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To the Reader:

The *Agricultural Economics Bulletin* is published twice yearly. Articles are invited from professionals working in universities, governments' ministries and departments and other organizations all over the world, who are interested in the economic problems and development of agriculture with particular relevance to African conditions. No fees are payable but authors will receive a minimum of 20 copies in English and/or French of *published articles*. Guide lines for submitting articles appear on the last page.

The Editor would be glad to receive copies of all official documents, reports statistical data, etc., dealing with agriculture and agricultural development in Africa.

The views expressed in signed articles are those of the authors and do not necessarily reflect those of the ECA/FAO Joint Agriculture Division.

The Editor

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(ii) Original challenging views or hypothesis based on the contributor's experience, observation and/or reflection meant for communication, through the Bulletin, to other readers to provoke an exchange of ideas thus establishing professional contacts among fellow workers in the field of African agricultural development.

(d) ECA/FAO File: The body of this section is comprised of a variety in information contributed by the various divisions and units of ECA and channelled to ECA/FAO Joint Agriculture Division (JAD). This information is made up of, but not confined to, the following items:

(i) Current activities being performed by the ECA/FAO Joint Agriculture Division and also abstract of study reports prepared by members of this Division.

(ii) Qualitative and quantitative information of special interest and significance produced, compiled and/or processed by ECA divisions and centres.

(iii) News notes on current, recent and future events related to agricultural economic situations and problems in Africa. These events include conferences, seminars, meetings, etc.

(iv) Significant policy statements on African agricultural development made by key officials in FAO, ECA and other international and national organizations.

(e) Guidelines for submitting articles and other material under "Views and Notes".

Finally we sincerely hope that you will feel free to send us any material you consider suitable for publication under "Articles" and/or "Views and Notes" sections, assuring you of the fullest attention given to your correspondence and extending our warmest welcome to your renewed relations with us.

Editorial Committee

ECONOMIC FACTORS IN RESEARCH AND EXTENSION INVESTMENT POLICY

By Robert Evenson
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Decisions with respect to the extent and form of investment in agricultural research and extension are likely to be of greater importance in the coming years than almost any others for low income countries seeking to achieve productivity or efficiency gains in food and fibre production. Unfortunately, such decisions will not and cannot, be made with complete information regarding the outcome or payoff to alternative investments. The process of real technology creation is only partially understood in all of its complex dimensions. Meaningful research activity has an inherent element of uncertainty in it. However, lack of perfect knowledge characterizes most investment decisions and certainly does not bar the pursuit of efficient resource allocation.

This paper summarizes sev studies of research and extension investment, chiefly in the United States, nd ttempts to relate them to the policy decisions facing contemporary Afri ations. An attempt is made to formalize an economic framework which yields plications for research policy.

Economic studies of research and extension

A number of studies of the realized payoff or rate of return to investment in research and extension have now been made by economists. Some have received considerable attention and approval by research administrators. In general, they have reached the conclusion that the research programmes studied have been extremely productive from an economic point of view. Estimated "internal" rates of return to investment have ranged from 30 to 50 per cent for a number of studies. It would be difficult to show that any other investments undertaken in these countries yielded returns as high as those for research. 1/

It might be concluded, that these findings provide a basis for a recommendation that major expansions in research efforts are called for. There are a number of reasons, however, why such a simplistic conclusion is not warranted. The research programmes studied have tended to be selected because they were obviously successful. For example, the well known study of Hybrid corn research by Griliches (9) is such a case. Peterson's (12) study of the returns to research in poultry production is another. A study by the present author (6) did attempt to overcome this difficulty by estimating the benefits (measured as cost reductions) of all agricultural research and extension in the United States in the Post World War II period. The estimated internal rate of return

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1/ A number of expressions of the productivity of investment exist; internal and external rates of return and cost benefit ratios. Unfortunately, all are sensitive to the timing of the relevant costs and benefits. Internal rates of return are less sensitive than the present value computations using a given discount rate. For comparing alternative projects they are not useful. The internal rate is that rate which equates the cost and benefit streams in present value terms and can be interpreted as that rate of return which is realized over the entire period of the incidence of both costs and benefits.

to all research, the highly successful and the less successful was, 46 per cent. This estimate, which included an adjustment for research conducted in the private sector, would seem to overcome the objections based on the study of only successful programmes. 2/

A more serious objection to the application of these results to the low income countries is that the research programmes studied were undertaken under conditions that are simply not comparable to the contemporary setting in low income countries. The case for the irrelevance of the high-income country experience can be made on two different, but related grounds. First, it could be argued that the research investment in the United States (and European countries as well) was undertaken at a different stage of development. Second, a case can be made that the special ecological conditions in a particular region determine the effectiveness of research programmes. Thus, research successes in the temperate zones may not be repeatable in the tropical and sub-tropical regions of the world.

Support for both of these cases can be developed from additional historical evidence. It is true that studies of the productivity of research in Brazil and Mexico have also estimated high rates of return (1, 2). On the other hand, we know that in many countries, agricultural research programmes of considerable size have probably not effected the efficiency of food and fibre production. More careful research is required to support this latter statement, but to the extent that it is true it implies that we must develop an explanation for the apparent lack of success of some research programmes.

In a recent paper, Hayami and Ruttan (10) made some comparisons of the agricultural productivity gains in Japan and the United States. They conclude that the research institutions in both countries directed their research efforts in such a manner as to economize on the factors of production which were least abundant and most expensive. Japan developed yield increasing new technology which economized on land. The United States first developed labour-saving mechanical technology to economize on labour. I wish to return to their factor price hypotheses, later. Here, it is of interest to note that both countries experienced an early spurt of technology advances, followed by a period of relatively little gain. 3/

This period of stagnation may have some important implications for contemporary research policy. One hypothesis for the pattern of change is that the earliest attempts to develop new technology in these countries did not

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2/ The fact that the estimated rate of return for all programmes was higher than the estimated returns to the specific programmes was basically due to the fact that the methodology enabled a more complete estimation of the benefits.

3/ In the United States output per unit input, or total factor productivity increased by 18 per cent from 1870 to 1900, then remained roughly constant until around 1930. In Japan, rapid gains were also achieved from 1870 to 1920 with a relative slowdown thereafter, Hayami and Ruttan (10).

require a thorough understanding of fundamental phenomena. That is, relatively little understanding of plant physiology or genetics, or soil-water relationships was necessary. In the United States the role of the farmer-inventor and the blacksmith-investor was important in the early period. In Japan the "model" farmer played a major role in the development of new rice varieties. 4/

These relatively easy gains were soon exhausted and the further advances that occurred after a period of stagnation were generally of a different sort. These modern advances were not possible until the fundamental studies in plant physiology, phytopathology, soils and genetics allowed them. Hybrid corn, for example, required some advances in the knowledge of genetics. Plant breeding programmes generally became more sophisticated. Likewise machine development began to require more engineering knowledge and the farmer-inventor gave way to the engineer.

This experience merits more study because it does have important implications. It is very tempting to believe that there are easy gains to be had regarding new agricultural technology. A great deal of technical aid has been given on this basis. This is especially the case regarding the borrowing of technology from another country. Yet it is probably true that the easy gains are just not there. While for the most part, the low-income countries have not experienced any rapid periods of technology change, they have experienced change and have very likely exhausted the easy gains which did not require a significant science component. The recent accounts of the experience in the Soviet Union of an agricultural research programme dominated by non-scientists bears this out. 5/ The "peasant scientists" and the "hut-labs" may have had a lot of political appeal, but there is little evidence that they produced gains in productivity.

Of course, no country or region will be producing new technology in isolation from other research efforts. As noted earlier, the thrust of many technical aid programmes in the LDC's has been to simply transfer technology into the sector, relying basically on extension activity. The blame for the general failure of almost all of the early programmes based on this model to meet their objectives was first placed on the ignorant culture bound peasant. While a great many planners and administrators still have faith that these programmes can overcome this supposed ignorance, most of the appraisals of these efforts have concluded that the premise on which the programme was based was simply wrong. We now have a good deal of evidence from the rapid adoption of the new wheat and rice varieties in the past several years to put to rest the stereotype

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4/ See Yamada and Hayami (10) for a documentation of the role of the farmer-breeder.

5/ Joravsky in The Lysenko Affair, (11) details the main features of the Soviet Research system during the period of domination by the "agrobiologists" led by T.D. Lysenko. He discounts the role of ideology in Lysenko's role, concluding that Lysenko was simply a non-scientist who had an ability to rise to power in the particular political situation of the time.

of the ignorant peasant. When provided with the new technology, the farmers in India behave pretty much like the farmers in Indiana. 6/

The real difficulty has been that the purveyors of the new technology usually were trying to transfer technology that simply was not economically profitable in the new setting. Fortunately, farmers have generally not followed the bad advice given to them in these cases. Actually, agricultural research administrators have paid a great deal of attention to the differences in ecological factors between relatively small regions in the establishment of research systems in most countries. Indeed they have generally carried the concept to excess. Most observers would agree, for example, that excessive fragmentation of research stations is one of the major problems of the contemporary modern agricultural research establishments.

Unfortunately, the region specific nature of agricultural technology has not been fully taken into account in most technical aid programmes. I believe that a more realistic appraisal of its importance would have resulted in very different investment patterns. Highest priority would have been given to the development of strong science-oriented research units capable of producing new knowledge, not only of an applied nature, but of the fundamental phenomena of biological relationships for the particular regions as well.

Table 1 presents data on international levels of investment in agricultural research. These data are annual expenditures in United States dollars for the mid-1960's. 7/ While they are subject to some error (especially for Eastern Europe and Russia) they do serve to place the world-wide pattern of agricultural research activity in perspective.

The major features of the table are:

1. The high rate of per capita income countries; United States, West Europe, Canada, Australia, New Zealand and Japan account for almost 70 per cent of the world's agricultural research and 60 per cent of the world's agricultural extension.

2. Adding Eastern Europe, Russia, Israel and South Africa and Southern Rhodesia to the above group raises the developed countries percentage to 89 per cent leaving the low-income countries of Africa, Latin America and Asia with only 11 per cent of the world's investment in agricultural research and 20 per cent of the extension investment.

6/ The study of the Indian Intensive Agricultural District programme by Dorris Brown (3) bears out this contention.

7/ The table is based on numerous sources. References are available from the author. For African countries the excellent study Agricultural Research in Tropical Africa by St. G.C. Cooper (5) has been the major source. The estimates for the East European and countries of the Soviet Union are approximations subject to a substantial error.

Table 1. International research and extension investment

	Estimated expenditures per year million 1966 US Dollars		Per cent of GDP originating in agriculture spent on		Number of farms per	
	Res.	Ext.	Res.	Ext.	senior researcher	extension worker
United States	388	178	2.17	.99	346	555
Canada	60	26	1.62	1.05	321	167
Australia	51	(24)	2.98		126	n.a.
New Zealand	6	5			159	160
W. Europe	200	130	.88	.62	1,605	822
E. Europe & Russia	200	(130)				
Mexico	2.0	.3			4,550	6,320
Other Central America & Carribean	4.0	3	.11	.52	4,270	3,407
South America	(24)	(18)	.16	.08	3,846	2,538
Africa (excluding S. Africa & Southern Rhodesia)	57	(52)	.49			
W. Africa	10.3	(10)	.11			
E. Africa	17.0	(20.1)	1.20	1.80	19,143	801
C. Africa	1.7	(2)			6,179	
N. Africa	18.0	(20)	.68		6,050	
(S. Africa & S. Rhodesia)	(7)	(5)				
Japan	62	36	1.24	.72	1,131	433
Israel	6	4	2.67			
Asian LDC's	42	(60)	.10		16,700	1,038
WORLD TOTAL	1,106	(671)				

3. Except for East Africa (and North Africa), the per cent of Gross Domestic Product originating in agriculture spent on research in the low-income countries is markedly lower than is the case for the high-income countries.

