Research and technology transfer for livestock development

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Introduction

Developing countries have nearly two thirds of the world's livestock but produce only about a quarter to a third of the world's meat and a fifth of its milk. Low output in the developing regions is due to both low offtake rates and low yields per animal. Beef and veal output per head of cattle in North America is 281 kg whereas yields in Africa and Asia are about half at 142 kg and 129 kg. In South America, the developing region where livestock production is most advanced, beef and veal output per animal is 213 kg. Milk yields are almost ten times lower in Africa and four times lower in South America and Asia than in North America and Europe (USDA, 1990; FAO, 1992a; 1992b; 1992c; World Bank, 1993). Relatively few cows are milked in Asia but the market is growing quickly. These figures suggest that major improvements in livestock productivity are possible. Research can provide technologies to help achieve productivity increases but technology needs to be transferred to producers to ensure impact.

Global research and development is expanding to include not only international, national, regional and developed country research institutions but also development and donor agencies (including NGOs) and developing country governments. These developments can be seen as problems or opportunities. They are opportunities if this group of expanding partners and stakeholders develops closer links and new functional models. New modes of functioning can help to link the interests and activities of all concerned in development. The mandate of the International Livestock Research Institute (ILRI) is also being broadened at a time when the growth rate of available resources may be slower than in the past. Making an impact in a global context with so many partners and stakeholders will require more focus and closer cooperation and coordination.

A framework for international action to support livestock development is thus timely. The goal of this framework is to help achieve increased and sustainable food production and generate more income for improved food security in low income countries. This goal fits within the new global mandate of ILRI which, although its main function is research, cannot ignore the need to link its research to technology transfer efforts if it is to make an impact.

This paper considers issues related to the role livestock research can play in strategies making up this framework for action and especially its effective linkage with technology transfer. The focus is on Africa because the region, while not being unique in facing the problems of the developing world, provides the greatest challenge to the global agricultural development community.

The current state of research

Development of an effective framework for action needs to take into account the current state of research in the global system and particularly in developing nation programmes *(Sanders et al,* 1995). Prevailing research and national policy need to be considered. The neglect of agriculture, and especially of research, since independence in Africa defines the current state of national research programmes. The great need of national programmes in Africa remains human capacity and institution building.

From the time of the Green Revolution successes in the late 1960s to the early 1980s the international and developed country donors operated on the paradigm that introduction of agricultural technology was the engine of growth. This was not only for agriculture but also for the whole economy in most lower income developing countries. The global research system has consisted until recently mainly of the National Agricultural Research Systems (NARS) and the International Agricultural Research Centres (IARCs) sponsored primarily by the Consultative Group on International Agricultural Research (CGIAR). The CGIAR grew out of the Green Revolution successes and has provided the predominant institutional model. Following the success of the Green Revolution, the response of the international donor community was to expand the IARC system. The IARC model has been that agricultural research requires narrow definition of priorities, well trained multidisciplinary teams of scientists and long term commitment (Ruttan, 1982). Developed country donors have attempted to isolate the IARCs from short run political and economic pressures and provided sufficient financial incentives and infrastructure to create and motivate multidisciplinary teams of scientists over long periods covering 10-20 years.

Donor support was also provided to NARS, the IARC model being adopted by most of these. Human capital formation in the NARS has now been supported by both the developed countries and the IARCs for over 20 years. NARS have been unable, however, to remain isolated from local political and economic pressures and to maintain size and continuity in their research programmes. As agencies of their governments NARS have had to respond to the continually changing objectives of their governments and, often, of donors. Thus, despite the progress made the NARS still need to improve human capital and institutional capacity.

