research organizations are structured; their formal, as well as informal, operational rules; and the incentive (explicit and implicit) facing an individual scientist, teams of scientists and the institution as a whole. In many ways these concerns with the "software" side of research organizations and the reformulation of procedures and organizational arrangements will be more important than new "hardware" investments. Unfortunately, to deal successfully with these kinds of issues requires attention by people well-grounded in the realities of agriculture and agricultural research as well as organizational and management sciences.

Agricultural Research in a Small Country

The importance of having a competent NARS, in the sense of its being able to identify, adapt, or develop appropriate agricultural technology, was cited above. But figuring out the scale of investment necessary for technology generation is still somewhat an art. Binswanger (1978) suggested that optimal size for a commodity research program is related to the area planted to the commodity. Ruttan (1987) suggests that appropriate size of a research unit or program involves balancing increasing returns related to the area covered by the commodity (or problem) against possible diseconomies of scale.

Using the work of Trigo and Pineiro (1984), who estimate that a minimum research module is four scientists at the Ph.D./MS. level, eight complementary specialists with graduate-level training, and support personnel, Ruttan estimates that, for a country with six to ten major commodities, several important agro-climatic regions, and the need for core disciplinary research that on soils, pests, policy, etc., an annual budget of 12-to-15 million dollars (1987 dollars) is needed. But for many countries in Asia such as Nepal, Sri Lanka, Bangladesh, Burma, etc., even this amount may be unrealisticly high. On the other hand it is also clear that not having sufficient research capacity could be even more costly. McMahon is clear as to the fundamental need of each production system for its own knowledge base. And it is only through research that this knowledge base is developed.

In many of the Asian NARSs, and in the state systems of India, we find relatively large numbers of scientists. For example, the state agricultural university (SAU) in Rajasthan has about 1,000, Haryana SAU about 2,200, Nepal 400, and so on. These scientists often have academic backgrounds which are not particularly strong, often are dispersed over long distances at numerous locations, face reward systems that do not emphasize performance, and have little recurrent budget support. This is topped off by administrative systems that seek control over scientists. The net result is low productivity overall as well as diseconomies in managing research resources in ways that encourage and foster creative, innovative, problem-solving science. Under these circumstances it may well be that NARSs are too big, at least too big given the level of scientific competence available and the existing management practices.

In trying to deduce an appropriate, affordable size for a small-country NARS, consideration has to be given to the decline in real terms of air transportation costs and the tremendous advances made in communication and information technology. These advances and declining travel costs may offer opportunities to rethink scale issues facing NARSs. That is, given the progress in cross-regional possibilities -- the IBSRAM work, for example -- and the increasingly integrated and interdependent global agricultural research system, it may be a lot more cost-effective for a small country to become somewhat more dependent on technological innovation done elsewhere. Competent NARSs still will be needed, particularly for establishing the knowledge base of the country. However, future investments also need to aim at enhancing a NARS' ability to take advantage of technological innovations outside the country more aggressively and rapidly. This does not mean this capacity should be something less than "first class;" rather, just the opposite, if this strategy is to work effectively. "Small, but smart" might be an appropriately- used motto here.

Chile's spectacular growth in the export of table grapes was largely built on technology from California. Nepal, for example, might do a lot better in concentrating on rapidly obtaining the results of India's considerable research capacity. India's research work in the Gangetic Plain is directly transferable to Nepal's Terai. Work in the hills of Uttar Pradesh and Himachal Pradesh is done under conditions not dissimilar to those of the hills of Nepal.

For sure, the issues of technological dependency and national pride are likely to cloud considerations on this matter. The experience of the most successful economic model in Asia today, Japan, is instructive in this regard. That is, in the early stages of modernization Japan freely borrowed and used technological innovations on the basis of their merit, not origin. The truth of the matter is that all countries, particularly small countries, cannot avoid some level of dependency on others. More than ever, hard-headed cost and effectiveness concerns have to be considered. In the end, farmers don't care where the technology comes from, so long as the technology meets their standards of performance.

Performance Standards

Performance of research and extension services remains a problematic area. Part of the problem has to do with standards of expectations -- by the general public, the institutions involved, and the scientists and extensionists themselves. The issue in extension is easier dealt with by involving beneficiaries in the support of the service. That is why dealing with the accountability issue as discussed above is so important. Beneficiaries can have a fairly direct interest in, and immediate impact on, extension and vice versa. It also takes the burden off extension management, for whom it is not possible objectively to take into account the qualitative dimensions of the service provided by agents. Whether or not an extension worker has held a bi-weekly meeting or not, for example, has little to do with the qualitative performance of extension, especially if viewed from the perspective of the target beneficiary. Therefore, it is a great deal more efficient and straightforward to let beneficiaries define what is important to them and then allow them to render their judgement on extension's performance.