4. The disparity between the LDC's and the high income countries is especially great when expressed on a research per farm basis. This is affected by average size of farm, of course. Extension per farm when less disparate indicated that expenditures per researcher are more uniform throughout the world than expenditure per extension worker.

Table 2 presents limited data on the size distribution of experiment stations. Again, the coverage, especially for the smallest stations may not be entirely accurate for all of the included countries. In particular, not all of the branch stations in the United Kingdom, Canada and the United States are included. Taking this into account, however, a clear difference in the proportion of researchers in relatively large stations between the low-income countries and the high income countries is apparent.

Table 2. Size distribution of experiment stations: selected regions

	Number of stations with senior research staff				
	0-4	5-9	10-19	20-49	50 +
United Kingdom	10	16	16	31	10
Canada	21	17	10	14	3
USA	—	—	—	—	20
West Africa	65	14	6	4	0
East Africa	61	4	7	0	0
Central Africa	26	8	1	0	0
Afghanistan	0	1	0	1	0
Ceylon	1	0	4	1	0
Taiwan	1	0	1	3	2
Indonesia	1	1	3	0	0
S. Korea	0	2	0	1	1
Malaysia	3	0	0	2	0
Nepal	0	0	0	4	
Philippines	1	0	0	2	3
Thailand	1	0	0	2	1
Japan	3	5	1	4	18
Australia	6	8	7	12	6
New Zealand	2	1	6	2	3
South Africa	7	5	1	7	4
India	5	8	18	14	8
Pakistan	12	5	6	1	1

An analytic framework

In this section an attempt is made to develop a framework of analysis, which can be used to deal with investment policy issues. The state of the

art in economics, for that matter in other fields of study, is not such that we have available to us rich analytic models with implications which have withstood the test of evidence. Instead we must rely on oversimplified formulations which are not inconsistent with what we know about research activity and yet provide a framework for analysis.

To begin, several distinctions should be made. The first is between final and intermediate research output. Final research output is the central focus of the framework. It is the set of new techniques which are economically useful to farmer producers. It includes new crop varieties, new chemicals, new machines and new intangible techniques such as fertilizer placement information. Intermediate research output is not in an economically useful form and is generally in an intangible form. It ranges from soil survey data to the development of experimental design improvements. It includes knowledge in plant physiology, phytopathology, genetics and related fields. It is "intermediate" in the sense that it is of use to the researcher creating final products. It generally is created in response to both the demands of the final output researchers and to a set of science related incentives such as publications standards in scientific journals.

We can conveniently separate the analysis of the adoption of the new techniques or final research output from the analyses of the creation or borrowing of these new techniques. It is easiest to turn to the adoption analysis first since we have a substantial body of economic knowledge to build on.

The process by which new techniques which are in some sense "available" to a country or region are adopted (or rejected) has received attention by sociologists and economists as well as by extension specialists. Some controversy over the relative importance of sociological and economic factors exists in the field. It does not seem fruitful to examine those issues here. This analysis is basically an economic one, but it does not imply that sociological factors are unimportant.

Fundamentally, the issue is; how do farmers behave when they become aware of potential new techniques? The perfectly rational producer is presumed to be continuously attempting to maximize profits. He may not actually do so and in a dynamic setting where new techniques are continuously becoming available he almost certainly will not. He will, however, have a demand for information about the potentially profitable new techniques. This will depend on his awareness of what is potentially possible (and hence is partially determined by the suppliers of information). Even if he is averse to risk, he will almost always take some risk in the adoption decision. In fact most early adopters may have a strong preference for risk.

The demand for information is derived from the subjective judgments of farmers and the understanding that information will enable them to generally make fewer mistakes and to produce at lower cost. This demand will be very limited in a situation where little experience with new factors of production has taken place. The traditional farmer in a community where few techniques of value have been available should not be expected to be a demander of information. Extension programmes with little substance to extend do not find

a receptive audience. On the other hand, when new techniques are available, farmers demand a great deal of information. In a situation of rapid change it is almost impossible for the extension workers to keep up with the flow of information. Progressive farmers often find that their experience with new techniques and with private suppliers leads them to conclude that the often poorly trained extension worker has little to offer. He then turns to the researcher as a source of information. This experience is quite common in regions where the "green revolution" wheat and rice technology is being adopted.

This is not meant to imply that the information suppliers, be they public extension agents or the agents of private input supply firms cannot perform an important function. The productivity of this activity does depend in a very crucial way on the availability of new techniques, and in a long run sense on a more or less continuous stream of new techniques becoming available. To be sure, in the early stages of change they play a crucial role in developing an awareness to change and an understanding of the technical features of production activity. They also play a key role in providing "feedback" information to the researchers. In a dynamic setting, information suppliers and producers also can create some new techniques. Farmers are likely to be doing some inventing or sub-inventing by adopting techniques to their special set of producing conditions. Change agents can participate in this process and convey information from it to other producers and to researchers.

Recent studies of the role of education as a factor of production have (Welch (16) and Chaudhri (4)) shown that the economic value of the education of the farmer is also closely related to the availability of new techniques. Education is viewed in these studies as having two possible effects on the productive capability of its recipient. The first is the skill or worker effect. It is simply the learning of particular skills or abilities to perform tasks. The second is the "allocative ability" effect. It is the capacity to process information and to make decisions which enable efficient or minimum cost resource use. Formal education, of course is not the only procedure for acquiring either skills or allocative ability. In fact, most farming skills are learned in the family and on the job. In a traditional setting, allocative ability is relatively unimportant. Through a long process of trial and error, the traditional methods of production are quite likely to be the most efficient.8/ Traditions are also learned predominantly in the family.

Under conditions of change, decision making capabilities become important. Allocative ability requires the ability to communicate in a relatively efficient language. Literacy should be important in this sense. In addition, decision making requires some orderliness of the organization of concepts and information. Formal education, and perhaps especially primary education, can thus serve to create capabilities that are of economic value. Education is both a complement to and a substitute for the services of the information

8/ T.W. Schultz (13) in his classic Transforming Traditional Agriculture develops the case for efficiency in traditional agriculture.

supplier. Extension and education are complementing in that education improves the efficiency of communication and the use of information. They can be substitutes in that information suppliers do (and should) partially process information by presenting it in simple and reliable form. In this sense they perform part of the task that education enables farmers to perform. 2/

We turn now to the touch stone; the availability of the new techniques or final research output. It has already been noted that one region or country may simply borrow them from another region. This borrowing is limited by the specificity of the techniques to the particular soil and climate conditions and factor endowments where they were created. Of course, it may be sensible for a particular region to borrow from other regions even if the techniques are specific to conditions which differ somewhat from the conditions in the region in question. This is the cheapest way to get available techniques. Unfortunately, it is not a realistic option for most countries for the simple reason that few countries have a reliable source of this kind of "spill over" supply of new techniques. Either the specificity of the technology prevents it or investment in the creation of techniques which it might use is not taking place. We have already noted the paucity of research investment in the tropics and sub-tropics.

Most regions consider the option of creating most of their techniques instead of simply borrowing them. This does not mean that they do not borrow, only that they do not borrow final research output. In general, not all techniques will be indigenously created, as producers will adopt the best technique without regard for its origin. In fact the decision to indigenously create particular techniques rather than borrow them has a peculiar property. The price a region pays for pursuing the strategy of indigenous creation of techniques is that it gives up the option of borrowing, at low cost, from other regions.

The creation of these new techniques is the direct object of researchers specializing in applied or final product research. Their activity is a combination of searching (in an experimental sense) and learning or borrowing knowledge from other sources in an attempt to improve the conditions of search. Some of the pertinent features of research are reflected in the "economics of information" models in economic literature (Stigler (14)). While somewhat artificial, they do provide an analytic framework. The basic feature of models of this type is quite simple. It is supposed that an individual researcher, or a particular group of researchers, commands a well defined set of information or stock of knowledge at a particular point in time. This stock of knowledge essentially defines a distribution of potential new techniques or final research output. Holding constant this stock of knowledge, researchers are constrained to searching within that distribution.

2/ On balance, education is probably complementary to extension, except in economics with relatively high levels of education. See Evenson (8) for some evidence of the substitution relation.

The ordered statistic relationship or the expected maximum value of the new techniques discovered then becomes a kind of partial research production function sharing the relationship between research effort and expected research output. As Stigler and other (14) have shown, the expected maximum value of the potential findings (not the expected value, since the only findings of value are those which are superior to those already known), the higher is the mean and standard deviation of the distribution. Also for all of the usual distributional forms the marginal productivity or the expected contribution of additional research is a diminishing function of the search effort.

Of course, the final product researcher will not be content to simply search and will generally attempt to add to the stock of knowledge which determines the potential research output. That stock will include new techniques produced in other regions, and intermediate research findings. The components of the stock may be tangible, as with plant breeding stock or research equipment, or intangible, as with experimental design concepts. We have noted that almost all final research products or new techniques have some degree of specificity to soil, climate, crop, and factor price conditions. The same holds true for intermediate research products, though to a much lesser degree. The extent to which the stock of this knowledge held by a particular group of researchers, depends on the effort devoted to learning, the capacity to learn, and most importantly, changes in the stock which is worth learning from their point of view.

The model is summarized in this simplified form as follows:

$$(1)\quad E(P_{it}) = F(R^F_{it}, o_{it}, \bar{X}_{it})$$

$$(2)\quad o_{it} = G(K^F_{it}, K^I_{it})$$

$$(3)\quad \bar{X}_{it} = H(K^F_{it}, K^I_{it})$$

$$(4)\quad K^F_{it} = L^F_{it} + (1 - o)\, K^F_{it-1} = W(L)\, L^F_{it}$$

$$(5)\quad K^I_{it} = L^I_{it} + (1 - o)\, K^I_{it-1} = H(L)\, L^I_{it}$$

$$(6)\quad L^F_{it} = J(P_{it}, R^L_{it}, K^{F*}_{it})$$

$$(7)\quad L^I_{it} = K(R^L_{it}, K^{I*}_{it})$$

Equations 1 - 3 simply state that expected productivity, gains (ignoring the adoption process) in country or region i in time period t, are a function of direct research effort, R^F_{it}, and the parameters of the distribution of potential new techniques o_{it} and $\bar{X}_{it}$. These parameters are related to the stocks of knowledge held by the researchers regarding final and intermediate knowledge. Equations 4 and 5 simply state that these stocks will change over time because of learning, L^F_{it} and L^I_{it}, and will decline because of depreciation

and obsolescence (1 - a). These stocks are thus a distributed lag function of present and previous learning, much of which might have taken place in graduate study, for example. Learning is posited in equations 6 and 7 to be a function of directed efforts to learn, R^L_{it}, and available stocks, K^{F*}_{it}, K^{I*}_{it}, to learn about.