The current state of research in Africa is also in part a function of the nature and focus of the institutions set up during the colonial period and the technical assistance model that has dominated since independence. A skeletal agricultural research infrastructure was established in most countries of sub-Saharan Africa early in the 20th century (McElvey, 1965). Research concentrated almost exclusively, however, on export crops such as oil palm, cocoa, coffee, groundnuts and cotton which yielded rather substantial returns. Little attention was given to research on food crops and, essentially, hybrid maize in Kenya and Zimbabwe was the only staple food receiving substantial research effort during the colonial period. After independence the institutional base of agriculture was largely geared to supporting large farms, plantations, ranches and export agriculture (Eicher, 1993).

African governments have mainly been concerned until recently with highly visible development projects. They have considered the agricultural sector to be a labour pool for industry and a source of cheap food for urban areas. Policy makers have overlooked the potential returns from investing in agricultural research. In economic terms the rate of time discount was too high. Agricultural research, especially increasing the institutional and human capital capacities of research institutions, is a long term investment. It has very high payoffs but most returns are subtle and not immediately obvious to policy makers. Diffusion of new technology is usually gradual and food price declines are small. With the historic major disincentives against the agricultural sector in most sub-Saharan countries, there should be even greater appreciation of the gains from new technologies that have been achieved.

The livestock research policy environment

Research policy is mainly translated into investment in agricultural research capacity. Where investment has been inadequate, such as in Africa, there has been a marked lack of success in development and transfer of new technologies. Slow development due to lack of support for human capacity and institution building by governments has been compounded by donor insistence on using expatriate technical assistance to support national research programmes (Eicher, 1990).

Life became more difficult in the global research system during the 1980s when there was a shift in the predominant paradigm in development to "getting the prices right". This implied structural adjustment, accompanied by devaluation, changes in emphasis from parastatals to development of a private sector and a stress on exports rather than achieving food self sufficiency. The forced economic changes of

structural adjustment and extraction of capital to repay the loans of the 1970s made the 1980s and the first half of the 1990s very difficult for most developing countries, especially the low income countries. Many changes resulting from structural adjustment will help the agricultural sector in the long run. With the shift of the development paradigm, however, there has been a levelling off of donor funding for international agricultural research. Competition for donor funds then became more intense and acrimonious in the 1980s and 1990s due to efforts by both IARCs and NARS to sustain research budgets.

The scientific gap and institutional immaturity in Africa is also in part the result of lack of investment in developing scientific and managerial capacity (Eicher, 1990). Following 30 or more years of independence, Africa has the lowest scientific capacity of the developing regions. It has only one fifth the number of research and development scientists and engineers per million compared to Asia. About a quarter of the total value of human resources in NARS, including academic staff, are expatriates (Eicher, 1990). About 20 per cent of researchers in sub-Saharan Africa are engaged in research related to livestock production compared to 17 per cent in Asia and the Pacific (excluding China), 21 per cent in LAC, 16 per cent in WANA and 18 per cent for the developing world in general (TAC, 1993). Africa, however, has far fewer scientists than other developing regions.

To function effectively NARS need not only trained personnel but also adequate funds to cover fixed and operating costs. Government funding for NARS in Africa has rarely been sufficient and has often been used ineffectively. Average expenditure on agricultural research for the less developed countries, including SSA, in 1981-1985 was 0.94 per cent of agricultural GDP (Pardey *et al,* 1991 cited by Eponou, 1993). Other sources put the figure at 0.54 per cent of agricultural GDP and state that this is only about a quarter of the percentage investment in developed countries (Jain, 1990). National resources are now mainly used for maintaining staff salaries, which often account for 90 per cent of the total budget, and infrastructure. Donor funding is thus used most often for the marginal costs of experiments. Many NARS are still considered to be performing badly in spite of donor aid.

The human capacity/institution building model must replace long term technical assistance in order to develop national research capacity. Building effective national systems capable of doing adaptive, as well as applied, research will require continued investments in human capacity through higher education in the agricultural sciences. IARCs can play an important role in NARS capacity building through training and collaborative research. Short term training courses should be supported by research training to collaborators in the context of projects undertaken in CGIAR-sponsored cross-centre and ecoregional initiatives. CGIAR scientists can also act as technical resource persons in applied and adaptive research projects that build upon results and technologies developed by the CGIAR. Increased efficiency will result from regional groupings of NARS or using established networks to carry out this research.