With research it is more difficult to measure performance, especially if failure is legitimized. That is because some research serves as an input to the next level of research work, and so on. Consequently, one or more levels of research results may never actually be seen by beneficiaries. Accordingly, performance has to be measured more indirectly. Publishing is one measurement, although in Asia it is common to see a paper that has not been peer-reviewed or published in a refereed journal to be counted as a publication. It is also useful, as Pray (1991) noted about the U.S. system, to have farmers have some say about the budget of research institutions. Along the same lines, it is valuable for farmers to have a significant voice in determining leadership as well as levels of compensation and recognition for research institution leadership. A fourth measurement is patents produced by a scientist or scientific institution. However, the problem with this in Asia is that the patent system often is not applicable to agricultural innovations. In any case, performance measurement is an area that must be examined carefully and in which meaningful standards need to be established.

Otherwise there is little alternative to the despotism of the seniority system.

Research/Extension Linkages

The synergism, indeed the interdependence, between extension and research is well known and recognized, yet the problems of lack of institutional coordination and cooperation have also long been noted and remain a source of constant frustration. The systemic reasons for these problems are well understood -- if not appreciated. Kaimowitz (1991) identifies five mechanisms to enhance linkages between these institutions: 1) integrate the organization, 2) establish liaison units, 3) organize committees for coordination purposes, 4) have members of the respective institutions carry out joint activities, and 5) communicate better. The implications of these tactical options are discussed extensively and sufficiently elsewhere (Sims and Leonard, 1991; Roling, 1990; Kaimowitz, 1991). What is required now on this issue is something more than monthly meetings, technical committees, and all the other "tinkering" commonly called for.

Where there is institutional separation between research and extension, none of the mechanisms Kaimowitz mentions, including integration, seem to have been particularly successful. Nevertheless the necessity of integrating research and extension more closely remains. One step toward breaking down these boundaries is to make it specifically in the career interests of individual scientists and extension personnel to have assignments in each others' organizations. But that is only one step and may not have any more promise than some of the other mechanisms. In any case, the bottom line is that the incentive environment facing research and extension professionals, and their respective institutions, has to be "tuned" to provide value to those individuals and institutions who enhance research and extension linkages. Doing so in Asia will be difficult because of the institutional rigidities that have been built up. Making the issue more problematic is that there is no universal prescriptive solution to the problem. In the first instance the seriousness of the problem clearly needs to have widespread recognition. That is seldom the case. Secondly, there also must be widespread political support and pressure, particularly from the clients, for satisfactory resolution of the issue.

Recruitment

Current standards of recruitment of most agricultural science institutions are too low for today's needs, and are certainly too low for the needs of the 21st century. Many governments in Asia act as if they must bring every university graduate into government service. Indeed, there is often considerable pressure to do so. The net result, which is particularly serious for agricultural research organizations, is a grave depreciation in the overall level of professional competence. Far too many research organizations have scientist positions filled with individuals who are not up to the mark. That does not deny the many good, hard-working, creative, world- class scientists in the Asian NARSs. But the NARSs, in too many instances, have been choked with less than fully-competent scientists, and thus the systems as a whole are dragged down and burdened with pseudo-scientists. New policies must be evolved that demand nothing less than the best and the brightest. These new policies need to encourage, and give weight, to young scientists with a practical farm upbringing. New policies for recruitment also need to allow for recruitment of scientists from non-agricultural universities. This is because some general universities have higher standards than agricultural universities, and also because they often offer a better education in some fields.

In the long run, extension systems most certainly will be called on to do more with less. It is not unreasonable to expect the overall numbers of extension personnel in government service to decline by more than 50% from today's levels. Given that the "core" staff of ten to fifteen years from now will be recruited in the next few years, it is imperative that the standards of recruitment be reviewed and revised now. Given the likely nature of the early 21st century, new recruits will need to be a cadre of professionals who: 1) can work under complex and fluid circumstances with little supervision, 2) can diagnose farmers' problems effectively, 3) are able and willing to listen to and learn from farmers, 4) can communicate effectively and work with farmers and farm groups, 5) are able to present options, based on principles of science and good agricultural practices, that widen real choices available to farm families.