This model may appear to be extremely artificial, but with some further clarification and enrichment it can be made more meaningful. For example, the search aspects of the model can be supported with some evidence. Note that a group of researchers may be quite competent and able to use sophisticated research tools in their work and still become subject to the diminishing returns from search, because K^F_{it} and K^I_{it} change very slowly. If, for example, K^F_{it} and K^I_{it} did not change through time, such a group would find that diminishing returns to learning would make it difficult to add to K^F_{it} and K^I_{it} and that diminishing returns to search would limit final research output. Situations of exhausted potential are not uncommon in research experience.

The development of improved varieties of sugar-cane illustrates and supports the features of the model. Prior to 1920 or so, the cane breeding programmes throughout the world were based upon simple crosses of a number of commercially important parent varieties of a single species. With relatively fixed breeding stocks and a relatively fixed research methodology we would expect the search situation to hold and consequently to observe significant diminishing marginal productivity to research. This testable implication of the model is supported by some evidence. The Barbados station in the British West Indies, for example, produced 10 commercially important varieties from 1890 to 1910. This declined to only 1 from 1910 to 1920. In the 1920's a major advance in K^{I*}_{it} occurred when the experiment stations in Java and India developed the "nobilization" or interspecific hybridization breeding programme. Barbados was late in learning about this methodology and did not introduce it until 1920. From 1929 to 1939, both breeding programmes were used. The exhausted "noble" programme yielded 4 commercial varieties, only one of which was of major importance. The nobilization programme yielded 12 varieties of major commercial importance, seven of them coming in the first few years of the new programme. With the same selection methods the exhausted programme yeilded one commercial variety per 40,000 seedlings tested. For the new programme, the ratio was 1 in 1,500 for the first seven varieties and 1 in 2,500 for the next five. (1).

I believe a considerable amount of additional evidence could be brought to bear on the search question. In some sense, the most important feature in the model is reflected in equations 6 and 7. Learning possibilities for a small country may be largely exogenous to the country. If the stocks K^{F*}_{it} and K^{I*}_{it} do not change because the research investments to change them are not being made, a small country will be able to do little about it. Again, it should be emphasized that the specificity of both the final and intermediate research output determines the size of the borrowable stocks. A large number of new techniques have been created over time in the agricultural sectors of many countries. It is probably true, however, that the specificity of the techniques makes very few of them of any relevance to the contemporary African setting.

The existence of borrowable intermediate research knowledge, K_{it}^{I*}, is perhaps of more policy relevance than K_{it}^{P*} for African countries. The larger is K_{it}^{I*}, the more sensible it is to pursue a research investment programme oriented to applied or final product research. I would hypothesize that in fact K_{it}^{I*} is relatively small for the entire tropic and sub-tropic regions of the world. The research on soils, water supplies, plant physiology and phytopathology in these regions is generally limited.

The specificity in the model is also testable and I am attempting to devise such tests for a number of crops at the present time. Preliminary results using wheat production data support the specificity hypothesis. The results are very tentative, but in view of the strong statistical support for the specificity hypothesis a summary is of interest.

Table 3 summarizes 4 alternative regressions of wheat yields from 64 countries and 21 years on several variables constructed from data relating to wheat oriented research. The number of scientific papers on wheat breeding and related agronomic work has been calculated from the journals, Plant Breeding Abstracts, and Field Crop Abstracts. These journals have been abstracting and classifying the world's literature for many years. The measures used do not reflect actual wheat research inputs, but are a good measure.

The model is basically a stock or "level" relationship and is consistent with the analytic framework developed here. The inclusion of dummy variables for countries essentially converts the dependent variables, yields, into yield derivations from each country's mean yield level. All variables have the expected sign (except for 6) and the estimated coefficients are several times their standard errors in all cases. It should be noted that we do not have a fertilizer variable for wheat by years. This will bias the results to the extent that fertilizer use is correlated with research.

Perhaps the aspect of these results of most interest is the significant relationship of the regional research variables and wheat yields. Two concepts of regions are developed here. The first is the micro-region relevant to indigenous research effort. Lacking other information this is taken to be proportional to wheat acreage, hence variable 3, the indigenous research variable is deflated by acreage. The second is the regional constraints to borrowing, i.e., the region which defines borrowable research. These were defined as the Koopen climate regions used by geographers (15). A total of 11 climate regions are thus defined and used to calculate the regional research variables. The number of regions (plus an adjustment for regions of unequal size) in each country is used to deflate these variables.

The regional variables are of the form:

$C(1 - {}^{-P_i/n})$ CRP/N. The interaction term SR is the borrowing term. [10] In this form S measures the amount of borrowing from the rest of the region

10/ Instead of Plant Breeding Abstracts data, the more agronomy oriented Field Crop Abstracts data were used in the borrowing specification. The two series are highly co-related.

that would take place without indigenous effort, P_i/N. In these tentative results this turns out to be surprisingly high 88 per cent. Note in regressions 3 and 3 that the papers produced in regions outside the defined regions are not positively related to yield levels. Obviously, these results are very tentative.

Table 3. Standard derivatives in parentheses

Regression	1	2	3	4
Constant	2.24	13.38	2.45	13.08
1. Time	.262 (.019)	-.107 (.056)	.354 (.032)	.217 (.084)
2. Area	-.00013 (.00001)	-.00013 (.00003)	-.0005 (.00001)	-.00020 (.00003)
3. CP/A	15.25 (1.23)	15.60 (3.32)	15.42 (1.23)	15.86 (3.30)
4. CRP/N	.00042 (.00006)	.00287 (.00014)	.00048 (.00006)	.00304 (.00014)
5. SR	-.00005 (.00001)	-.00046 (.00003)	-.00005 (.00001)	-.00044 (.00003)
6. WP			-.00042 (.00012)	-.00140 (.00029)
7. Country dummies	Inc.		Inc.	
R^2	.9073	.2974	.9082	.3099
F ratio	909	111	857	98

Definitions:

Dependable variable: yield of wheat per acre

1. Time - measured in years
2. Area - acres harvested wheat
3. CP/A - Scientific publications abstracted by Plant Breeding Abstracts, cumulated to time t, divided by average acres harvested.
4. CRP/N- Scientific publications, (PBA) cumulated to time t, for the region in which country i is located minus the publications of country i. (Countries which have more than one region are appointed to regions on the basis of acreage) divided by N, where N is the number of regions plus the variance of the regional share in country i $(ni - \bar{n})^2$.
5. SR - $\int_0^t e^{-P_i(s)} CRP/N(s)\, ds$, where Pi is the current number of papers in Field Crop Abstracts in country i.
6. WP - cumulated number of papers (PBA) for world minus country i's papers.

Further work is planned with alternative definitions of regions and with other distributed lag formulations to test for depreciation of knowledge. Other crop yields will be tested in a similar fashion. It will be possible to include fertilizer data in a specification for all crops and expenditure and numbers of research data will be utilized as well. Here we note only surprisingly significant relationships between research and yield in a crop, where prevailing mythology holds that the only major change has come from a "green revolution".

A final point on the aspects of the framework. New techniques, the sought after final research products, may be quite complex in nature. In certain cases, as with a crop variety, a technique can be expressed as a weighted sum of several components, the weights being implicit prices. For example, a plant has characteristics of disease resistance, fertilizer responsiveness, drought resistance, ease of mechanical harvest and others as well. The value of the plant variety will depend on the relative values of the characteristics. For example, if fertilizer prices decline, as they in fact have, the value of fertilizer responsiveness and related characteristics such as lodging characteristics will change. This calls for a change in the search strategy placing more emphasis on the now more valued characteristics. As Hayami and Ruttan (10) have argued, responsiveness to changes in prices and technical conditions are extremely important sources of productivity gains.

Policy issues

This review of economic studies and development of formal models, is not adequate to do more than suggest some major, and probably obvious, conclusions. Hopefully it suggests some avenues of information collection which can serve to improve allocative efficiency in research and extension investment. The following statements reflect the implications of the models presented here and the rather limited information about the contemporary African setting that I have.

1. There is a clear ordering of investment priorities which derives from the asymmetry regarding the interdependency between research, extension and education. The value of extension effort (and education, to a lesser extent) depends critically on the availability of research results. The value of research results depend to a much lesser extent on extension, since profitable new techniques will be adopted albeit at a slower pace, even without extension. The pursuit of massive extension programmes when there is nothing to extend not only wastes scarce resources, it destroys the credibility of the extension service, thus hampering its effectiveness when it does receive techniques worthy of extension.

2. In the early stages of transition from traditional agricultural forms of production, the adoption process is more difficult and the role of education and extension in changing attitudes for purposes other than immediate productivity gains may be important. The pursuit of massive extension and education programmes, for these reasons, means that the marginal pay-off to research or borrowing is much higher as a result.

3. Perhaps the major policy issue in technology creation focuses on the specificity of the techniques created. The more specific the techniques the less sense it makes to pursue either a simple borrowing strategy or an "adoptive" research programme. The evidence supports the existence of a considerable amount of geographic specificity. An individual country will generally find that its prospects for rapid productivity achievement will be governed heavily by the region-specific final products it can borrow and by the region specific intermediate products that it can build indigenous research programmes on. Investment decisions by individual countries, each acting in its own best interests, will not result in an optimum investment policy from the point of view of all countries (unless the specificity is very high). This is because each country will invest to the point where the expected return to the country is equal to the expected return on alternative investments. The global optimum requires that investments be made such that the return to research to all recipients of research benefits be equated to returns on alternative investments. This, of course, is the argument for regional research co-operation. It is an extremely important argument.

4. The creation of what we have called region specific intermediate knowledge is very possibly the most critical to the realization of sustained productivity advance in the African countries. It is also the type of research to which the regional research argument applies most consistently. In addition, the conduct of this research is most affected by economies of scale, that is, researchers are more efficient in producing this knowledge the larger is the institution in which the research is conducted. 11/ A powerful case for investment in strong regional (or national in the case of the larger countries) research centres oriented to the production of intermediate research knowledge in the service fields exists. The "International Institutes", are providing some of this work, but many such centres are required.

5. The crucial contact between final product oriented researchers and intermediate product researchers argues that the intermediate research institutions should not be isolated from the applied final product research. Nor should extension workers be organized in such a way that they are isolated from the researchers. The forces which result in the isolation of these activities are very strong; different government agencies may be involved, intellectual snobbery on the part of discipline-oriented researchers and a general lack of understanding the importance of these interactions. Great organizational skills are required to achieve the research productivity potentially available with the proper mix of activities.

6. The training of researchers is crucial. The graduate school facilities of the high income countries are generally available, and should be taken advantage of in the short run. The framework of this paper, however, suggests that the value of this training is of less value than might be supposed. A great part of graduate training is of less value than might be supposed. A

11/ For a discussion and some evidence on the economies of scale to research conduct see Evenson ( ).

great part of graduate training is the mastery of a body of intermediate knowledge. As we have noted this is lesser value to the extent that it is specific to other regions.

A further bit of theory can be brought to bear on the graduate study policy. The "brain drain" literature has shown that the production of brain through graduate study is a relatively labour time intensive activity. In the long run those regions with the most abundant labour time should have the comparative advantage in their production. Few countries with abundant labour time have moved to exploit this comparative advantage. Of course it requires a considerable amount of intellectual capital, but producing value added in graduate students and intermediate research knowledge are highly complementary products. Long run investment strategy calls for the building of graduate study centres as an integral part of the centres emphasizing the production of intermediate knowledge.

