CHAPTER 11

ADOPTION OF RESEARCH FINDINGS IN AFRICA: THE NIGERIAN EXPERIENCE

by

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INTRODUCTION

One of the main features of African agriculture is its low productivity. This is so, not withstanding the fact that the continent is endowed with a generally favourable agricultural resource base. Primarily as a result of small and fragmented land holdings, the use traditional farming practices, and the near total dependence on human muscle power for virtually all the farm operations, the typical African farmer produces an amount of food that is barely enough to feed his household. This has aggravated the food problem in most African countries that a significant proportion of the population is said to be either undernourished or chronically malnourished. Although other factors have in some countries greatly influenced food production (e.g. civil wars, droughts, floods, etc.), however many African countries have of late become increasingly dependent on imported food to feed their populations. There is thus the "African food crisis", the "African economic crisis" in the World media, all of which can be said to emanate from the sorry state of our agriculture.

With the population of Sub Saharan African countries increasing at a very high rate, the food and agricultural production problems are likely to become even more serious as we turn into the 21st century. This is occurring when the level of science and technology in the World has made important breakthroughs such that the problem in other continents is not one of food shortages but of food surpluses and how to dispose such surpluses. This is occurring in continents which are endowed with less favourable agricultural resource base than Africa. The breakthrough in biochemical technologies has been spectacular in particular in the last 50 years. Some of such technologies have begun to trickle down to the African farmer and as such there are more farmers using improved seed varieties, better crop and livestock husbandry techniques, as well as better crop and livestock protection measures. Although the level of adoption of these Biochemical technologies in Africa cannot be compared with that of the other continents, it suffices to say that there has, at least, been some adoption. It is to the physical technologies however that the level of adoption, by a majority of African farmers, has been dismally low. Thus a majority of the farmers are still using the handtool technology with entire reliance on human energy, in most field operations-a technology, which farmers in other continents were using three to four centuries ago.

Why then has the rate of adoption of these agricultural mechanization technologies been so low in Africa? As has been stated elsewhere in this volume, despite over 60 years of popularization of draught animal power technologies in the Savannah belt of Nigeria -- the level of adoption is still very low with less than 6% of total cultivated land area in these Northern states being tilled using this technology and less than 100 000 farmers have adopted this technology (see paper by Makanjuola et.al.). This is so despite numerous socio-economic studies which have conclusively shown that adoption of this technology leads to not only an increase in overall production and productivity, but also significantly reduces the drudgery of performing field operations compared with using the handtool technology. Why then have farmers not adopted such a useful and good technology? The main objective of this paper is to try and present some thoughts on the problems associated with extension of agricultural mechanization technologies to small holder farmers. It is not intended to cover the problems in this area for the whole of Africa, as we shall confine ourselves to our experience in Nigeria. Our analysis is also not exhaustive and our intention is to examine this problem of extension of physical technologies from an agricultural extension specialist point of view and hopefully at the end of it all we shall all be a little bit more knowledgeable of the problems involved. We shall first briefly analyze the Nigerian research institutional framework and the research/extension linkages and finally we shall focus our analysis to the problem of dissemination of research findings in particular on the physical technologies.

INSTITUTIONAL ARRANGEMENT FOR AGRICULTURAL RESEARCH AND EXTENSION

Before dwelling on Nigeria's experience in technology dissemination and transfer, it is pertinent to have an insight into the country's technology development process. In recognition of the strategic importance of technological development in procuring raw materials for overseas industries, the British Colonial Government evolved, in the early 1900s, an implicit research and development policy involving mainly export crops. Soon after independence in 1960 and resulting from the country's participation in the 1963 United Nations' conference on the application of science and technology as well as the UNESCO conference on research and training in Africa, the need for greater focus on agricultural research and development as a tool for rapid national development became more apparent. This subsequently led to the creation, in 1966, of the first science and technology central supervisory organ - the National Council for Scientific and Industrial Research. Since then, to date, there have been as many as six different organs of government charged with overseeing research and technology development. The existing central supervisory organ, the Federal Ministry of Science and Technology (FMST), was created in 1985. While the FMST is responsible for the overall coordination of the technology generation aspect of the agricultural system, its dissemination, adoption and utilization rests largely with the Federal Ministry of Agriculture (FMoA) as well as the different state Ministries of Agriculture.