Those parameters suggest recruitment standards for new employees who have fairly solid educational backgrounds and competency bases. Certainly the current competency levels at the village level in many Asian countries, especially in South Asia, are appalling. For example, in a Bank-supported, Government of India, Ministry of Agriculture-sponsored study (1990), one of the conclusions was:

> "With few brilliant exceptions the VEWs are neither an educated nor a knowledgeable lot and some of them are even illiterate. They will continue to be so ... are the most unlikely persons to become engines of technological transformation. Also, in the present scheme of things it would not be correct to anticipate a qualitative change at this level."

Under these circumstances it is not unreasonable for the planning and finance ministries of the various states in India to have a serious concern for extension's continued drain on state budgets. In the future, a B.Sc. might be required, but that depends on the availability of educational options in a particular country and the quality, especially, of the practical, farm-useful principles, practices, and skills taught at the B.Sc. level.

A B.Sc. is not always essential, however. For example, in Taiwan 95% of the extension agents had a vocational agriculture background (Lionberger and Chang, 1970). This would not be possible in South Asia where vocational schools are generally substandard. On the other hand, B.Sc. degrees in South Asia do not have much practical content either. Under these circumstances it is particularly important that practical farming experience be given a fair amount of weight in the recruitment process. Lionberger and Chang (1970) also found that nine out of ten Taiwanese extension agents were brought up on farms. The same is true for China (Grimshaw, personal communication).

Lastly, a significant number of the future staff -- maybe even half -- should be female.

While this paper does not address the gender issue specifically, it is expected that if the starting place is having an extension service that is relevant, responsive, and effective, then we need to consider women farmers as well. It then follows that, in many societies, to effectively communicate with farmers extension agents have to be women. Therefore, from both the qualitative dimension and the gender perspective, recruitment is a policy issue of some magnitude. Given that most extension systems are stuck with the current staffing profile, i.e., a low level of competency as well as a male-dominated cadre which is likely to weigh the systems down for some time, changing the recruitment system in the near future has an even greater urgency to it.

Constituencies

The reason this is an issue for research and extension is that, in the long-run, planning and finance ministries of Asia do not provide dependable financial bases. Numerous OED reports suggest that "government commitment" plays a key in this issue. But government commitments are only good as long as it is in government's interest to keep them, the leaders who made the commitment remain in power, and/or other needs do not crowd out the earlier commitment. In short, commitments by governments, with respect to research and extension at least, are not worth a lot. Political winds of the moment usually take precedent for whatever reasons. Ruttan (1986) is convinced that the long-term viability of NARSs will hang on the development of organized farmer groups that have vested interests in the products that research can produce. The same could be said about extension and the importance of having organized farmer groups with vested interests in the provision of extension services. In Asia there are very few places where these vested interests exist. The exceptions are cases such as the Punjab Agricultural University in India, and the poultry and grape producers in India, who have organized respectively to hire their own veterinarians and extension agronomists.

There is another aspect of this problem which stems from donors. Too often, research and extension leadership have found it easier to go to donors for support than to have beneficiary groups argue the merits of support on their behalf. Often donor officials have been more than willing to accommodate requests for support because they understand the importance of agricultural development, not to mention the fact they have had their own annual obligation schedules to meet. The problem with this is that, too often, it has contributed to radical swings in the resources available to these institutions, a situation which is extremely disruptive to research. There are good examples of this from India. First was with the buildup of the U.S. support to the state agricultural universities in India over the 1960s and the abrupt termination of that support in 1971. A second example is the large build up of the extension cadre in Karnataka state in India to about 6,000 with Bank support; by the last year of the project the state was able to fund only about 4,800 positions and was hoping to decrease those.[5] In neither case was there a broad- based constituency organized and supportive of the respective institutions on the basis of the value they provided to the beneficiaries, with the possible exceptions of the Punjab and Tamil Nadu.

Ruttan (1986) suggests that the one thing donors might do is link support to real growth in domestic support. He calls it a "formula-funding" model. This has merit in that it would force research and extension leadership to be more concerned about the quality of services they provide, and, thus, the basis of political (and ultimately domestic financial) support. Indeed, this issue is linked closely to the issues of accountability, responsibility and performance mentioned above.