7. Research programmes should anticipate as best they can, changes in the prices and form of related inputs. Plant breeders, for example, should alter their selection procedures in response to lower fertilizer prices (which will probably decline much more in Africa) by giving fertilizer responsiveness much more weight. Likewise, the introduction of improved machines, will alter programmes.

8. Most African countries have had research programmes which concentrated on export crops such as cocoa, tea and sugar. Many have been productive. The shift in emphasis after independence from colonial powers have been toward other crops, especially the good grains. The potential in these crops is large and the shift in emphasis consistent with economic theory. That is, the larger the number of units over which a new technique can achieve cost reductions, the larger the value or benefits to be derived from research creating the new technique.

9. Ex Post studies of research experience are of course of limited usefulness for research planning. They cannot really be used for microplanning at the project level. This kind of planning is best achieved by seeking access to as much technical information from the bench scientists as possible. In general, effective research organizations have given competent researchers freedom to pursue studies which the researchers felt would have the highest pay-off. It is very easy to overdirect or over-plan research at the micro-level. In the context of our framework, this is a hampering of the search-learning process. The model predicts lower pay-offs in the presence of most restrictions.

On the other hand, research can be directed at a somewhat more aggregate level without inhibiting the individual researcher. Decisions with respect to who is hired, and emphasis on fields of training allow research administrators to shift the allocation of resources between fields without hampering individual effort. The experience of other research programmes can give valuable insights and allow the achievement of a productive "mix" of research, extension and teaching resources.

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COST AND RETURNS: A STUDY OF UPLAND PADDY PRODUCTION UNDER TRADITIONAL FARMING CONDITIONS IN THE EASTERN STATE OF NIGERIA

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INTRODUCTION

The modernization and expansion of food crops production have become important features of Nigeria's agricultural policy since the 1962-1968 economic plan period. 1/ With the change in policy, the Western Nigerian Government, like most governments in the country, has campaigned for the rapid development of the rice industry. In spite of the campaign, not much appears to be known about the economics of rice production among the myriad of small farmers 2/ (who constitute the dominant agricultural producers in the area) to justify the implicit exhortation to farmers to risk their limited resources for rice production. The gap in knowledge encouraged a survey to be mounted on the industry in the Eastern State in 1969. 3/

The main objective of this paper is to examine the economic basis for the current policy towards rice production in the Western State by use of the 1969 survey information. From the examination of the results, efforts will be made to suggest measures for improving the level of efficiency of paddy production.

I. METHOD OF STUDY

Our approach in this paper is primarily analytical. Costs, returns and subsequent determination of profits will be analysed from the farmer's point of view. The approach is based on the assumption that the farmer desires to optimize his farm income within the limits of his environmental constraints. A prerequisite for the ideal situation is that every enterprise on the farm should be profitable.

1. Specification of costs and returns elements: The major operations required for transforming the various elementary factors of production into the product paddy (unhusked or rough rice) under the prevailing "slash

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1/ The strong emphasis on food production is clearly indicated by the FAO experts who were commissioned to advise on agricultural development in Nigeria. Vide FAO, Agricultural Development in Nigeria, 1965-1980, Rome, 1966, pp. 19-24. Before 1962-1968, official policy mainly favoured the expansion of the export crops industry.

2/ The 1962-1968 plan for food crop production was handled in a rather vague way as there was insufficient agricultural data. The chief architect of the 1962-1968 Nigerian National Development Plan, Dr. Stolper, indicated that "Planning Without Facts" was most evident in the agricultural sector.

3/ The directors of the project are Drs. Osifo and Anthonio, University of Ibadan.

and burn" technology 1/ in the Western State are, land preparation (including underbrushing, felling of trees, burning and clearing of the farm), planting 2/ (at stake), fertilizer application (by an insignificant number of farmers), pest control (especially birds), weeding (once or twice), harvesting (including transportation) and threshing. The elementary factors of production required include the following: labour, fertile land, adequate climate,,seeds, fertilizers, chemicals (including 'black magic' for scaring away birds), implements (including cutlasses, hoes, axes, harvesting knives, baskets).

We employed the following definitions and conventions in order to simplify the problems of measuring the factors of production and product:

(a) Labour (excluding management) was broadly divided into family and hired categories. Under each category is the sub-division to adult male and female (who are over 15 years) and youths (who are less than 15 years). Labour input for each operation was measured in hours. Aggregation of labour inputs was done after converting adult female and youth-hours into man-hours. 3/ The aggregate labour input was valued at the model wage rate which was effective among the farmers in the areas under study in 1969. (The observed modal wage rate during the 1969 rice growing season was 5 shillings per day.)

(b) Land was measured in acres. The rationale for the method was the assumption that rice land in the sample area was homogeneous. This convenient assumption was adopted because we lacked the resources for standardizing the basic variations in potential land inputs. In other words, there was no reliable means for differentiating the various soils in our sample area.

(c) Capital: Here we were mainly concerned with the direct expenses (for paddy production) and the part of the fixed cost elements in the farm that could be imputed to paddy production. The various elements of fixed cost were valued at their prices in the market nearest to the farmer. In regard to the fixed cost elements, capital consumption was computed by the

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1/ The only important innovation accepted by some traditional farmers in our sample is the acceptance of improved seeds (O.S.6) for planting. An insignificant number of farmers applied fertilizers to their rice farms.

2/ Upland rice is mainly grown as a sole crop in Abeokuta Circle. The practice of sole cropping makes the estimation of costs and returns an easier task than if mixed cropping had been adopted. Sole cropping was practised in all our sample farms.

3/ Following the Ministry of Agriculture and Natural Resources (M.A.N.R.), Western State, one youth or female-hour was held equivalent to two-thirds man-hour. A working day is equivalent to 8 hours.

straight line depreciation method. The annual depreciation figure for each element was further divided by the number of farm enterprises in which the particular implement was used in order to derive the estimate of capital consumption. The summation of the adjusted depreciation figures for the recognized elements of fixed costs gave the required capital consumption figure for paddy production. (We did not include the valuation of buildings in computing the depreciation figures.)

(d) Management: No attempt was made to measure this highly qualitative factor.

(e) Output: The product of the transformation processes which were mentioned earlier is paddy. The product from a sample farm was valued at the model producer price for paddy just after the harvest period in 1969. The price just after harvest was used in order to avoid the complications of value added due to storage and related factors. (In 1969, the model producer price after harvest season was 5 pence per pound weight of paddy.)

2. Sources of data: The farm records technique was adopted for collecting information on specified elements of costs and returns from 211 sample farmers distributed over the important paddy growing areas in the State. The compilation of the farm records for the largely illiterate respondents was made possible through the agency of specially trained staff (including 20 field assistants and two supervisory senior field assistants), who are normally extension workers in their various locations. The field staff assisted the farmers to make entries on the following rice farm records: cash, daily labour analysis, valuation, output and use of rice books. To avoid memory lapses, a field assistant visited each farmer once or twice a week throughout the production period. The special teams of field staff were commissioned to measure and record the acreage of the rice farms and output from the sample farms.

3. Sampling: On the basis of reports 1/ and our discussions with Senior Executives of the Western Nigeria's Ministry of Agriculture and Natural Resources, we identified the important rice growing areas of the State. With the assistance of the various agricultural officers, we obtained a census of all 1968 rice farmers, by location in scheduled areas (including Egba, Egbado, Ijebu Remo, Oyo North, Ekiti, Akoko and Ilasha (divisions). We decided on a sample size of 2.5 per cent of our universe after taking our staff position into account. The chosen number was then proportionately allocated to the various divisions where rice was grown in the State. Within each division, the quota was allocated on a proportionate basis to the rice growing villages. The actual choice of sample farmers, was left in the hands of the field staff who were requested to select willing rice farmers with stable rice farming business. The

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1/ The reports were prepared by some senior executives of the Western Nigeria's M.A.N.R.

sample was randomized as far as possible in the various locations.

Comments on method of study

First, the enterprise costs and returns for a single crop in the farm is unrealistic, as it does not give an indication of the income position of the whole farm. A rational farmer is perhaps more interested in his overall farm income position rather than in the maximization of returns of a single enterprise in the farm.

Secondly, the derived financial position of the rice enterprise is rather arbitrary as a substantial volume of inputs for production is not paid for. For example, the estimated cost of production is dependent on the imputed values of inputs not paid for like, family labour, family owned land, etc.

Thirdly, the supply of some of the factors of production is rather institutionally determined than by economic factors. The position is especially so in respect of family labour and land. The rather inflated farm labour wages in Egbado and Egba divisions are largely due to the institutional restrictions on labour mobility in the country. At this phase of Nigeria's development, various ethnic groups have limited capacity for absorbing 'alien' labour from other populous ethnic groups. Many youths are practically excluded from operations in the rice industry because they "migrate" to schools.

Despite those factors, there is still a case for obtaining information on the economic factors affecting the rice industry. A good impression of some important economic circumstances of the industry can suggest whether there is wisdom in encouraging scarce development resources for expanding and modernizing the industry.

II. RESULTS

The findings which are presented below are based on the analysis of data from 32 farms in Wasimi and Ilaro areas of Abeokuta Circle of the State. We could not secure sufficient data for other sample farms for certain reasons including the following special factors: First, the orderly collection of information in many sample farms was seriously disturbed by the 1969 political upheavals in various parts of the Western State. Many of the field staff were obliged to move out of their normal operational areas while the disturbances lasted. And secondly, some field assistants 1/ were interrupted by other special duties which prevented them from giving full attention to the rice economic survey in the State.

1/ The field assistants were drawn from the Western Nigeria's Ministry of Agriculture and Natural Resources extension staff. Although they were deployed on the economic survey, they were still called upon to carry out some of their previous extension duties. Some were even transferred away from their original locations.

Table 1 presents the profiles of average costs and returns of producing paddy per acre and an examination of the costs and returns structure.

Table 1 (a). Costs and returns on producing paddy per acre in two areas of Abeokuta Circle

(in shillings)

Items	Wasimi a/	Ilaro b/
Variable costs:		
Seed	18.1	17.6
Labour (a) family	282.4	268.0
(b) hired	205.4	161.0
Interest on operating capital c/	16.3	13.2
Others d/	40.1	18.8
Sub-total	562.3	478.6
Fixed Costs:		
Depreciation on equipment	7.2	5.3
Total costs	569.5	483.9
Average yield in lb.	1763	1787
Gross returns e/	734.6	744.6
Net returns (including returns on land, management)	165.1	260.7

a/ The entries in this column are based on the average for 22 farms.

b/ The entries for Ilaro column are based on the average for 10 farms.

c/ The rate of interest of 8 per cent (charged by commercial banks) was used for the calculation.

d/ Others include fertilizers, pesticides, etc.

e/ The average yield is valued at 5d per pound weight of paddy; 5d was the modal producer price for paddy after harvest in 1969.

The table indicates that paddy production was profitable in Wasimi and Ilaro areas. The net returns per acre in Ilaro (261 shillings) higher than the returns for Wasimi (165 shillings). The equivalent statistics for O.S.6 1/ variety of rice are presented in Table 1 (b).

1/ This is the improved variety of rice which the M.A.N.R. is distributing to farmers in the State.