It is, however, questionable whether the necessary human and institutional development can take place in a research environment increasingly dominated by short term project related research funding. Short term funding is a particular problem for livestock research since the reproduction cycle of animals is so long. Many technological advances in the continent, such as the development of Zimbabwe hybrid maize, have their roots in research studies undertaken by a small group of scientists working over several decades (Delgado and Mellor, 1984). Human capacity/institution building strategies and long term funding for livestock research projects would be worthwhile components of any framework for action.

Sectoral and macro policy effects on livestock research impact

The environment affecting research is determined not only directly by research policy but also by sectoral and macro policies. These policies can have a direct bearing on the demand for technological change and the extent of adoption and thus the impact of research efforts. Some such policies can depress domestic production and encourage poor management of the natural resource base. These include: food pricing policies that subsidize consumers and tax producers; overvalued exchange rates that favour imports rather than domestic production; and inefficient input and credit market policies that inhibit the uptake of new technology (Ehui and Lipner, 1993).

Sound sectoral policies in support of animal agriculture can have several effects on producers. They provide incentives to intensify livestock production with purchased inputs and to commercialize livestock activities and integrate them in the market economy. They also encourage investment in items such as barns and fencing, encourage public investment in infrastructure to improve market efficiency, provide regulations that facilitate market operations for the supply of inputs and the delivery of animal health

services and assist in providing improved credit facilities (Fitzhugh *et al,* 1992).

Macro policies can affect research impact through their influence on food production, distribution and consumption. Until recently trade policies encouraged imports of cheap dairy products into Africa and discouraged development of domestic dairy industries (von Massow, 1989). Policy changes on the part of the EU, the USA and other major dairy exporters under the GATT agreement have led to a decline in world milk supplies, pushing up world market prices and making African domestic production more competitive with imports from developed, especially European, countries. Even if world market prices do not continue to rise as expected (Shapiro *et al,* 1990; Shapouri and Rosen, 1992) domestic milk production in many sub-Saharan countries will remain competitive due to recent currency devaluations (Walshe *et al,* 1991). Livestock production in the semiarid areas of West, East and Southern Africa also has a comparative advantage relative to livestock production in coastal humid countries that improves the prospects for interregional trade.

Policy reforms such as structural adjustment need to go beyond liberalizing output and input prices. A recent analysis of effects of price and macro policies on livestock production shows that, since the early 1980s, there has been a reduction in price discrimination against producers in sub-Saharan Africa. There is still scope, however, for improving price incentives if macroeconomic imbalances that cause exchange rate distortions and high domestic inflation are corrected (Williams, 1993). An analysis of the effects of policies on periurban dairying near Nairobi looked at institutional factors beyond prices that needed policy reform. Producers were found to have major opportunities for higher profits since market access is good and productive technology can be profitably used (Steal and Shapiro, 1994). An analysis of dairy price decontrol indicated, however that the market remained non-competitive. The effect on producer incentives is thus still negative compared with potential profitability in a policy free environment.

Policy research and information dissemination may need to be a part of the strategies making up the framework for action. Such efforts will need to improve the data base on livestock, as well as its accessibility to NARS and regional research institutes (RRIs). The framework for action should also improve the ability of NARS to provide analyses to help policy makers in developing countries anticipate and understand the probable consequences of policy actions. Policy research and analysis of this type is needed because new livestock policy instruments such as full cost pricing for input services, payment of full market prices and interest rates are being introduced in many developing countries. There is a need to know whether these policies facilitate or hamper livestock development, including the sustainable use of the natural resource base.