Donor Support

Two things are of concern here. First, while the CGIAR model has operated successfully at the international level for some time, at the individual country level the donor coordination for support of research and extension seems to work on a more casual basis. Even within some countries in which mechanisms exist for effective donor coordination, such as Sri Lanka, the level and effectiveness of donor coordination have varied considerably over time. One reason is that the departments and ministries of agriculture sometimes discourage close collaboration between donors. This probably is short-sighted and, over time, counter-productive. In a time when (in real terms) donor support for research and extension is declining, it is more important than ever to insist that effective donor-coordination mechanisms be put in place.

The second concern is over recurrent expenditures. Some donors have problems financing recurrent expenditures as opposed to incremental expenditures. However, as NARSs mature and put most of their capital infrastructure in place, it may not be prudent to continue expansion, so much as to get as much productivity out of existing capital and human capital investments as possible. Consequently the highest returns on investment may be to complement existing resources with funds not necessarily incremental for recurrent expenditures. If Bank support for research and extension is to continue, this issue will have to be sorted out. Given the importance of technological innovation in agriculture and the fungibility of resources, it would seem inconsistent with the Bank's overall interest in development to continue to have difficulties funding non-incremental recurrent expenditures.

The World Market for Scientists

The world recognizes the value of a skilled scientist. As is money, good scientists are interchangeable and therefore relatively marketable. It makes little sense to pour new investments into NARSs if the best and the brightest leave. This cannot be stopped completely, and maybe, in the interest of heterogeneity in the world science, it should not. Nevertheless NARSs have to

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[5] Reported to the Bank's Agriculture Development Project pre-preparation team by the Secretary of Finance, Government of Karnataka, November 1991.

address the issues of compensation, recognition, work environment and other factors that can attract and hold competent scientists. While this issue has been discussed much, little has been done explicitly about it in Asian NARSs. Personnel systems and systems of reward are basically those of conventional civil services -- almost always out of sync with the requirements necessary to manage scientists and research institutions effectively.

INVESTMENTS

The usual needs of research and extension are pretty well known, e.g., buildings, laboratory equipment, transport, and the like. These will not be discussed further. What follows is a discussion of those areas which warrant particular mention because of their vital role in future research and extension services. Note that most of the areas identified relate to maintaining or enhancing the quality of human capital.

Communication/Information Technology

Modern communication and information technology has obvious and important implications for both research and extension. For research it primarily means better, more cost-effective ways to take advantage of new technical knowledge being generated around the world, as well as to join forces electronically with scientists working on problems of mutual interest. Indeed, modern information technology is a particularly important investment, necessary to complement investments in modern biotechnology.[6] There seems little excuse today for scientists in Hissar, India; Bogor, Indonesia; Madrid, Spain; and Ithaca, New York, not to be able to "communicate" with each other in real time if it is in their interests to do so. Similarly, scientists from anywhere should have access to the abstracting services and databases that are now available. In this context, modern, up to date libraries, perhaps much more dependent on CD-ROM technology than on the printed word, will be important investments. Individual scientists need to eliminate the necessity of replowing already-plowed fields of enquiry, thus "leveraging" their work to tremendous advantage in terms of time and productivity. The potential for synergism is obvious, but a certain competitive "kicker" also should be gained from more effective real-time communications. This is not an unimportant benefit to the extent that it spurs scientists on to more relevant and responsive work.

In the context of information management, modern communication techniques and technology, as in research, offer powerful "force multipliers" to conventional extension efforts. Indeed, appropriate harnessing of these options cannot help but make the job of extension agents easier (Mody, 1992). The flexibility of radio, and the ability of TV to combine audio and visual messages, suggest immense potential. Tilson, et al. (1991), document the cost effectiveness of radio for teaching in Honduras, Bolivia, and Lesotho, from which extension can learn. India's experience with the "Farm and Home Cell"

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[6] Simon Best, for example, of ICI Seeds reported at an ASTAG/AGR workshop June 11, 1992, on biotechnology that information technology is second in importance behind plant breeding/biotechnology in terms of ICI Seeds' costs.

and the Philippines' experience with "Massagana 99" are two older examples of radio complementing extension programs. The Indian use of satellite TV in the SITE program demonstrated the technical possibilities of reaching wide audiences in remote areas with modern communication media. Ironically, extension services still seem to rely heavily on a rather labor-intensive model of extension and do not capture the potentials offered by modern information systems (Wallis, 1991). Or, if they do use some of the new technologies, they only seem to do so if they own and control the equipment. This means, of course, having to invest capital and acquire media staff, who in government service have a tendency to not be very cost-effective. This also precludes taking advantages of the economies of scale and expertise offered by commercial broadcasting, publishing, advertising and video production companies.