Also of relevance is the fact that the bulk of training institutions which are involved in considerable generation of technology and the dissemination of research results are supervised by yet a different ministry - the Federal Ministry of Education (FMoE). The present state of institutional arrangement for agricultural training, research and extension may be briefly highlighted as hereunder.

Training and Research Institutions

As of today, Nigeria has 26 commissioned research institutions and centres of which 19 deal wholly or partially with agricultural problems. These are in addition to 16 university faculties of agriculture, two fully fledged Universities of Agriculture, about 60 other agricultural institutions offering middle-level technical training, one international agricultural research institution as well as a number of other national and regional training and research outfits. Specific to agricultural mechanization, virtually each of the 28 degree-awarding institutions and not less than nine of the commissioned research institutes, plus well over two dozens Polytechnics are involved in training and research in this area. While the FMST is charged with the overall supervision of the national agricultural research system, university level training is coordinated under the FMoE. Coordinating research activities specific to agricultural mechanization towards ensuring the effective dissemination and adoption of new and improved technologies is the National Centre for Agricultural Mechanization (NCAM) established under the FMoA.

Agricultural Extension and Research Liaison Services

These service-oriented units are presently integral components of the various broad-based and multi-disciplinary zonal Research Institutes charged with the dissemination of research results in specified geo-political areas of mandate. The best known Agricultural Extension and Research Liaison Services (AERLS) unit was carved out of the Institute for Agricultural Research (IAR), Samaru, in 1975 as an autonomous institution and charged with the servicing of the same mandate area as the IAR - until the re-organization of the national agricultural research system in 1975. Today, the original AERLS has assumed national responsibility in coordinating the extension activities of zonal AERLS.

Specific Programmes for Technology Adoption

Over the years, both State and Federal Governments in Nigeria have vocalized a wide range of agricultural research and development strategies, up to and including large-scale and completely mechanized farms. However, it is evident from existing policy documents that the federal and state governments believe that a major constraint to increased agricultural production is insufficient knowledge by peasant farmers of improved agricultural techniques. Consequently, a number of programmes and projects have been promoted in

recent years by state and federal governments with the aim of providing this knowledge and making it available to the peasant farmers in the country. Among such programmes are the following:

(i) National Accelerated Food Production Programme - Launched in 1972, the National Accelerated Food Production Programme (NAFPP) had been, at least on paper, the most all-encompassing effort in the development of Nigerian agriculture up to the early 1980s. The programme was regarded as a major strategy to improve production conditions for specific and specified food crops. Using a concerted action in research, extension and agro-service, the results of scientific crop research and improved production technologies were planned to be brought to the farmers in a short period with the expectation of mass adoption.

(ii) Agricultural Development Projects - Supported jointly by the State and Federal governments on the one hand and the World Bank on the other, the Agricultural Development Projects (ADPs) have become the focal points of all agricultural development activities nation-wide. Established in the mid-1970s to increase agricultural production, the ADPs presently constitute the direct link with farmers in terms of input delivery and extension services.

(iii) River Basin Development Authorities - Presently numbering 11 and under the Ministry of Water Resources, River Basin Development Authorities (RBDA) are charged primarily with water resources development.

(iv) Directorate of Food, Roads and Rural Infrastructure - This Directorate (DFRRI) was established in 1985 with the main aim of removing bottlenecks in the transfer of proven technologies and support in rural infrastructure rehabilitation.