Table 1 (b). Costs and returns on producing O.S.6. paddy per acre in two areas of Abeokuta Circle

(in shillings)

Items	Wasimi[a]	Ilaro[b]
Variable costs:		
Seed	18.1	17.6
Labour (a) family	282.4	288.0
(b) hired	205.4	161.0
Interest on operating capital c/	16.3	13.2
Others d/	40.1	18.8
Sub-total	562.3	498.6
Fixed costs:		
Depreciation on equipment	7.2	5.3
Total costs	569.5	503.9
Average yield in lb.	1767	1853
Gross returns e/	736.4	772.1
Net returns (including returns on land, management)	167.1	268.2

a/ The entrics in this column are based on the average for 21 farms.

b/ The entries for Ilaro farms are based on the average for 7 farms.

c/ d/ e/ Same as for Table 1 (a).

The dominant item of cost is that for labour inputs, which accounts for over 86 per cent of the total cost of producing paddy in either Wasimi or Ilaro. The implements (fixed cost elements) account for less than 1.3 per cent of total costs.

In Table 2, the importance of the cost elements is indicated by the (elements) absorption of the value of gross output. The dominating position of labour input in the cost structure is also confirmed.

The modal cost of producing a pound weight of paddy among the sample farms is 3.5 pence. (See Table 3 (a) for the distribution of costs of producing a pound weight of paddy among sample farmers.

Table 2. Percentage of input values to gross output of paddy by area

Area	Labour	Seed	Other operating costs	Depreciation on equipment	Total costs
Wasimi	53.7	2.0	2.9	0.8	59.4
Ilaro	48.9	1.9	1.8	0.5	53.3

Table 3 (a). Distribution of costs of producing a pound weight of paddy among sample farms

Cost of producing a pound weight of paddy in pence	Wasimi (Number of farmers)	Ilaro (Number of farmers)	All areas
1.01 - 2.0	3	3	6
2.01 - 3.0	5	2	7
3.01 - 4.0	9	2	11
4.01 - 5.0	1	2	3
5.01 - 6.0	4	1	5
	22	10	32

This modal cost of producing paddy in Abeokuta Circle under upland conditions does not compare badly with estimated costs of paddy production in selected main rice growing areas of Nigeria and countries like Sierra Leone, the Philippines and Pakistan. Vide Table 3 (b).

The modal cost of producing paddy in the area studied was much higher than the average cost (of 1.9 pence per pound weight of paddy) that was derived from the three least cost paddy producers in either Wasimi or Ilaro. A cost figure of 6d per pound weight of paddy has been quoted by the M.A.N.R., Abeokuta source in 1965.

Table 3 (b). Costs of growing paddy in selected countries

Year	Kind of rice situation	Country and area	Cost of paddy per pound weight (in pence)
1962[x]	Swamp (rainfed)	Nigeria-Abakaliki	4.2
1966[x]	Irrigated	-Bida	3.3
1964[x]	Swamp (flood plain)	-Ilushi	4.3
1969	Upland	-Abeokuta	3.5
1966[x]	Swamp (transplanted)	Sierra Leone	2.0
	Swamp (broadcast)	" "	3.7
	Upland	" "	5.8
1966-67[xx]	Irrigated (IR-8)	Philippines-Baliuag	2.4
1967[xxx]	Irrigated (IR-8)	Pakistan-Comilla-Tona	2.2

Sources: x United States Department of Agriculture and USAID, Rice in West Africa, Washington, 1968, pp. 138, 159.

xx E.U. Quitana and R. Barker, The Seminar-Workshop on the Economics of Rice Production, International Rice Research Institute, December 1967, pp. 1-33.

xxx H. Anwarul, Costs and Returns: A Study of Irrigated Winter Crops, Comilla, Pakistan 1968, p. 76.

Table 4 indicates the effect of scale factor on the output, costs and net income according to farm size by different areas.

The data suggest: (a) decreasing costs of production per acre with increase in farm size; (b) gross output per acre varies directly with increasing farm size to 3.0 acres; diminishing returns appear to set in after the 3.0 acre farm; (c) net income is a rising function of farm size.

The observed average labour input required per acre for paddy production in either Wasimi (88 man-days) or Ilaro (81 man-days) compare well with the 85 man days which have been suggested as the ideal labour requirement for paddy production per acre in the Circle by the Ministry of Agriculture and Natural Resources, Abeokuta staff. 1/ Table 5 (a) shows the distribution of average labour per acre among various operations in two areas studied.

Table 4. Gross output, costs and net income er acre by farm size by area

Area	Size group (acre)	Number of farms	Average size of farm (acre)	Average output per acre (shillings)	Average total cost per acre (shillings)	Net income per acre (shillings)
Wasimi	Up to 1.00	12	0.69	710.3	639.2	71.1
"	1.01-2.00	7	1.27	723.8	417.5	306.3
"	2.01-3.00	2	2.52	779.2	356.9	422.3
"	3.01-4.00	1	3.75	708.3	237.6	470.7
Ilaro	Up to 1.00	2	0.87	606.7	508.6	98.1
"	1.01-2.00	4	1.44	731.9	480.9	251.0
"	2.01-3.00	3	2.73	867.5	453.7	413.8
"	3.01-4.00	1	3.63	683.3	198.1	485.2

The labour requirement for paddy production in the areas studied is compared with the situation in selected paddy growing areas of Nigeria, Pakistan and Sierra Leone, Table 5 (b).

Table 5 (a). Distribution of average labour required for upland paddy production per acre in Abeokuta Circle

Operations	Labour required in Wasimi (man days) (1)	Labour required in Ilaro (man days) (2)	Percentage distribution for (1) and (2)
Land preparation	33.1	28.7	36.5
Planting	3.9	7.8	6.9
Weeding	17.5	13.7	18.4
Harvesting	24.3	27.4	30.6
Threshing	7.4	3.7	6.6
Others	1.7	-	1.0
	87.9	81.2	100.0

Table 5 (b). Labour requirement for paddy production in selected areas

Year	Kind of rice situation	Country and area	Labour required per acre (man-days)
1962[x]	Swamp (transplanted)	Nigeria-Abakaliki	82
1966[x]	Irrigated	-Bida	73
1969	Upland	-Abeokuta	84
1966[x]	Upland	Sierra Leone	223
1967[xx]	Irrigated (IR-8)	Pakistan-Comilla-Tona	69

Sources: x United States Department of Agriculture - USAID, Rice in West Africa, op. cit. pp. 138, 159.

xx H. Anwarul, op. cit. p. 73.

Simple indices of productivity were developed for land and labour in Table 6. When returns per man-day in either Wasimi (8.4 shillings) or Ilaro (9.2 shillings) is compared with the modal wage rate of 5 shillings, the enthusiasm among the rice farmers for expanding paddy production can be understood.

Table 6. Gross output unit of land and labour (average of all farms)

	Wasimi	Ilaro
1. Output per acre (shillings)	735	745
2. Labour input per acre (man-days)	88	81
3. Output per man-day (shillings)	8.4	9.2

SUMMARY AND CONCLUSIONS

In Wasimi and Ilaro areas of Western Nigeria, the results of the costs and returns analysis support the hypothesis that upland paddy production is profitable under the traditional small farmer conditions. On account of the dominating position of labour in the cost structure, the pattern of imputing labour values has much influence on the decision on profitability.

It is pertinent to observe that the main innovation by the majority of the farmers in the sample is the acceptance of improved seeds for planting (28 out of 32 sample farmers in Wasimi and Ilaro planted O.S.6. paddy instead

of the local planting material). Only one of 32 farmers applied fertilizers to his land. The adoption of a single innovation contrasts with the package of technology which many professional agricultural scientists in Nigeria insist on as important for improving efficiency in the production of paddy.

Despite the observation that paddy production is profitable in the areas studied, there is evidence to suggest that there is room for improving efficiency in the industry. First, there are indications that farmers can experience increasing returns to scale if individual farm acreage can be expanded to three acres. (In 1969, over 50 per cent of the rice farmers in our sample had farms of less than one acre.) But there is need to investigate the general resources' availability and use position for the whole farm, before possible gains from increasing returns to scale in the rice enterprise can be exploited. Secondly, the technology adapted for paddy production is usually not fructified with capital. More injection of capital input (especially in the form of fixed assets) can improve the productivity of labour. Thirdly, the average cost of producing paddy is relatively high compared with costs of production of the six least-cost producers (in Ilaro and Wasimi) and efficient rice producing countries like Philippines, Pakistan, etc. The conclusion is that there is room for more efficiency in mobilization and allocation of resources for paddy production. The key factors to be taken into account in reducing costs, include the following: adoption of further elements of improved technology and organization, which will enable available resources to be better combined for paddy production.

The fact that paddy production is profitable is, however, not the only information required for the development of a good farm plan. Other farming enterprises have to be similarly studied before information can be collected to facilitate a rational decision about the level and pattern of farming that will optimize the farmer's income. Deductively, the Western Nigerian policy-makers need to be cautions on the extent to which they stimulate rice producers to transfer more of their scarce resources to the industry, until more is known about rice enterprise relative to other farm enterprises, in the rice growing areas of the Western State.

SOME ASPECTS OF RURAL EMPLOYMENT IN ARAB REPUBLIC OF EGYPT— AGRICULTURE UNDER PREVAILING FARMING CONDITIONS

By A. A. Eltonbary, A. A. Goueli and
N.T. Habashy

The ratio of labour force differs in any society from time to time according to social, economic and political circumstances. It is practically impossible to estimate a constant ratio of labour force with respect to the whole population. The ratio of human resources to other natural resources is an indicator to the economic position for a particular country. The position of a developed economy for a country can be realized when the ratio of natural resources to human resources is higher. The available labour force is an estimate for the supply of this resource. The requirements of labour force is an estimate for the demand side of this resource. The balance between the demand and supply for labour force indicates the economic position of the country.

The current study aims at the estimation of agricultural labour force and rural unemployment under Egyptian farming conditions.

The available agricultural labour force:

The available agricultural labour force is estimated at about 4.4 millions in 1960 representing about 59% of the total labour force in all economic activities. In 1968 the agricultural labour force was estimated at about 4.2 millions representing about 53% of the total labour force in all economic activities. The ratio decreased by about 6% in 1968 as compared with 1960 (Table I). Such decrease was due to the industrial development which took place in Egypt during that period, resulting in a shift from the agricultural to the industrial sector. The number of males are estimated at about 3.955 million men while the females are estimated at about 248.4 thousand women, i.e. 124.2 thousand men[1/] (Table 2). To estimate available agricultural labour force in all months throughout the year the boys of 6 to less than 12 years must be included since they perform some agricultural jobs such as grass cutting, manual cotton leaf worm control. The number of boys of 6 to less than 12 years was estimated at about 304.8 thousand boys, i.e. 152.4 thousand men. Also, the school boys must be included in summer season since they are in summer vacation and can be available to work on the farms. On the contrary, they should be excluded in winter season since they are attending schools. They are estimated at 491 thousands, i.e. 246 thousand men. The available agricultural labour force in January, February, March, April, May, October, November and December is estimated at 3.832 million men. Whereas, in June, July, August and September, it is estimated at about 3.985 million men (Table 2). The available number of labourers in winter and summer equal to 86.22 and 89.66 million men days per month respectively[2/].