Because of economies of scale in managing and utilizing communication media, particularly mass media, a primary concern of public sector extension in the future will be to facilitate tapping into the power of communication techniques and technologies in the private sector, particularly in the advertising industry. Given the inherent limits of government servants, those concerned with reaching farmers should concentrate on the use and management of private sector market research, programming and delivery services. Public sector extension should not seek to build up a cadre of communication experts, printing presses, programming studios and the like. Those are better left to the private sector and utilized on an as-needed basis.

Biotechnology

Since the 1980s biotechnology has captured the imagination and attention of those concerned with technological innovation in agriculture. In some ways this is reminiscent of what happened to plant breeding as a result of the green revolution in the late 1960s. Nevertheless, it is recognized that modern biotechnology covers a wide spectrum of new scientific tools which obviously have inherent potentials of farther- reaching significance than plant breeding. However, the "popularity" of biotechnology has its dangers, just as the popularity of plant breeding brought to NARSs 25 years ago. In particular, the attractiveness of plant breeding led to an over- investment in plant breeders at the cost of some of the basics, such as agronomy, natural resource management, soils, etc. These are important disciplines, but technological innovations from these disciplines tend to lead to more incremental innovations. Furthermore these kinds of innovations are often long in gestation, less readily visible, and, therefore, less attractive and consequently lower in status.

Investment opportunities in Asian NARSs are numerous. Part of the reason for this is the desire to "get on board" with modern biotechnology. Frivolous investments are possible and need to be avoided. Nevertheless, in general, investments in biotechnology must be made to: 1) take advantage of the power of the technology to solve problems and complement existing research resources; 2) position Asian NARSs so that they more rapidly can identify and acquire biotechnological innovations from wherever they are developed; and 3) enhance the political and popular support base of overall research systems because of the attractiveness and topical nature of biotechnology. The latter point can backfire if the promise of biotechnology does not lead to significant applications that are valued by the clients and supporters of agricultural research.

Besides the investments in physical infrastructure and equipment, investments in biotechnology have to be supported by complementary investments in human capital. This means high quality Ph.D. opportunities for young scientists, as well as opportunities for information systems mentioned above. Investments in biotechnology also have to be made so that they do not lead to biotechnology units that are institutionally and functionally isolated from other disciplinary work. Rather biotechnology needs to be viewed as an adjunct to the other scientific disciplines applied to agriculture and not an end unto itself.

Networking

This is an investment area that is particularly important for research organizations. Evenson and da Cruz (1989) found that the Latin American PROCISUR (Programa Cooperativo de Investigacion Agricola del Cono Sur), designed to facilitate the exchange of agricultural scientific findings, had extraordinarily high economic returns even if the statistically robust estimates are divided by four. But networking is universally under-invested because it usually is treated as a "recurrent expenditure" item, as well as something which can be cut. In so doing, investment opportunities necessary for the maintenance and enhancement of NARSs' human capital, the most important asset a research entity has, are missed. The kinds of investments in mind are those that maintain and enhance the professional currency of scientists. International, not just domestic, opportunities for workshops, collaborative research, seminars, sabbaticals, and post-doctoral studies, are examples of those kinds of investments. A pro-active policy that links those kind of investments to performance, to encourage and reward scientific staff, can have large payoffs. Of particular importance are "recharging" of intellectual energy, opportunities for first-hand exchange and challenge of ideas, synergy and updating state-of-the-art knowledge. While this is an area of chronic under-investment, those resources that are available for these kinds of activities generally are utilized poorly. This is because access to the opportunities generally are allocated on a "turn basis" to more senior staff with little consideration given to performance, staff potential, or relevant priorities.

There is another dimension to networking as well, and this is to leverage available research resources for projects that are otherwise impossible financially. For example, regional cooperative research projects can be an important way for any one of the cooperating NARSs to avoid having to invest in a full-blown program. At the same time, it allows the participating NARSs to take advantage of a much larger level of effort than it might ever be able to afford on its own. Consequently, this particular dimension of networking also allows for a more cost-effective way of meeting the demands for technological improvements than a NARS would have if trying to be "self sufficient." IRRI's cropping systems research network is one of the oldest and most successful networks. IRRI, CIMMYT, and other IARCs also have long histories of effective networking to exchange germplasm. More recently, the vetiver network has shown how cost-effective it is to "hook" people who have mutual interests together.