Approaches to Technology Dissemination

For several decades now, the tendency in Nigeria has been towards emphasizing the development and transfer of biological-based technologies such as improved seed varieties, animal species, fertilizers and management practices. Proven research results and improved technologies emanating from the country's numerous research institutes, universities and polytechnics are normally translated into production packages for specific crops and animal species and transmitted to the various extension agencies who are then charged with the responsibility of disseminating the same to farmers and other end-users. The approach to technology dissemination employed by the Samaru-based AERLS up to 1987 and which strategy has been mostly continued since then by the various zonal AERLS, involves assembling proven research results and tested technologies from the various research institutes, universities and

polytechnics located in and/or relevant to the area of mandate being serviced and putting them together for adoption in the form of "recommended practices". The target is usually farming families in an area, although priority is often given to the so called "progressive farmer", largely because of the limited number of available extension field staff.

Quite often, field plots are used to demonstrate the potential of the new agricultural techniques. Both the print and electronic media are sometimes used to achieve awareness and posters, agricultural exhibitions and shows as well as such other extension approaches are used to persuade farmers to carry out trials on their own fields. Periodic visits by extension agents to individual farmers during the trial period are undertaken to facilitate the adoption process. In carrying out these responsibilities, the AERLS units are expected to liaise closely with State MoA in general and the ADPs in particular. In addition, they are to identify problems requiring solutions through basic research which are communicated to the research centres. Other key responsibilities of AERLS include the conduct of applied research on farmers fields and investigating into ways of improving extension services in the country (Yayock 1983). The integrated rural development programmes currently being pursued in Nigeria are characterised by a preference for achieving increased agricultural productivity through improvements of existing peasant systems rather than by radical changes. A key element in the ADP operation is the Training and Visit (T&V) system which aims at providing an effective link between extension and research activities towards ensuring a continuous flow of practical recommendations suited to the farmer's needs. The adoption of the T&V extension approach by the ADP's is most probably a result of the cofunding of these ADP's by the World Bank as this approach, can by and large, be regarded as the 'officially' adopted method of extension by this international agency. The T&V system was originally developed in India (Benor 1978) and it is claimed it was quite successful there. However some observers have noted that it is quite expensive method of extension especially to farmers who have their farms scattered all over the place. It is too soon to say now if this method will produce the same results in Africa as it is claimed to have done in India. In addition it may well produce some impressive results under the ADP system especially in the beginning when the World Bank funding is still available. It remains to be seen whether the state and federal governments can sustain such a system when the World Bank assistance is terminated.

Problems of Biological Based Technologies

Probably, as in many other developing countries, the Nigerian agricultural research system is often blamed for failing to make an impact on the nation's agricultural output. This is not to deny the fact that dramatic improvements in agricultural technologies have been demonstrated to be possible as can be seen from Table 41. Dramatic increases in the productivities of virtually all the major

crops have been achieved under research station conditions. Indeed, there is evidence to suggest that aspects of several improved technologies and recommended practices emanating from the national research system have been and are being adopted by a reasonable number of farmers. However, the problem remains that of only very few farmers having the willingness or even the capability of following in any significant manner, available improved technological packages - with the possible exception of maize. The reasons for this problem is the subject of considerable contention, with some charging the farmers as being tradition-bound and, therefore, unwilling to change their ways. Others blame the problem on ineffective extension services. And yet many argue that the credit system is unsuitable whilst a school of thought puts the blame on inadequate farm inputs. There is no doubt that one or a combination of these explanations has been valid at different times and locations.

TABLE 41: Yield (kg/ha) performance of major food crops at three levels of technology under sole cropping

Crop	Farmer's Practice		Research Station Practice
	Traditional Technology	Improved Technology	Improved Technology
Sorghum	785	1,680	3,920
Millet	740	1,344	2,800
Maize	1,046	3,000	7,840
Rice	940	4,445	3,360*
Wheat	1,750	2,500	4,500
Cassava	5,750	11,263	22,580
Yam	5,272	9,004	20,070
Groundnut	586	1,120	2,240

*Refers to upland rice; best swamp rice yields of 4,800 kg/ha and irrigated yields of 5,600 kg/ha have been recorded (Yayock and Karikari (1989)).