Making the case for livestock research

Livestock research objectives have a direct bearing on the strategies chosen and the ways that research is organized to achieve them. The chosen objectives also affect the ability to obtain the needed resources. Research objectives derive from policy decisions made by partners and stake holders in development -NARS, RRIs, research networks, developed country research institutes, IARCs, NGOs and developing country governments and donors. Objectives should ideally reflect the goals and aspirations of the direct beneficiaries in addition to consideration of the interests of society as a whole. Stakeholders in developing countries, including farmers, extension agents, agribusiness and policy makers, must be involved in setting research and development priorities. Involvement is essential to ensure that research is relevant to the needs of the targets.

It is increasingly recognized that even local decisions can affect the whole world. In a world growing ever smaller and more closely interconnected the global interests of the developed world are not only becoming broader but also more powerfully enunciated. International concerns about livestock development are exerting a strong influence on research policy and affecting donor attitudes to funding of livestock activities. These concerns include: the environment; human health; animal rights; equity issues, including poverty and gender; the use of existing food surpluses from the developed world; and private versus public sector involvement in agricultural development. The concerns and interests of donors and interest groups must be carefully considered and efforts made to educate the general public. Education of the public and policy makers in the developed countries would be a worthwhile component of the framework for action.

The case of environmental concerns is particularly instructive. Too often, and mistakenly, development of animal agriculture is seen as harmful to the environment. Global losses of tropical rainforest are a major international concern and deforestation has been associated with increased production of greenhouse

gases and global warming. Another global concern is desertification. That livestock are a major factor in deforestation and desertification has become a widespread controversy in the developed world and affects donor contributions to research and development. Empirical evidence does not support the contention that livestock necessarily contribute to these problems. In the humid and subhumid zones the major impetus for expansion of agricultural land is population growth combined with shifting cultivation (NRC, 1993).

Work on the dynamics of Sahel ranges shows that livestock are not a major factor in degradation. Even under the extreme grazing pressure that occurs during drought less palatable and lower productivity plants supplant more palatable, more productive species only in the short run. The more productive species are then able to re-establish themselves earlier than they might have if they had been subject to continuous grazing pressure (Hiernaux, 1994). A recent review of literature on the impact of livestock on rangelands (Dodd, 1991) concluded that effects of grazing and drought had been confused and that there was no solid evidence of irreversible effects on vegetation from livestock except around water points and permanent human settlements.

Other recent research shows that it is mainly poverty that drives farmers to exploitative resource-depleting practices (Vosti *et al,* 1991). Raising farm incomes by cash generating activities such as livestock can lead to a withdrawal from marginal areas that are susceptible to degradation. Neither people nor policy makers in poor countries will feel concern for the environment or biological diversity, however until a higher proportion of the population is able to satisfy its basic needs and the economic system develops its capacity to respond to the rapidly increasing demands for food products. The immediate problem, therefore, is to get intensive technologies moving through NARS research systems and onto farmers' fields. Developing country policy makers will then have the flexibility to respond to environmental concerns (Sanders et al, 1995).

More research and policy attention should certainly be devoted to the environmental concerns of the global community. These issues should not, however, be barriers to funding livestock research and efforts to introduce new livestock technologies since such introductions can help resolve these problems. The low income developing countries need to accelerate the pace of food output increases.

Research strategies to promote livestock development goals

Until recently the IARCs had global or continental objectives for specific commodities. The NARS role was seen as selecting and adapting what was most useful for their own environments from IARC results and to do agronomic and production systems research Specific to their regions (Lynam and Blackie, 1994). NARS have taken over more of the breeding functions as they have developed and have fought for a larger share of international resources as these have become scarcer. RRIs are also coming into being to achieve critical mass and to attempt to solve problems common to more than one developing country. This is causing the IARCs to redefine their roles and seek to move upstream in the technology development process. At the same time the IARCs must ensure that their work results in impact. To accomplish this there is a need for greater cooperation and closer collaboration between IARCs and NARS so that more impact is achieved with available resources.

