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REPORT ON THE IMPACT ASSESSMENT OF SAFGRAD NETWORKS:

ECONOMIC ANALYSIS OF THE PROCESS OF ADOPTION OF TECHNOLOGICAL INNOVATIONS AND THEIR IMPACT: A CASE STUDY OF EIGHT SAFGRAD COUNTRIES.

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IV. ECONOMIC ANALYSIS OF THE PROCESS OF ADOPTION OF TECHNOLOGICAL INNOVATIONS AND THEIR IMPACT: A CASE STUDY OF EIGHT SAFGRAD COUNTRIES

A. INTRODUCTION.

1. Nature of the Analysis.

This part of the assessment deals with measuring and interpreting the extent of adoption of new agricultural technology at the level of the producer and the resulting impact of that technology on production, productivity and income, as well as, indirectly on rural and overall economic development.

2. Scope of the Analysis.

The overall assessment refers to two major types of agricultural technology or innovation: 1) new or improved materials for the four commodities under the aegis of SAFGRAD; and 2) new agronomic practices (such as tied-ridging), developed for the production of the same commodities. The economic analysis will deal primarily with the identification and measurement of the impact the first type of technology, which is directly manifested through the use of improved varieties of the commodities in question.

The temporal scope of the economic analysis, and indeed of the whole assessment exercise, covers the period 1982-92, in consideration of the fact that the usual gestation period for the generation, adaptation, dissemination and adoption of agricultural technology could extent from about 9 to 15 years. Thus, while being mandated by the Terms of Reference to assess SAFGRAD II (which spans over a 5 to 6 year period), it was felt useful to extend the reference period backwards to 1982, in consideration also of the spillover effects of the activities of SAFGRAD I into the second phase of the project.

The economic analysis refers to 8 of the SAFGRAD member countries, which are: Burkina Faso, Mali, Niger, Ghana, Nigeria, Cameroon, Kenya and Ethiopia. These countries were chosen as a representative sample of the 26 that comprise the SAFGRAD member states, because they were found to possess, among them, the full range of situations and conditions with respect to agricultural research for the four commodities examined. The criteria used in this selection of these countries, and the procedures followed thereon, are described in Annex .

3. Data Gathering and Analysis Framework.

The data needed for the economic analysis, were gathered in each of the sample countries, in a set of 13 tables specifically designed to obtain information indicative of impact at the producer's level. These tables were intended to capture nation-wide data on:

a) basic production and productivity for the four SAFGRAD crops and their five competitive crops;

b) production and sales for the main livestock enterprises in the SAFGRAD countries, cattle, sheep and goats;

c) expenditures on production inputs, for all the crops under consideration;

d) disposal of production, by destination, for the same crops;

e) disposal of production, for the same crops and for selected livestock products, at the international level;

f) some significant sectorial and macro-economic indicators for the sample countries; and

g) the cost structure of the main network entities and the budgetary allocations dedicated to agricultural research, in the sample countries.

A full set of the returned, completed tables for the eight countries, is presented in the Annex 4. The tables with no data were excluded.

4. Some Measurement Considerations.

The depth and quality of the economic analysis undertaken, is a function of the completeness and adequacy of the data scrutinized. Since the TORs and the available time period for the assessment mandated the examination of "available data", the analysis was constrained to the quick gathering and evaluation of relevant disposable data, which has limited the detailed consideration of some of the intended variables and relationships in some of the sample countries. The data gathered exhibited some measurement problems, which were common to all or most of the countries being analyzed, to various degrees. Outstanding among these problems, were:

a. data incompleteness.

For some of the basic agricultural production indicators, the data requested were either not systematically collected by the respective statistical systems, or they simply did not exist. This was the case, for instance, concerning: i) the number of producers, by type of enterprise; ii) the area of permanent pasture; iii) production and crop area by varieties, for the four main crops being examined; iv) average expenditures on production inputs; and v) differential disposal of production, by end use destination.

b. data inconsistencies.

A common, significant inconsistency was found between the total production, recorded in Tables 1 and 2, and the corresponding totals, for the same crops, obtained from Tables 6 and 7.

Moreover, information on the same variables, gathered from different sources, oftentimes exhibited drastic divergencies, which called for effecting a value judgement as to their relative reliability.

c. Lack of or questionable data validity.

The property of statistical validity refers to the extent to which the data indeed measure what they intend. Among the information collected, the most significant statistics subject to validity concerns, refers to the area planted, by crop. This is the case, since the crops under scrutiny are often intercropped (especially maize and sorghum with cowpea), and considering also the multiple-cropping of the same area for a given year. Thus, in the absence of a specific assessment of the data collection methodology for "area planted" in each country -- which is beyond the scope of this study -- it is impossible to ascertain the validity of a great deal of the data collected on area by crop. It was found, for instance, in one of the countries visited, that in cases of intercropping, the area of a particular field was simply divided equally among all crops grown there in a given year.