It should be appreciated that the Biochemical technologies by their very nature are divisible and avail to the farmer an opportunity to experiment on his own without taking much risk. Thus a farmer may buy a quarter of a kilogram of a new seed variety and plant it in a corner of his field whilst planting his traditional seed in the remaining part of the field. If there is a remarkable and quite apparent increment in yields he may well adopt this new seed variety in the next season. If however there is no apparent increment in

yields or if the new variety demands higher labour input than he can provide given all his other tasks he may well not adopt it, the key issues in this regard is that he has had the opportunity to test the new technology at a minimal cost and risk to himself.

However, a very important but less frequently mentioned explanation for the relatively poor performance of Nigeria's agricultural sector relates to the development of technologies that are inappropriate and/or unacceptable to a majority of farmers. A major aspect of the agricultural process that has not received as adequate attention as the biological-based system relates to the physical technologies (mechanization and irrigation). Drawing from the experience of the more technologically developed world, it is evident that a more balanced combination of biological and physical/mechanical technologies can result into a rapid agricultural transformation in Africa. The fact is that the development, progressive improvement and eventual adoption of mechanical/engineering technologies for the various farm operations invariably ensures, among other things, their speedy completion, enhanced job quantum as well as the preservation of human muscle power (Kaul 1989).

AGRICULTURAL MECHANIZATION DEVELOPMENT

In quite a number of African nations there are networks of agricultural mechanization research and development programmes established with the country's or with donor assistance to enhance farmers' productivity. These local and donor supported research efforts have yielded some results in terms of the development of prototypes of agricultural equipment and implements, many of which have a potential in contributing immensely to increased and sustained food production (Kaul and Misari 1989; Olugbemi and Kaul (1989)). In the specific example of Nigeria, the broad policy for agricultural mechanization has been to consider the totality of the agricultural production process towards applying engineering solutions to specific aspects and problems. The overall research thrust is aimed at reducing human drudgery, minimizing labour costs and enhancing productivity and efficiency. While the major focus is on agriculture, considerable attention is also given to other sectors of the agricultural process, especially in terms of identifying operational constraints and management. Most of the research projects undertaken on agricultural mechanization have focussed on small-scale farmers, indegenous food habits, adaptability to local soil, weather as well as socio-economic conditions and involving as much locally obtained components and materials as is possible. In virtually all departments of agricultural engineering in Nigeria's universities, polytechnics and research institutes, there are a large number of different prototypes of agricultural equipment and implements which have been designed and developed, and in some cases have been widely field tested and demonstrated to farmers but which have not yet moved to the next stage of development - commercialization and ubiquitous manufacturing and dissemination. Significant amounts of national and donor funds have been spent in these research and development efforts and yet the results of all these

efforts is not apparent in our rural areas as the farmers are still using the centuries old handtool technology in most field and post harvest operations (Mohammed (1989); Kaul (1989); Yayock (1989 a,b)). What then are the constraints to widescale adoption of mechanization technologies? What makes the dissemination of agricultural mechanization technologies lag so much behind the biological based technologies?

Constraints in Adopting Agricultural Mechanization Technologies

The following would seem to be the major constraints which have led to low adoption rates of agricultural mechanization technologies:

(a) Controls of importation - Given the chance, the average Nigerian consumer would prefer a piece of imported agricultural equipment to one that is locally fabricated, not necessarily because of its reliability, durability or performance, but it would seem to us, primarily for its physical appearance. In the absence of any policy provisions for the localization of the imported technology, it would literally amount to economic suicide for a local manufacturer to commit huge financial resources to the mass production of a particular agricultural equipment prototype which his/her competitor in business is easily able to import and sell. The implication is that until and unless there is a deliberate and clear-cut policy by the government to control the importation of certain types of agricultural machinery and equipment, the dream of mass-adoption of locally generated technologies would continue to be elusive. By control here we do not necessarily mean outright banning of importation of equipment which are locally produced but other fiscal measures can be used like huge excise and customs duties; and/or importation quotas, etc. Such controls should be accompanied by provision of assistance to the local manufacturers to increase the quality of their products through enactment of legal standards and other provisions. Control through fiscal measures will also allow the local traders who are importing the foreign manufactured implements to take up the distribution of locally manufactured implements as their profit margin will then be reasonable and leave the manufacturer to concentrate on manufacturing.