Among modes of functioning that are emerging to meet global agenda needs are research programmes headed by the CGIAR. Cross-centre programmes are being called for by TAC and ILRI has been charged with taking the lead in livestock research in the CGIAR system. ILRI will thus have a major role in the livestock components of many CGIAR projects. It will also take the lead in CGIAR systemwide livestock programmes and collaborate with sister institutions concerned with livestock research including CIAT, ICARDA and IFPRI. A challenge facing ILRI and the CGIAR is effective integration of NARS in ecoregional and global initiatives to help them develop their human and institutional capacities.

In these new modes the comparative advantage of the various partners in research needs to be taken into consideration in defining their respective roles. Research can be categorized as basic/strategic, applied or adaptive (Figure 1). These categories form a continuum in the research spectrum and all have implications for development. Basic/strategic research is scientific investigation that advances the knowledge of feasible biological processes but may not have immediate application in farming practices. In basic/strategic research the problem definition is more general, the degree of predictability of results is moderate and the extent and time of impact are broad and long. Applied research is oriented towards achieving a practical objective, such as developing the genetic resistance of animals to parasites. Adaptive research refers to adjustment of technology to a particular set of farming conditions, an

example being the selection of certain forage species for use as feed in a specific agroecological zone or region. Problem definition in adaptive research is very specific, the predictability of results is very high and the extent and time of impact are narrow and short.

In the global system, NARS and RRIs have a comparative advantage in adaptive and applied research whereas the IARCs and advanced institutes have advantage in basic/strategic and applied research. Basic research requires expensive equipment and staff skills that few developing countries possess. The IARCs represent, however, only about 3.5 per cent of the global agricultural research expenditure of US $ 9 billion (Eicher, 1993). IARCs are well positioned to assist NARS and RRIs with transfer of basic research results from specialized institutes in developed countries. IARCs and RRIs have comparative advantage for doing research from which results "spill over" to similar agroecological and socio-economic conditions across national boundaries.

One challenge of the framework for action will be to define strategies to increase cooperation with institutes in donor countries. Some of these already contribute to development of the livestock sector in developing countries. There is, however, a need to increase collaboration with universities in North America, Europe and Asia. Involvement of these institutions in the new modes of undertaking research will influence the policies of their governments with regard to research in developing countries and will help determine the extent of support provided.

Figure 1 Characteristics of types of research and comparative advantage of research institutes that make up the global research system

Characteristics	**Types of research**		
	Adaptive	**Applied**	**Strategic**
Definition of problem	Specific	Specific	General
Predicability of results	High	Moderate	Moderate
Likelihood of achieving impact	High	Moderate	Low-High
Applicability for impact	Narrow	Moderate	Broad
Time to impact	Short	Intermediate	Long
Research institutes	**Comparative advantage**		
	Adaptive	**Applied**	**Strategic**
NARS	+++	++	+
RRIs	++	+++	+
IARCs	+	++	+++
Advanced institutes	n.a.	++	+++

Effective collaboration with RRIs offers opportunities to accomplish more with the scarce resources available. Several regional organizations have been formed in Africa in attempts to use resources more efficiently while tackling problems of a regional nature. The Centre International de Recherches et Développement sur l'Elevage en Zone Sub-humide (CIRDES, formerly Centre de Recherches sur les Trypanosomes Animales - CRTA) in Burkina Faso and the International Trypanotolerance Centre (ITC) in The Gambia are attempting to serve broader regional mandates. Regional programmes can complement the functions of NARS and IARCs and serve as mechanisms for NARS to pool resources and rationalize responsibilities in the accomplishment of individual and collective objectives. Like NARS, however, they frequently lack sufficient funds.

Networks are another mechanism for cooperation and are maturing rapidly as an effective means of allocating resources. Networking allows collaborating NARS partners to pool and coordinate scientific efforts, do more effective research on problems of mutual interest and avoid inefficient multiplication of effort. National scientists are increasingly well trained but there are few in the same discipline in one institute or even in one country. Multilocational projects managed through networks provide opportunities for enhancing research efficiency and allow the introduction of standardized methodologies that lead to more significant conclusions than can be obtained from isolated experiments.