B. <u>MAIN FACTORS AFFECTING ADOPTION</u>.

In addition to this quantitative information obtained in the sample countries through the 13 tables designed for that purpose, impressionistic, oracle-type information was obtained in each case from local officials knowledgeable about agriculture and agricultural research. This was accomplished through non-scientific, unstructured informal meetings/interviews, which yielded particularly useful unsight concerning the factors that significantly affect the adoption -- positively or negatively -- of agricultural technology, with especial reference to the dissemination and use of improved seeds for the SAFGRAD mandated crops. The consulted/interviewed persons included: senior government officials in the ministries of Agriculture and Science and Technology; representatives of international organizations

active in the field, such as the World Bank; officials and researchers from the NARS and the IARCs; representatives of relevant NGO's, such as the "SAA-GLOBAL 2000" in Ghana; officials from key governmental parastatals dealing particularly, with inputs' supply and distribution and with the marketing and industrial transformation of the commodities under scrutiny; and officials involved in the collection and dissemination of agricultural statistics.

From the above consultations/interviews, some of 18 "main" factors affecting adoption of new technology were identified, and cross-tabulated by country where they occur (Table IV-1). An examination of the latter matrix, leads to the following conclusions concerning the process of adoption in the sample countries:

1. *The overwhelming majority of the factors cited (fifteen out of eighteen), which also had the highest frequency of occurrence, had a negative effect on adoption, by either retarding it or impeding it altogether;*

2. *The most important negative factors, which were mentioned in every country at a high frequency level, were: a) the price and availability of key inputs such as commercial fertilizers and seeds; and b) the effectiveness of the Extension Services and of the corresponding linkage between agricultural research and the producer;*

Table IV-1.

MAIN FACTORS AFFECTING ADOPTION* OF NEW TECHNOLOGY**
IN SAMPLE SAFGRAD COUNTRIES.

F A C T O R S	SAMPLE COUNTRIES							
	Burkina Faso	Mali	Niger	Ghana	Nigeria	Cameroon	Kenya	Ethiopia
1. Price and availability of commercial fertilizers	N-2	N-1	N-1	N-2	N-3	N-1	N-2	N-5
2. Price and availability of certified seeds	N-3	N-1	N-2	N-1	N-3	N-4	N-2	N-6
3. Effectiveness of Extension Services and linkage to research	N-5	N-4	N-2	N-1	N-1	N-3	N-7	N-5
4. Pricing of agricultural products							N-3	N-1
5. Socio-political situation								N-1
6. Effectiveness of Agricultural Research System	N-1					N-1	N-1	N-2
7. Availability and Cost of Credit			N-1	N-1		N-1	N-1	N-3
8. Effectiveness of marketing system	N-2	N-1	N-1	N-2		N-1	N-3	N-2
9. Adaptability of improved seeds								N-1
10. Government macro-economic policies	N-1		N-2		N-2	N-3	N-1	N-2
11. Effectiveness of SAFGRAD networks			N-1		N-1			N-1
12. Relative financial viability of technology				N-1	N-1	N-1	N-1	
13. Socio-cultural preferences	N-1	N-1					N-2	
14. Farmers end use needs						N-1	N-1	
15. Spillover from cash crops		P-1		P-1				
16. Government end use policies		P-1		N-1	P-2		P-3	
17. Availability and cost of labor					N-1			
18. Activities of NGO's				P-1				

* Factors mentioned at least once in each sample country, as affecting adoption, negatively (N) or positively (P). The numbers indicates the frequency of occurrence.
** New technology = improved varieties of SAFGRAD-mandated crops.

3. *At the second level of importance, are found a set of three factors that affect adoption less directly, through the impact on the disposal of production (i.e., the "effectiveness of the marketing system"); or through the curtailment of access to production factors, as was the case for "government macro-economic policies" and "availability and cost of credit";*

4. *The most important factors identified as having a positive impact on adoption were, in descending order: a) "government end use policies" for the commodities in question -- eg explicit efforts in Kenya and Nigeria intended to enhance the agro-industrial transformation and use of sorghum -- and b) "spillover from cash crops" (as in Mali and Ghana, where the application of improved technological packages to cash crops enhanced the production of intercropped basic grains;*

5. *While further, more in-depth research is needed to ascertain the relative impact of these factors on adoption, it seems patent that their combined workings have an overall negative impact on technological adoption, which is reflected, in turn, on vast differences in performance, for the same crop varieties, between the research station level and the average producer's fields. In Kenya, for instance, the same variety of improved maize, with a yield of 110 bags/ha at the research station, only produced 14 bags/ha at the farmer's level.*

C. CHANGES IN ADOPTION AND THEIR IMPACT

This section delves into the economic data collected in the 13 tables described above for the sample countries, in an attempt to ascertain the extent and impact of technological adoption, at

the national level and the corresponding changes over time in the indicative variables scrutinized.

The analyses herein will be conducted on a country-by-country basis, depending on the completeness and adequacy of the data provided.