(b) Commercialization of Research Results - Partly because of the long-term nature of investments in the commercialization of agricultural prototypes and partly as a consequence of uncertain market situation as earlier mentioned, entrepreneurs are often quite reluctant to commit resources to the mass-production of new and improved equipment and machines. With the get-rich-quick syndrome of the typical entrepreneur and especially given an uncertain political environment, there is no known easy solution to the dilemma of mass-production of prototypes in the absence of controls on importation. An additional factor is the weak

operational linkages that exist between the various sectors in the nation and various nations, the African Regional Centre for Engineering Design and Manufacturing (ARCEDEM) and potential entrepreneurs. In the specific case of Nigeria and largely as a consequence of inadequate support, the effect of NCAM in the transfer of tested technologies is yet to be felt.

Drawing from the successful experience of establishing a seed production unit in the late 1960s, for rapid multiplication and direct distribution to farmers of large numbers of recommended crop varieties released by it, the IAR, today, finds itself in exactly the same situation in respect of labour-saving mechanical devices. Even with the strenuous efforts made towards having interested entrepreneurs to mass-produce some of the equipment prototypes developed by the Institute (as shown Table 42), no major success has so far been recorded. Consequent upon this unbearable situation, the IAR is presently in the process of setting up a prototype production unit, akin to the seed production unit - which was later taken over to become the nucleus of the National Seed Service of the FMA. Once established, such a prototype production unit would be of service not only to other Nigerian institutions, but should also serve the training needs of the African region.

(c) Appropriateness of Imported Technology - Through the regular testing of imported machinery, the IAR has firmly established that the design and production of a large number of equipment and machinery do not normally take into cognisance the nature of the soil, environmental conditions as well as the agricultural production system outside the place of development and manufacture. This is evident from the poor performance, frequent break-downs, as well as the wear and tear of components for an over-whelming number of the imported equipment and machinery tested. Through its regular testing programme, the IAR has, thus, to some extent, been able to advise against the importation of unsuitable equipment. In addition, through the release of test results, some manufacturers have been motivated to modify on their equipment designs in order to suit local farming systems, conditions and practices.

(d) High Cost-Benefit Ratio - An important consideration that influences the adoption of a new technology, whether imported or locally developed, is the financial capability of the prospective user. For example, a farmer may realize and appreciate fully the advantages intrinsic in a particular agricultural equipment and still snub it, purely on the grounds of its high price tag. Indeed, some of the farm equipment currently manufactured locally are too expensive for the average end-user - a situation which will undoubtedly hinder their adoption. In order to reduce overhead costs and, thereby bring down prices, it would be desirable to mass-produce such equipment and machines for sale in the African region where conditions are relatively similar. To overcome this problem of high initial

capital costs three approaches have been used. First is to design equipment of smaller size suitable for use by one farmer and hopefully cheaper due to scaling down of size. However due to their inherent nature, scaled down mechanization technologies do not often lead, to commensurable reduction in cost and in many cases the scaled down device does not perform as well as the full scale model. This in many cases has led to non-adoption of such appropriate technologies. The second method is to encourage cooperative or multi-farm ownership of equipment and machines. There are of course a number of management problems in such ventures and this can only work in specific areas and under specific local conditions. The third method is to provide for local hire services through Government or private ownership. Experience so far in the whole of Africa, especially with tractor hire services, shows that these are beset with so many problems in particular the Government owned schemes. This is perhaps an area where research can assist in developing better management techniques for equipment hire services be they public owned or privately owned.