IARCs already play a major role in networks as partners in collaborative research, providing training opportunities to network participants, disseminating research methods and results and facilitating the exchange of information. IARCs also assist with network support functions which include helping to

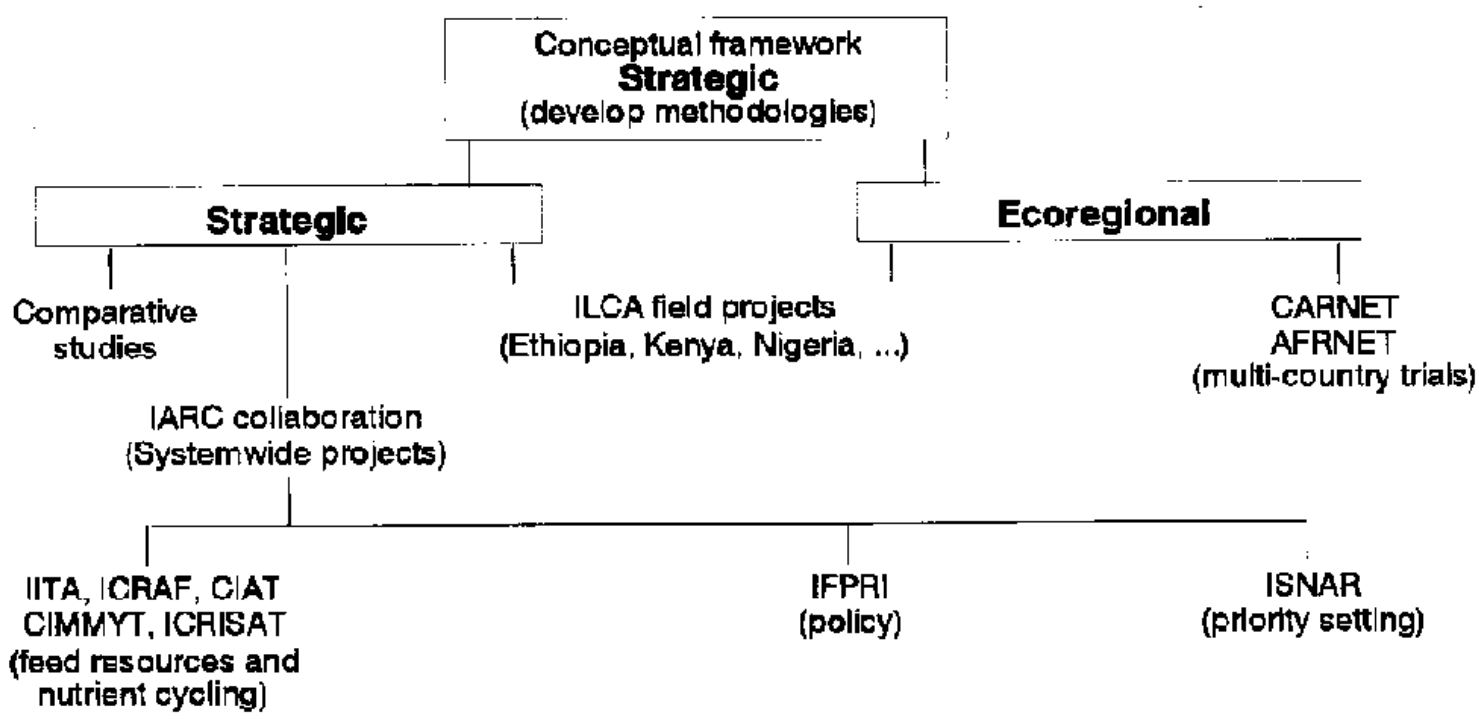
attract donor funding, organization of meetings for setting up network steering committees, sponsoring meetings of participating scientists and providing services in areas such as data analysis, documentation and publishing. A challenge for ILRI to be included in the framework for action will be how to maintain and expand its networks to include the new NARS partners of the global mandate.