1/ Work of the female or a boy equals $\frac{1}{2}$ man day under Egyptian farming conditions.

The number of working days per annum are about 270 days.

Table 1. Available agricultural labour force in million man days by number and percentage in 1960 and 1968.

Item	1960		1968	
	No.	%	No.	%
Available agricultural labour force	4.406	59	4.202	53
Total labour force in all sectors of economy	7.607	100	7.944	100

Source: Habashy, N.T. : An analytical study of agricultural resources allocation in Arab Republic of Egypt, Ph.D. Thesis, Faculty of Agriculture, University of Ain Shams, Cairo, 1972, p.54.

Table 2. Available agricultural labour force in Arab Republic of Egypt in 1968.

Category	Available Agricultural Labour Force	Available Agricultural Labour Force in winter	Available Agricultural Labour Force in summer
Men	3954400	3954400	3954400
Women	248400		
Number of men equal to women	124200	124200	124200
Boys of 6 to less than 12	304800		
Number of men equal to boys of 6 to less than 12	152400		152400
Boys of 12 to less than 14	491000		
Number of men equal to boys of 12 to less than 14	245500	(-)246000	(-)246000
Total :		3832000	3985000

Remark (1): Boys of 6 less than 12 are not included in the survey of agricultural labour force. They are added in summer because they are in summer vacation.

Source: Habashy, N.T. O.P. CIT. p.57

The agricultural labour requirements

Labour requirements in agricultural include three main categories, viz. labour requirements for crop and livestock production and for capital maintenance.

Labour requirements for crop production

The need of various crops for agricultural labour force differs from one crop to another according to the duration the crop stays on the land and to the various agricultural operations required during its life time. Cotton and sugar cane are considered the two field crops that need the highest requirements of agricultural labour force as compared with other field crops. They need about 74, 77 man days per year respectively. The least rrquirements of agricultural labour force were estimated at about 9.5 man days required by temporary clover. The labour requirements for other crops are indicated in (Table 3). If these needs multiplied by the cropped area cultivated by different crops during the period under examination the result would be the total labour requirements for crop production.

Amongst the vegetable crops, tomatoes and other summer vegetable crops score the highest needs of labour force as compared with other vegetable crops, i.e. 78, 80 man days per annum respectively (Table 3). Summer and Nili potatoes are considered the vegetables which need the minimum requirements of labour force i.e. 39 man days annually. As regards orchard crops citrus, mangoes, grapes, bananas need 102, 144.96 and 165.5 man days annually respectively. These orchard crops cover about 90% of the total cultivated area of orchard crops in Egypt.

Labour requirements for livestock production

The total number of livestock in Egypt is estimated at about 8.87 million animals. Cows and buffaloes totalling about 4.1 millions represent about 46% of the total number of livestock. Other categories of livestock, such as sheeps goats, donkeys, horses, mules and camels totalling 4.7 millions represent about 54% of the total livestock in Egypt (Table 5). Labour requirements for cows and buffaloes are estimated at about 219 and 268 thousands man days respectively on the bases indicated in Table 4. These requirements represent about 75% of the total labour needs for livestock production. Labour requirements for other categories of livestock represent about 25% of the total labour needs. The total labour requirements for livestock amount to 654 thousand man days. They equal about 177 million man days annually or about 15 million man days monthly.

Table 3. Standard labour requirements in man days for crop production throughout the year, 1965 - 1968

Crop	Labour requirements	Crop	Labour requirements
Wheat	25.0	Winter squash	71.0
Barley	23.5	Winter cabbage	49.0
Beans	22.0	Garlic	50.0
Soft beans	17.5	Other winter veg.	39.0
Flax	30.5	Summer tomatoes	79.5
Permanent clover	31.5	Summer squash	75.0
Temporary clover	9.5	Summer eggplant	73.0
Winter onion	44.0	Summer squash	75.0
Other winter crops	16.0	Watermelon	42.5
Cotton	74.5	Summer potatoes	39.0
Summer rice	67.0	Other summer veg.	80.0
Summer maize	37.0	Nili tomatoes	79.5
Summer sorghum	37.5	Nili squash	75.0
Sugar cane	77.0	Nili cabbage	49.0
Sesame	32.0	Nili potatoes	39.0
Peanuts	51.0	Citrus	102.0
Nili rice	44.1	Mangoe	144.0
Nili maize	37.0	Grapes	96.0
Nili sorghum	32.2	Bananas	165.5
Winter tomatoes	77.5		

Source: Records of Department of Agricultural Economics and Statistics, Ministry of Agriculture, Giza, Arab Republic of Egypt.

Labour requirements for livestock production

The estimation of rural employment must include labour requirements for agricultural capital maintenance, such as workers performing dredging and weeding. It is estimated that one cultivated feddan needs about .52 man days monthly. The agricultural areas in Egypt totalling 5.83 million feddans in 1971 needs about 3.03 million man days monthly, i.e. the annual labour requirements for agricultural capital maintenance are estimated at about 36.36 million man days.

Table 4. Standard labour requirements to care for livestock under dominant Egyptian farming conditions. 3/

Livestock category	No. of labourers	No. of animals cared by one labourer
Camel	1	2
Buffaloe or cow	1	10
" " "	1	15 (for milking only)
Ox or big calf	1	10
Small calf	1	15
Horse or mule	1	3-4
Donkey	1	15
Sheep and goats	1 + 1 boy	100
Poultry	1	300-500

3/ A cow milker works half man day.

Source: Elthonbary, A.A., Principles of Farm Management, El-Saada Press, Cairo, 1967, p.268.

Table 5. Labour requirements for livestock production, Arab Republic of Egypt, 1970

Category of Livestock	Livestock No. 1000.	%	Number of workers per animal	Labour requirements No. 1000.	%
Cows	2115	46	4/30	219	75
Buffaloes	2009		4/30	268	
Sheeps	2006	54	15/1000	31	25
Goats	1155		15/1000	17	
Donkeys	1362		1/15	45	
Horses	35		1/4	8	
Mules	6		1/4	2	
Camels	1127		1/2	64	
Poultry*			1/400		
Total :		100		654	100

Source: Collected and calculated from:

1. Ministry of Agriculture - Department of Agricultural Economics and Statistics - Numbers of Cattles in 1970.
2. El-Tonbary, A.A., Principles of Farm Management, op.cit. p. 268.

* Labour for poultry production is not computed since their numbers are not available.

The total requirements of agricultural labour force differ monthly according to the differentiation of the needs for the production of crops and livestock and capital maintenance (Tables 6 and 7). Agricultural requirements of labour force are estimated at about 80.2 and 35.4 million man days in May and December scoring the maximum and minimum needs throughout the year respectively. The needs for the other months throughout the year fluctuate between these two figures.

In view of the development of technology which took place in agriculture, labour requirements should be reviewed in Egyptian Agriculture so that rural employment can be accurately calculated. Table 7 indicates that total labour requirements for agricultural production are estimated at about 656 million man days annually while the available labour force is estimated at about 1000 million man days annually4/ and consequently it is likely to find out rural unemployment in agricultural production in the form of disguised and seasonal unemployment.

Disguised unemployment is identified as a zero marginal product for the labourer. It can be calculated as the difference between the available labour force and the optimum requirements of the labour force in any month throughout the year. It is here calculated in two periods summer and winter. The former is greater than the latter because available labour force in summer exceeds that in winter since children are out of schools and accordingly are available to work on the farm.

Table 6. Labour requirements for crop production in million man days per month, 1965-67

Month	Labour requirements in million man days
January	25.3
February	23.3
March	37.3
April	50.1
May	62.4
June	44.7
July	43.3
August	33.0
September	32.2
October	49.0
November	27.6
December	17.6
Total :	445.8

Source: Habashy, N.T. : op.cit., p. 796

4/ Please refer to p.2 (86.22 million man days are available monthly in winter (8 months) and 89.66 million man days are available monthly in summer (4 months).

Table 7. Total labour requirements and seasonal unemployment in million man days throughout the year, Arab Republic of Egypt, 1965 - 1968.

Month	Total labour requirements	Seasonal unemployment
January	43.11	37.05
February	41.06	39.10
March	55.06	26.10
April	67.86	12.30
May	30.16	-
June	62.46	17.70
July	.07	19.90
August	47.79	32.77
September	49.96	30.20
October	66.76	13.40
November	45.44	34.72
December	35.37	44.79
Total :	656.20	306.63

Source: Calculated from:
Tables 1, 3, 5 and 6.

Disguised unemployment is estimated at 6.06 million man days monthly throughout the months of winter, namely October, November, December, January, February, March, April and May. This equals to about 270 thousand men representing about 9% of total available agricultural labour force during these months. In summer months, namely June, July, August and September the disguised unemployment is estimated at 9.5 million man days monthly. This equals to about 422 thousand men, representing about 10.7% of available agricultural labour force (Table 8). This excess of disguised unemployment in summer is due to the number of school children who are available to work on the farm in summer vacation.

It should be mentioned that disguised unemployment has no effect on agricultural production if such a proportion is excluded from the labour force. The obvious corollary is that any decrease in the excess of agricultural labour force would help increase labour productivity.

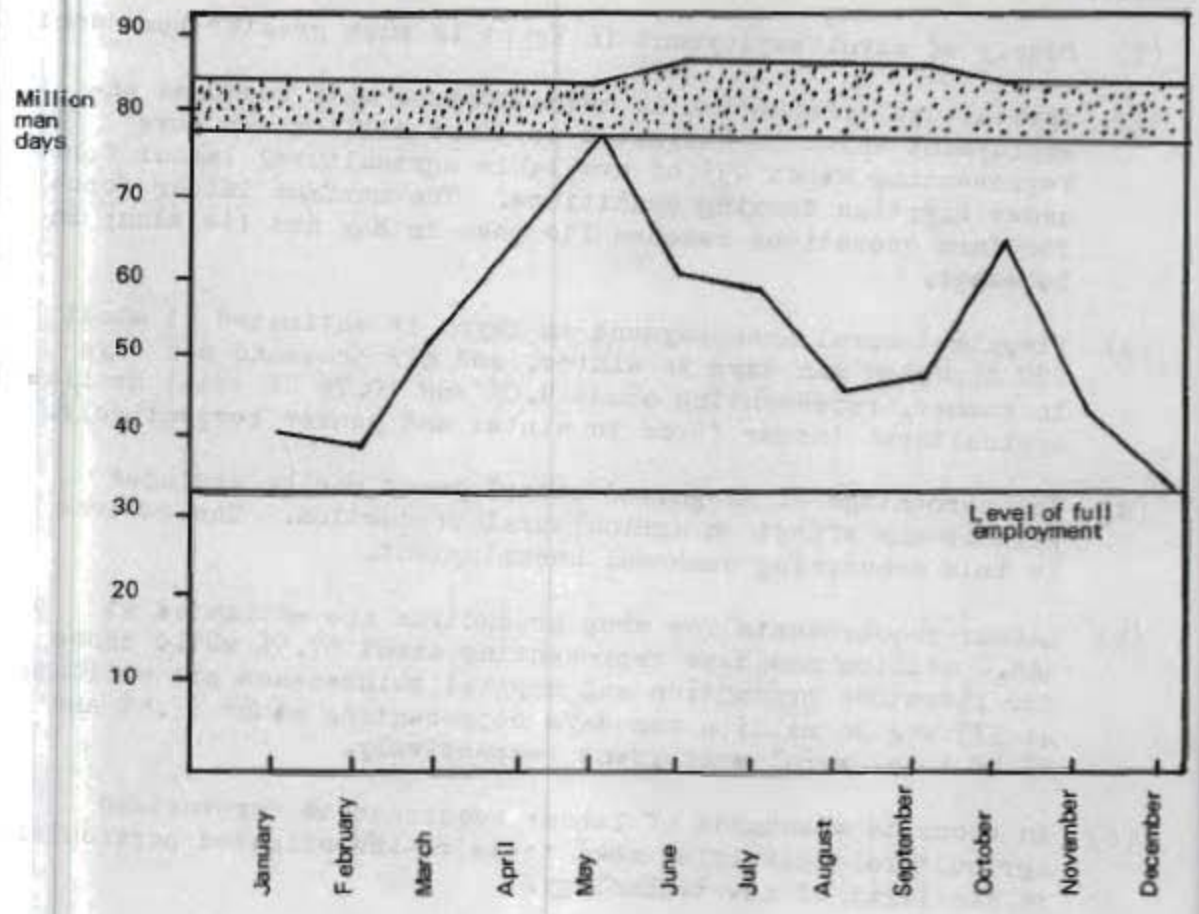
Seasonal unemployment is defined as the difference between the optimum requirements of labour force and the requirements of the other months throughout the year. It reaches its maximum in December where it is estimated at about 44.79 million man days as against 12.3 million man days in the month of April which is the minimum month throughout the year (Table 7). The total seasonal unemployment in all months of the year amounts to about 306.6 million man days representing 29% of total available agricultural labour force. Figure (1) indicates seasonal unemployment which is limited by the area spotted in the figure.