In-Service Training

Even though current competency levels may be considered "good enough," or rationalized on the basis that "the country is poor and therefore not much competency can be expected, particularly at the going salary levels," they are not acceptable. To believe otherwise is to accept that the complexity of problems of Asian agriculture is somehow related directly to the level of economic development. Indeed, there might even be an inverse relationship. Given that most of the on-board staff will remain for some time, considerable staff upgrading is necessary. Downsizing would make the job of increasing competency levels easier. However, for the next decade or so most of the research and extension systems likely will continue to have large numbers of under-qualified staff; hence the need for this kind of short-term investment.

Usually in-service training is not a controversial issue. But it is an area that has not been dealt with very successfully. Very often there is a poor level of understanding of what training is required. An even worse problem is the lack of trainers who are technically competent and have effective pedagogic skills as well. The technical training needed will be a function of the relevant farming systems, level of science, access of outside information, etc. In any case, considerable importance needs to be given to providing staff with the skills necessary for competent diagnosis of agronomic problems, oral and written communication expertise, as well as leadership and organizational capabilities.

Instrumentation

Technological breakthroughs in instrumentation enable scientists today to pursue research issues in the hard sciences a lot more cost-effectively than ever before. There is always the issue of appropriate levels of instrumentation for developing NARSs. However, in the context of new investment needs for Asian NARSs, the too-often negative reaction to new, sophisticated, state-of-the-art instrumentation needs to be guarded against. The problems to be addressed should drive decisions on investments in this area. Nevertheless, it is recognized that there are not inconsiderable maintenance problems with modern equipment. In this regard, it is clear that it is a principal mistake to depend on service capability within a public sector organization. Rather, service contracts with technical specialists need to be made with private sector firms.

Performance Reviews

One way of enhancing performance is a system of program and project reviews. Although a system may be structurally sound, unless a country's system is very big, such as in India or China, it is difficult to get truly objective outside evaluation of research. Even then it is not easy. In India, for example, those qualified to serve as so-called external reviewers of the ICAR system tend to be relatively small in number. In addition, the culture makes it very difficult to have the level of frankness that good science demands. Therefore, as part of the effort to upgrade quality in NARSs, it will be important to invest in the help of outsiders who have the stature, expertise and objectivity necessary for a rigorous external program and project review process.

CONCLUSION

The challenges of growth, sustainability and poverty facing Asian agricultural systems remain. Hence the strategic importance of agricultrual research and extension remain and indeed are even more important than ever, given the realities noted above. These challenges will need to be met in a faster-moving, more interdependent world, in which public sector support is likely to be less generous. It seems clear that thinking about agricultural research and extension services needs to have conceptual horizons broader than the conventional public sector. It also follows that thinking as to how to support research and extension services needs to expand. To develop the research and extension capacities concomitant with the needs of the future certainly means that it will not be "business as usual."

However, to get beyond "business as usual" 15 or 20 years hence means the time for change is now, given the long gestation periods for institutional modernization. In that context it's useful to develop some general parameters for the future that will provide useful guidance for contemporary policy changes and investment initiatives.

- Farmers need to be "first." This means *placing* real *ownership* in, and *accountability* of, public research and extension organizations *into the hands of the client community*, particularly farmers (but agri-business as well).

- *Competition* in agricultural science and provision of extension services *needs to be fostered through pluralism* in the provision of research and extension services.

- *Pluralism means* redefining the role of the public and private sectors in research and extension and, in particular, *enhancing the role of the private sector* through privatization, particularly of frontline extension and the more applied aspects of agricultural research.

- *Mechanisms for public support*, e.g., vouchers, cost-sharing, local taxes, etc., *need to be developed whereby farmers*, farm organizations and/or farming communities, particularly in the poor, marginal areas, *can draw on public resources* to be used by them *for research and extension* services *of their choice* (public or private).

- *Current public research and extension systems* need to be *downsized*.

To do this will require leadership and initiative from the public sector, agri-business and farmers. Donors can help as well. Difficult decisions are called for. For the public sector, downsizing, developing an institutional and personal stake in how farmers view their performance, and accepting the increasing role of the private sector will not be easy. Farmers and agribusiness, on the other hand, will have to recognize that to own, control, and obtain the benefits they want from these services, the previous "free lunch" is not good enough, and that for the future they must take some responsibility for support of research and extension. That is not to say the public sector will be unimportant, but that in the future the public sector needs to confine itself to only those activities it must do, e.g., advanced, basic research or informational activities that have significant economies of scale, and to being a catalyist in seeing that research and extension services are adequate, available, relevant, and responsive to the needs of farmers and agri-business.

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