The organization of dairy research programmes within the conceptual framework developed by ILRI provides an example of how partners in research can work together to increase impact. The conceptual framework is a research management tool that ensures:

- coherence between strategic, applied, and adaptive research objectives and across disciplines;
- research at any level is done in a systematic manner;
- organization of mulidisciplinary research;
- there is no duplication of research across sites; and
- consistency of research methods and resulting data across sites to increase relevance and impact.

Use of the conceptual framework (Figure 2) allows involvement of many partners, enables them to coordinate efforts at all research levels and encompasses both systemwide and ecoregional endeavours. Support for these activities in the framework for action would ensure that there are sufficient resources to realize the potential impact.

Figure 2 Organization of dairy research projects under the conceptual framework



Linking research and technology transfer

As the number of partners and stakeholders expands the effective linkage of livestock research and technology transfer is becoming more complicated. Greater coordination and synergy between research and technology development will also be required if technologies are to be transferred and impact achieved. The expanding global research system will need greater interaction with development agencies, including multilateral organizations such as FAO and UNDP, trilateral government agencies and NGOs. Developing country governments will also have an increasingly greater say in the research and development activities that take place within their borders. The framework for action must thus tackle the effective linkage of technology transfer with research.

Among other international organizations, FAO confronts livestock development across a broad spectrum.

It provides technical advice and assistance to the agricultural community, governments and funding agencies. It collects, analyses and distributes information, advises governments on policy and planning and provides opportunities for governments to meet and discuss food and agriculture problems collectively. FAO is taking the lead in organizing work on the conservation and utilization of animal genetic resources in which ILRI plays a major role. Partnerships of this kind can provide essential critical mass and state of the art technology and knowledge for the benefit of national research institutes.

NGOs can also play an important role in transferring livestock technologies in developing countries. They have close contact with producers and their potential to expand delivery of technical services to producers and to participate in field testing activities is high. Many donors are increasingly channelling development support through NGOs.

Examples of new modes of functioning in this area include the "FAO/IARC Collaboration for Technology Transfer" projects organized by FAO in collaboration with CGIAR centres. These projects are to promote proven IARC technologies that are awaiting diffusion. Included are NARS and extension experts from countries in a region (or ecoregion) where conditions conducive to the adoption of the technologies prevail. In the first phase, a workshop is held to present the technologies and to prepare country project proposals that can be part of a regional proposal to be submitted to donors. In the second phase the country projects are carried out with technical assistance from FAO experts with the IARC scientists who developed the technologies acting as resource persons. An important innovation of these projects is the role of information sharing between regions. In the FAO/ILRI project on cow traction the second phase projects are initially to be carried out in Eastern and Southern Africa but Asian traction experts will participate in the first phase workshop to share their expertise and experience and to explore the possibilities of extending the project to Asia.

Where the needed resources will come from

African governments will need to improve their support for agricultural research and extension institutions. They will also need to become more efficient in the use of their own funds. Reliance on donor funding for critical investments is increasingly risky because donors often have short time horizons and make quick changes in priorities and funding. This is incompatible with institutional research development requiring long term investment. The key issues in Africa are whether and where governments can find resources to support agricultural research.

Structural adjustment is making agriculture more profitable. African governments are increasing their revenues through these programmes by tax reform and by selling public enterprises that they had to subsidize in the past. They are also cutting food subsidies to urban consumers. Since agricultural research is a public good with a very high return on investment - even though it takes a long time to realize - more revenues should be invested in it as they become available.