Table 8. Disguised unemployment in million man days and percentage in summer and winter, Arab Republic of Egypt, 1965 - 1968.

Disguised unemployment	Million man/days	Million men	Percentage
Summer	9.5	0.422	10.7
Winter	6.06	0.270	9.0

Source: Tables 2 and 4.

Fig (1) - Agricultural unemployment according to the present cropping system



Conclusions

The main results disclosed from the current study can be summarized as follows:-

(1) Supply of rural employment in Egypt is much greater than demand.

(2) Agricultural production is characterized with seasonal unemployment which is estimated at 306.6 million man days representing about 29% of available agricultural labour force under Egyptian farming conditions. The maximum labour force for farm operations reaches its peak in May and its slump in December.

(3) Disguised rural unemployment in Egypt is estimated at about 270 thousand man days in winter, and 422 thousand man days in summer, representing about 9.0% and 10.7% of total available agricultural labour force in winter and summer respectively.

(4) The percentage of disguised unemployment can be excluded without any effect on agricultural production. The reverse is true concerning seasonal unemployment.

(5) Labour requirements for crop production are estimated at 445.8 million man days representing about 67.5% while those for livestock production and capital maintenance are estimated at 177 and 36 million man days representing about 27.5% and 5% of total rural employment respectively.

(6) An accurate standards of labour requirements for various agricultural activities need to be re-investigated particularly in the light of new technology.

VIEWS AND NOTES
REVIEW OF ECA/FAO JOINT AGRICULTURE DIVISION STUDY, "PROSPECTS FOR PRODUCTION, MARKETING AND TRADE IN LIVESTOCK AND LIVESTOCK PRODUCTS IN EASTERN AFRICA TO 1985", VOL. I & II 5/ OCTOBER 1972

This study was the product of a co-operative effort between the United States Agency for International Development (USAID) and the ECA/FAO Joint Agriculture Division and was designed around the intra-sub-regional concept. The basic premise of the ECA/FAO sub-regional trade approach is that certain countries, in this case Eastern African countries, may have a surplus of animal products while other countries in the sub-region may have a shortage. Thus, the promotion of co-operation and trade could result in the surplus countries providing livestock and livestock products to the deficit countries in the sub-region. In this connection it should be emphasized that the term "surplus" is not used to denote the excess of domestic supply over and above the quantity necessary to satisfy adequate nutritional requirements, but rather the surplus over effective demands.

In the case of beef, Eastern Africa production and per capitalconsumption are high relative to that in the other sub-regions and for Africa as a whole. Eastern Africa beef consumption (per capita) exceeds the African average by about 65 per cent. Beef consumption per person is more than two and a half times that in Central and West Africa. Eastern Africa 6/ has about a half of the continent's cattle population and about a quarter of the human population, so it is only natural that beef consumption would be high. But at the same time, Eastern Africa has been exporting significant quantities of beef, and most of these exports go outside the continent. Eastern Africa exports beef to Europe while West Africa imports beef from Europe. In terms of African welfare, given the necessary economic and political adjustments, a goal of using continental supplies to satisfy continental demand would seem appropriate. The projected Trans-African Highway will, of course, play an important communicative role in achieving such objectives.

Except for trade among the three East African Community countries, official trade among the countries in the sub-region is negligible in terms of the total. Most of the factors responsible for the low level of intra-sub-regional trade in a sense relate to the underdeveloped nature of the countries. The expansion of intra-sub-regional trade requires concurrent strategy for co-operation in general overall economic development.

5/ Copies available on request.

6/ The fourteen countries are Burundi, Rwanda, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Somalia, Tanzania, Uganda, Zambia, Botswana, Lesotho, and Swaziland.

In general, the transport and communications links within the sub-region are wholly inadequate. The transport and communications systems within the various countries are at a low stage of development, and as a general rule the transport network has been traditionally oriented toward external (overseas) markets. Not only are the transport facilities inadequate from the structural and functional point of view, but the great distances and high costs per se, inhibit sub-regional trade.

With respect to tariffs, various preferential arrangements often serve to discriminate against other countries in the sub-region, as in the case of the more favourable rates given by some countries to the United Kingdom and other metropolitan countries, often in return for reciprocal treatment. Those countries that are associated with the European Economic Community have granted reverse preferences to the EEC countries. Even so, it is not certain that tariff barriers are a major factor in trade restraint regarding livestock and livestock products.

As in the case of transport structure, the trade information system is usually geared to better serve the developed country trade partners than sub-regional neighbour countries. Information regarding prices, supplies and marketing conditions are usually more readily available to the developed countries than to sub-regional neighbours. Botswana is a member of the South Africa Customs Union and this results in closer trade ties with the south compared to the north. Partly because of factors such as these, the natural tendency to maintain traditional trade patterns persists.

The study indicated that the key to increasing production and trade in animal products lies mainly in improvement in productivity and management levels, along with the related structural and operational aspects of marketing.

Main production constraints and recommendations

The principal constraints to increasing livestock production are more or less the same in all of the eight countries studied[7/]. Although the basic resources for improving livestock production are generally abundant, a certain combination of circumstances restricts the use of these resources to their full potential. Although most countries in Eastern Africa envisage relatively rapid improvement in cattle production, expansion of the cattle industry is essentially a long-run process. The reason for the long-run nature of the problem is that solutions must be sought through an integrated programme which combines disease control and animal health measures, the development of water supplies, providing

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7/ Kenya, Uganda, Tanzania, Somalia, Malawi, Zambia, Madagascar and Botswana.

an adequate system of stock routes, improved breeding, improved marketing facilities and methods, and the like. Attacking one or two of these problems at a time may be counter-productive. If, for example, disease control and animal health measures are instituted, the problems of over-grazing and inadequate water supplies may be intensified so as to negate the benefits of disease and health control. For these reasons, it seems inappropriate to rank the various constraints in some sort of a priority continuum. As a matter of pragmatism it may be useful to discuss the various constraints one by one, but the interrelationship among them should be kept in mind.

Calving rates in all the eight countries are low. The rates in some countries are higher than in others, but the problem is universal. Many factors come to bear on the problem of low calving rates. In most countries there is a relative large proportion of sterile females. The ratio of bulls to breeding-age females is also low. Disease is also a factor in the unsatisfactory calving rate problem, as is the poor level of nutrition during dry seasons.

Calf mortality rates, as well as adult animal mortality, are a major restraint on beef production. Many of the same factors associated with low calving rates also impinge on the calf mortality problem. It is not uncommon for mortality to reduce the effective calving rate to the 25 to 30 per cent range.

Extensive over-grazing is common to all the countries included in the present report. Over-grazing is usually, if not always, associated with water supplies. Cattle numbers tend to be concentrated in areas where water is available, and such concentration leads to overstocking. In most of the countries some areas are greatly overstocked, while other areas are understocked, partly because of the geographic distribution of surface water supplies.

Marketing cattle on the hoof is prevalent in all of Eastern Africa. The trekking distances are great and there are significant losses in both weight and quality. A Botswana experiment indicated that the majority of the cattle trekked a distance of 307 miles dropped at least one grade in quality; in value terms, the average loss per animal from quality and weight loss combined was estimated at R 15.35. Data regarding the economic losses from trekking are scarce, but from a practical point of view it seems that trekking will remain the chief mode of cattle marketing for many years to come. For this reason the main emphasis in terms of policy and development planning should be placed on improvement in existing stock routes rather than on providing alternative transport modes to replace trekking. Improving the stock routes by providing water and rest and recuperation stations should be given high priority for all the eight countries. There is also great need to develop systems for supplementary feeding along the stock routes, even if on a limited basis. Experience in Botswana and other countries has shown that this measure can be considerably strengthened by integrated disease control, disease free zones and range management.

Border trade in live animals, be it official or unofficial, is significant in many of the countries. Most of the border trade in live animals is unrecorded and usually unofficial in the strict sense of the term, and the magnitude of such trade is a matter of guessing. It is known, however, that Tanzania-Uganda, Kenya-Uganda, Somalia-Kenya, Ethiopia-Kenya and Ethiopia-Somalia border trade has been quite large. In general, the recipient countries of border trade appear to give tacit, even though unofficial, sanction to the live animal inflow. This is true in the case of Tanzania-Uganda, Kenya-Uganda, Somalia-Kenya and Ethiopia-Kenya flows of live cattle. The countries appear to raise little objection to inflows but considerable objection to outflows. It is perhaps natural that a country would prefer to process its own livestock and sell the products therefrom. Each country wants to utilize its processing facilities more fully and reap the attending economic benefits. Among such benefits is the earning of foreign exchange, largely by exporting meat (usually in canned form) to foreign markets. It is equally natural that countries on the receiving end would seek the same benefits. Countries that experience border outflows, Tanzania for example, often take official action to reduce or eliminate live cattle outflows. But the borders are so vast and uncontrollable that such actions are likely to meet with limited success. Prices in the inflow countries are often considerably higher than in the outflow countries. In the recent past this appears to have been the case in the Kenya-Uganda and Tanzania-Uganda price ratios. And, sometimes the outflow is a matter of locational economics and transport distance. In any event, it seems likely that a significant amount of unofficial border trade will continue far into the future. Therefore, the study recommends that the countries involved take co-operative action to normalize and record border movements that are now unrecorded.