TABLE 42: Some prototype equipment designed and fabricated at IAR, Samaru, indicating their advantage over traditional methods*

Prototype Equipment	Operations Performed (kg/man-hr)	Prototype Output (kg/man-hr)	Traditional Output
Multi-crop Thresher	Threshing & winnowing of:		
	- Wheat	40	5
	- Sorghum	30	20
	- Millet	30	15
Groundnut sheller	Shelling & practical cleaning	30	1
Groundnut thresher	Picking pods from harvested plants	30	2
Straddle Row Weeder	Weeding on ridges	0.1(ha/hr)	0.02(ha/hr)
Maize sheller (manual)	Shelling of maize	14	9

Source Kaul and Misari (1989) and Kaul (1989)

(e) Standardization of Products - The standardization of engineering products is a generally accepted tool towards ensuring the quality and functional performance of finished agricultural equipment and machines. In the absence of any national standardization of agricultural machinery, many institutions have independently developed or improved on prototype equipment that perform similar functions, but which are different in design and specification. Such variations are manifested in the materials used, sizes of the various components, arrangement of the parts as well as their effective and efficient performance. Thus, in order to ensure sustained production of quality and functional agricultural prototypes and spares and in order to gain a wider market, it is necessary to evolve acceptable national standards as well as restricting the types and makes of machinery which can be imported/manufactured.

(f) Trained Manpower - The availability of trained manpower is a crucial factor in the successful adoption of research results, the adaptation of appropriate technologies as well as the overall effective promotion of research and development work. As of today, there is a dearth of trained and experienced specialist manpower for virtually all the training and research institutions in the country. The situation is, indeed, becoming of increasing concern, especially in the context of the high mobility of the more experienced staff to more lucrative and satisfying involvements, both within and outside the country. In no disciplinary area is the problem of trained manpower more acute than in agricultural, applied sciences and engineering. A possible way of resolving this serious constraint is through a total invigoration of and support to postgraduate training programmes of some selected African universities towards serving the training needs of the region. It is also important, in this regard, to ensure that the manpower involved with extension of agricultural engineering technologies is conversant with the technologies they are extending. Many of the frontline extension workers are normally trained to certificate and diploma levels in general agriculture. Although they do a few agricultural engineering courses, this is not sufficient to make them conversant with most agricultural engineering technologies. It is necessary therefore through short courses (1 - 3 months) that they are continuously trained to understand basics of operation and maintenance of such engineering technologies so that they can extend the information to farmers. Alternatively specially trained agricultural engineering extension workers could be trained and employed specifically for the engineering technologies just like we have veterinary frontline extension personnel. The lack of knowledge of engineering technologies by the frontline extension workers is perhaps one of the major constraints in dissemination of these technologies. The situation is similar to a car dealer employing a salesman who does not know how to drive a car! Coupled with training of frontline extension workers on engineering technologies, there is need also for the design and development engineers to understand more the whole agricultural

production system. It is only by understanding this system that they can design and develop appropriate implements for use by farmers. It is necessary therefore to offer short courses as well as introduce more agricultural courses in the engineering programmes.

CONCLUSION

The problems encountered in dissemination of engineering technologies to small and large scale farmers have been described above. It would seem, extending such technologies, compared to the traditional biochemical technologies is much more difficult. In the more advanced countries the development of implements and machinery has been left to the private companies and public research and extension system has been more involved with the development of the management systems for such technologies. In Africa however the private companies hardly do any research to be able to develop the necessary hardware which their counterparts in the more developed countries have been so successful at. Thus this is left to the public research system to initiate research to develop the 'hardware'. A major problem would seem to be that the public research system has been unable to get the private and public companies to commercialize and start large scale manufacturing of the prototypes developed. In addition even where such technologies have been imported the public system has not been able to develop an efficient management system of such technologies (i.e. the software) which they can then extend to farmers. These problems necessitate a different approach in the extension and research efforts in the field of agricultural engineering. In the initial stages however concerted efforts have to be made in training the frontline extension workers to have a basic understanding of the engineering technologies as well as the research and development engineer to have a better understanding of the agricultural system. The problems however are many and we are just beginning to tackle them. Collaborative efforts between the different disciplines involved will be necessary if we are to overcome the constraints which have so far impeded the adoption of engineering technologies by African farmers.

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