As economies in the developing countries improve they need to play a greater role in funding research but developed country contributions will clearly be required for some time. This need not be seen solely as a philanthropic or humanitarian activity as funding research in developing countries can benefit agriculture in developed countries. Far more genetic diversity exists in plants and animals in Africa than in the developed countries. This is true, for example, of resistance to endoparasites in some African sheep and goat breeds. Embryo transfer has allowed five African goat and sheep breeds to be introduced to Australia where they will be reared for live (re)export. This was not possible before due to the disease considerations that have been a constraint to export of live animals from Africa. The transfer of this technology was possible due to the public good nature of research generated technologies.

There is current debate in the donor countries on whether the private or the public sector should finance the development of agriculture in developing countries. Its origin lies in concerns for liberalization and privatization arising from the process of structural adjustment being undertaken in the developing world and it is gaining in importance with the conclusion of the GATT negotiations. The belief is that in many countries the economic situation can only improve if the public sector disengages from economic activity. This argument neglects, however, the role that government can play to correct for market failures arising from the existence of public goods (Smith and Thomson, 1991).

An example is the significant role that research can play in economic development. There is now broad consensus that a large proportion of agricultural research must be recorded as a public good and requires funding by the public sector even in countries pursuing free market philosophies. The reasons

for this (Ellis, 1992) are:

- most agricultural innovations (including, for example, cultivation practices and disease resistant animal breeds) are in the public domain after release and cannot be protected by patents or copyright laws;

- private enterprise usually restricts itself to applied research that lends itself to copyright protection but this is a small fraction of the research needed to achieve the long run output, equity and food security goals of society;

- small holders, who are often the main beneficiaries from research in developing countries, cannot easily organize and finance the scale of research required for widespread advances in technology; and

- consumers, who are the other main category of research beneficiaries, would not organize and finance agricultural research of their own volition.

It has been said that "The only meaningful approach to modern agricultural research is to conceptualize most of its contribution as public goods. As such they must be paid for on public account, which does not exclude private gifts to be used to produce public goods." (Schultz, 1984). Public investment in livestock research can also be very profitable judged by the high rates of return to research of greater than 50 per cent obtained in other parts of the world (Pinstrup-Andersen, 1982).

Conclusions and recommendations for the framework for action

Major improvements in livestock productivity are possible and needed to assist economic growth in developing countries. Research can provide technologies to help achieve productivity increases but transfer of technology is needed to achieve impact. The global research and development community is expanding and new functional modes are required to ensure coordination of the use of resources. This paper considers issues related to the role of research in the strategies making up an action framework to promote livestock development and especially effective linkage of research with technology transfer.

The action framework will need to include strategies for research and technology transfer policies especially in the developing countries. It will also need measures to promote an increase in agricultural research investment within the framework of a human capacity and institution building model to replace the technical model that has been dominant in the past. The effects of macro and sectoral policies affecting research impact also need to be considered as do international concerns about the consequences of livestock development on the environment, human health, equity and other critical issues.

An effective mix of the various types of research and the strengths of all the partners in the global research and development system need to be included in the strategies chosen to promote livestock development goals. Models such as CGIAR ecoregional projects, the CGIAR systemwide livestock initiative and the ILRI conceptual framework for dairy research provide useful examples. Organizational models that ensure the transfer of research generated technologies also need to be designed and must include the role of international organizations and NGOs. FAO/IARC cooperation provides a useful model for the effective linkage of research and technology transfer.

To accomplish the framework's objectives explicit measures will be required to harness resources and ensure impact. Such activities could include:

- an ILRI/FAO/IFPRI policy unit charged with carrying out impact and policy analysis, educating the public, and garnering advocacy and support for livestock development; and

- a livestock policy network such as that seen as part of the ILRI/IFPRI project on the determinants of dairy demand, which could help train NARS scientists in policy research and analysis and could be tied to the previously described policy unit.

Using these two structures, a "2020 Vision for Livestock Development" could be mounted to promote the message of the positive effects of livestock development for the public, interest groups and donors in the developed countries. These tangible measures would ensure that the framework for action is translated into reality and result in livestock development that will have a strong impact on human well being in low

income countries.

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