Veterinary regulation and disease control problems not only retard development of the livestock industry within countries but also the development of trade within and outside the sub-region. Up to the present time at least, veterinary regulation and control has almost prohibited trade in cattle and beef between Tanzania and Zambia and between Tanzania and Malawi So far, except for one trial shipment, the Zambian Veterinary Department has declined to approve the import of even frozen boneless beef from Tanzania. There is disagreement, even among veterinarians, regarding the potential disease danger involved in such transactions, but the veterinary regulation remains a fact. Some authorities assert that veterinary regulations, within the sub-region and in European markets, are often used as rationale for disguising non-veterinary motives for trade restriction. But this is a problem for veterinary co-operation and discussion that cannot be assessed in the present economic study. Veterinary regulation and disease control also affect the movement of live animals from country to country. Even though all of the eight countries covered by the study have rather serious animal disease problems, Botswana, Zambia and Malawi are usually considered to be relatively "disease free" compared to the other countries. Nevertheless, the study recommends that a sub-regional programme of veterinary co-operation and co-ordination be established without delay. Sub-regional veterinary regulation and control should be as uniform and co-ordinated as the real status of disease and disease control will permit.

The proverbial inadequacy of livestock processing and marketing facilities presents a strange paradox. While such facilities are admittedly inadequate in a particular sense, it is an obvious and indisputable fact that every major abattoir in the study area operates far below its physical and economic capacity except during odd seasonal peaks. There are various reasons for this. One important reason is that abattoirs are often prevented by government authority from paying (producer) prices that are high enough to attract adequate supplies. If the abattoirs are not permitted to compete in the market, cattle supplies will be diverted to other buyers. This situation appears to have been particularly characteristic of Kenya and Tanzania during the recent past. Another reason for largely unused abattoir capacity is that abattoirs of the wrong size are often located in the wrong places. The major abattoirs are usually located in or near the large urban population centres because this is where the demand for beef is great and where the transport and communication facilities for export are located. But it is also well known that abattoirs are often located and constructed without adequate studies having been made of the supply potential in the chosen area. Abattoirs are usually located in one place while the cattle supply concentrations are located in other places. On the surface, at least, it would seem to be an indisputable thesis that the transport of meat is cheaper and more economic than the transport of live animals. The great losses in weight and quality involved in live animals transport throughout the sub-region lends credence to this thesis. The feasitility of establishing a network of small, simple slaughter plants in or near the main producing areas should be fully explored. The urban area plants would then serve partly as receiving stations for chilled (or perhaps frozen) carcasses. Such decentralized systems would, of course, require road (or rail) transport facilities, along with refrigeration facilities for chilling or freezing. In addition to the potential gain in such systems through reducing quality and weight losses, there is also the possibility that the decentralized slaughter system would in itself aid in disease control. It should be possible to reduce the costs involved in the present system of holding grounds and quarantine camps.

The prestige of cattle ownership and the attending reluctance of traditional farmers to sell their animals is commonly presented as a major constraint to increasing beef production in Eastern Africa. While there is no doubt some validity to this contention, the conclusion of the present report is that the constraining influence of this phenomenon has in many cases been over-emphasized. It appears that there are more basic reasons for the low offtake and sales from the traditional areas. In the first place, the offtake from traditional herds is low because productivity is low. In turn, productivity is low because of animal disease, poor nutritio poor management and the like. The offtake rate in many traditional areas, assuming the herd size is maintained, amounts to no more than 2 or 3 per cent per year. The usual assumption that traditional producers, including nomads and semi-nomads, do not respond to the price incentive has not been satisfactorily demonstrated. Officials in Kenya, Tanzania and Botswana asserted that these producers <u>are</u> price conscious. In both Kenya and

Tanzania there seems to be a general feeling that producer prices are too low to attract large supplies. A study in Botswana reported that there is no social or customary inhibition on selling cattle as it has sometimes been alleged. Nevertheless, it is no doubt true that traditional producers are somewhat reluctant to sell cattle, except to meet particular needs for cash. These "particular needs" cover a narrow range because of the isolation of traditional producers from the mainstream of the monetary economy. Their range of demand for monetary sector goods and services is simple and narrow partly because of the lack of communication and transport links with the "outside world." It is thus suggested that efforts should be made to bring the traditional sector "closer" to the mainstream of the monetary economy by developing two-way communication and transport links. Expanding the range of demand for monetary goods and services in subsistence sectors usually comes from external rather than internal stimuli. In other words, subsistence sector demand more often than not has to be created from outside. This is an important element of development policy.

Land tenure systems are an important deterrent to livestock development in the whole of Eastern Africa. A large proportion of the grazing land comes under a communal or tribal system whereby all members have a right to use land. Such tenure systems, along with the related problem of water availability, make it almost impossible to develop schemes for controlled grazing, disease control or range improvement. This is a problem of institutional structure that is manifestly difficult to solve. But the problem must be solved if development of the livestock industry is to be achieved. In Kenya, Tanzania and Uganda some successful attempts have been made to adjusting customary and traditional land tenure/use patterns to modern husbandry requirements. Co-operative ranching and controlled communal grazing with integrated management are among the new methods.

Tariff barriers do not appear to be a major constraint to trade in livestock products in the study area. Non-tariff and veterinary barriers appear to be much more significant. In the East African Community countries, where in theory there are no tariff restraints at all, constraint by dictum and direct control are often practised.

The development of a realistic currency exchange system is an absolute necessity for the enhancement of Eastern Africa trade or inter-sub-regional trade, whether it be in livestock and livestock products or other commodities. At the present time, the sub-regional norm, as well as the African norm, is to settle trade transactions in the so-called "hard currencies." It is also characteristic for most, if not all, African countries to suffer serious foreign reserve problems. Intra-African (at least south of the Sahara) currency convertibility is almost non-existent. Even in the East African Community, where at least a quasi-common currency existed, stringent government controls of currency movements are exercised. A further difficulty is that, even though the official par of the three currencies is the same, the exchange rates in international currency markets vary greatly. Such divergence, in other as well as EAC countries, renders the settlement of trade balances and exchanges extremely difficult. In addition, the uneven departures of official from market rates makes inter-country price and value comparisons hazardous. African countries apparently -

their external trade largely toward overseas, convertible currency areas. So long as this policy or structural element continues, significant changes in trade patterns are unlikely. The study therefore recommends that the Eastern African countries co-operate to the fullest extent toward the development of an intra-African exchange system. So long as the various countries, individually, gear their current exchange rates to the western (developed country) world, the trade pattern is no likely to change much.

Table 9. "Most probable projections" of surpluses (+) and deficit (-) in Eight African Countries.

METRIC TONS

Country	1975	1980	1985
Botswana	+29,100	+31,500	+33,500
Somalia	+15,200	+16,450	+17,450
Tanzania[a]	+12,700	+11,600	+10,200
Madagascar	+ 7,000	+ 7,000	+ 7,000
Malawi	0	0	0
Kenya	+ 2,300	-13,500[b]	-39,900
Uganda	- 7,250	-14,845	-31,500
Zambia	-10,500	-19,500	-31,500
Total, eight countries	+48,550	- 4,495	-34,750

a/ The projected surplus for Tanzania, given present government pricing policies and the rapid rise in Dar-es-Salaam beef consumption, may disappear by 1980 or 1985.

b/ A mimeographed "Mission Paper", available in ESF, FAO Rome, projects a Kenya beef deficit of 80,000 metric tons by 1980.

The above so-called "most probable" projections should not be considered as representing true absolute values. Since they represent data that are subject to a rather wide range of error, their relevance should be considered to lie mainly in relative magnitudes and directional changes. It should also be noted that most of the projections are made from historical bases and are not intended to represent a picture of what the future will actually be. In most cases, the procedure used is based on the implicit assumption that the forces influencing change during the historical base will be more or less the same in the future. This means in essence, the assumption that the historical changes in governmental policy, price relationships, technological advance, management improvement and the like are assumed to continue at something like the historical rate. It is only by changes in such historical forces that the future course of events can be modified. This, of course, is the essence of development strategy and policy - this being the real challenge facing the countries under study and, for that matter, all countries of Africa, if a remarkable breakthrough in livestock production and trade is to be achieved. Some claim, for example, that a breakthrough in the development and production of poultry meat in Kenya may well reduce, or eliminate - the projected large imports of beef into country in the eighties.

ECA/FAO FILE
PILOT PROJECT ON INTRA-REGIONAL CO-OPERATION AND TRADE IN THE FIELD OF AGRICULTURE - PHASE II FOR WEST AFRICA

An advanced multi-disciplinary team composed of ECA, FAO, IDEP, and USAID experts started mid-November 1973, the implementation of a pilot project covering six countries - namely, Dahomey, Ghana, Niger, Nigeria, Togo, and Upper Volta - with the purpose of developing an appropriate methodology of research, considering that several studies have been made on the questions of agricultural development, co-operation and the promotion of intra-African trade in West Africa. The team is analysing with particular interest the main problems of agricultural development and promotion of trade among the countries concerned. The field work will be developed in two periods and shall be concluded by the end of April 1974.

SIXTH SESSION OF THE FAO AFRICAN COMMISSION ON AGRICULTURAL STATISTICS

This session was held at ECA Headquarters in Addis Ababa from 12 to 17 November. The participants represented agricultural and rural economy members of thirteen African countries. The meeting was held to review developments in FAO's work in food and agricultural statistics in the African region since its fifth session. It also heard statements from the delegates about recent developments in compiling statistics and their use under African conditions. A third area of discussion centered around the forthcoming 1980 World Census of Agriculture and the development of Socio-economic indicators in African countries.

A number of speakers underlined the important role that reliable and adequate agricultural statistics play in formulating, implementing and evaluating agricultural projects and plans. Practically all African governments have realized the strategic role that statistics do play in the development planning and have consequently assigned a higher priority to obtaining and improving agricultural statistics in their respective countries.

GUIDELINES FOR SUBMITTING MATERIAL FOR PUBLICATION IN THE BULLETIN

All material submitted for publication should relate to agricultural development and experiences in African countries or to similar ones in other countries. Articles presented should be of an applied nature, preferably specific in regional or subject matter coverage and clear and concise in formulation and analysis.

Length: Material submitted under "Article" section must NOT exceed 3,000 words; those submitted for the "Views and Notes" section NOT more than 500 words (or equivalent space for tables, charts and graphs). Authors should present their ideas and data in as condensed form as possible. They should also indicate whether the article or the other material has been submitted for publication.

Manuscript: The manuscript must be either in English or French. Four copies should be submitted double space on white paper 21 by 27 cm. The left-hand margin should be 3 cm.

Title: The title of the paper should be specific and typed in capitals. The author's name, occupation and mailing address should appear in ordinary type centrally below the title.

Abstract: Every article (not material for Views and Notes section) must have an abstract of less than 150 words following the title and preceding the main text.

Sub-headings: Papers should be divided into sections with appropriate headings and sub-headings.

Footnotes: Footnotes should be avoided. References are NOT to be cited in a footnote. Clarifying and qualifying statements should be incorporated into the text.

References: Reference to literature must be complete and conform to official standards for publication. They must be indicated in the text by superscript numerals and a list correspondingly numbered should be given at the end of the text of the paper under the heading References.

Tables, charts and graphs: These should be placed on separate pages with a clear indication as to where they should appear in the text.

Editing: The editor's reserve the right to edit the manuscripts for clarety and to conform to format requirements.

Manuscripts should be sent to:

The Editor/African Agricultural Economic Bulletin/
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ECA/P.O. Box 3001/ Addis Ababa, Ethiopia

The Section in which the material is to be published ("Article" or "Views and Notes") should be indicated on the first page.