1. Extent of Adoption.

The inadequacies of the available data base and the paucity of time which characterized the assessment, rendered quite difficult the task of ascertaining the extent of adoption of the technologies in question, at the producer's level. This was the case, in particular, given that none of the countries in the sample produced time series data on production and/or area covered by crop varieties. The next best alternative, consisting of actual data on adoption, by variety, from a broad-based, statistically-reliable sample survey, also proved elusive, as neither of the sample countries had undertaken such a survey in the study period. It was clearly outside the scope of this assessment, to carry out such data-generating activity, even with a substantially-reduced sample of countries.

Thus, an attempt would be made to arrive at estimates of the extent of adoption of the improved varieties of the main commodities under scrutiny (maize, cowpea, sorghum and millet), through the combined use of the data gathered from the following sources: a) the national agricultural statistical series obtained through the 13 economic tables; b) suplemental national-level information on certified seed production and distribution; c) data on varietal release and seed multiplication and distribution -- from Tables 9 and 10 of the technical formats -- which are presented and discussed in Chapter III of this Report; and d) one-shot recent previous studies effected in the sub-region. The discussion below will be based on the amalgamation and scrutiny of the information from these sources.

The information in Chapter III identifies and tracks over time the technologies which were generated, developed, tested and released, for the four commodities being analyzed, up to and including the release stage. Furthermore, this source ascertains the relative performance of these varieties, as well as the quantities and price of seeds produced and distributed by variety. Thus, these data clearly indicate that new technologies for the four crops have been developed and made available (disseminated) to the producers. However, this source does not pinpoint the precise level of adoption of these technologies by the producers, nor their rates of change over time. Other sources will be examined in turn below, to try to shed some light on this issue.

It is worth noting, that while the amount of improved seed production and distribution -- from this source as well as others -- is directly related to the quantum of certified seeds actually incorporated into the production system by the farmer, there is not a one-to-one relationship between the two magnitudes, ostensibly for the following reasons, which were confirmed during the tour of the sample countries: a) the technologies are usually released as packages, specifying given levels of application of seeds and agro-chemicals and recommended cultural practices (to ensure high performance). However, most of the producers of these commodities in the sub-region, are either at the subsistence or small-scale technological level, which render them financially unable to fully adopt the new technology packages; b) partially because of a), but also in the exercise of the prevalent risk-avoidance technique, the producer may try to cut corners and reduce the level of application of the package, at least until he/she sees some results that do not compromise food security; c) there is a significant proportion of improved seeds of the commodities that are transferred (disseminated) informally from farmer to farmer and these exchanges -- which some times take place internationally -- are not likely to follow the recommendations of the release entities; d) there is also a certain amount of largely undocumented, pre-release of technolo-

gies taking place, directly from the on-farm testing level, in an attempt to not discourage the eager early adopters, and/or to countervail deficiencies in the release-distribution system; e) the certified seed production and distribution systems in the subject countries of the sub-region, are oftentimes unable to keep up with the demand for these technologies, because of operational inefficiencies and/or lack of resources; and f) the prevailing, below normall rainfall situation in the sub-region in the last few years, may compell a significant number of adopters of the technologies, to over-seed or re-seed their fields, in order to minimize the risk of failure.

Further indications about the extent of adoption of the technologies of concern, can be discerned from the national level economic data -Table EC1), for the three countries (Cameroon, Ghana and Nigeria), which provided production and area statistics that distinguished between the improved varieties and the non-improved, or "traditional" varieties of the crops in question.

In the case of Cameroon, Table IV-2 shows that the improved varieties of maize had not made a substantial inroad in area nor quantity produced, accounting only for 9% of the hectareage and 5% of the total production for the country by 1988. Figures from CIMMYT's "World Maize Facts and Trends 1989-90", confirm that improved varieties of maize were planted in 1988 in a significant proportion of the total area. However, the 18% level reported by the latter publication, begs the question as to which estimates are more accurate, albeit they both move in the same direction.

The proportion of area planted to improved varieties of cowpea was moderate, but changed little in the period, hovering around 27% of the total, while production increased appreciably, from about 19% to almost 30% of the total.

In terms of quantum, virtually all of the sorghum and millet produced in Cameroon comes from improved varieties, which have

experienced a more or less steady increase in its share of the total since 1984. In terms of area, the improved varieties of these crops account for more than 90% of the total, having declined slightly from the high level (98%) attained in 1984.

Table IV-2. CAMEROON

Relative Importance of the Improved Varieties of SAFGRAD Crops.

(% of Total)

CROP, AREA AND PRODUCTION	1984	1986	1987	1988
MAIZE				
Area	10.7	13.9	7.0	9.3
Production	4.7	9.5	5.8	5.4
COWPEA				
Area	27.3	27.0	23.6	26.5
Production	19.1	22.5	18.4	29.8
SORGHUM*				
Area	98.1	98.0	97.9	91.3
Production	87.1	97.8	96.6	99.1

* Includes millet

Source: Resultats de l'Enquête Agricole, various years.

In the case of Ghana, Table IV-3 shows that the proportion of area planted to improved maize varieties have steadily increased over the decade, reaching more than 55% of the total by 1991. Production of these varieties have followed the same trend, though at a higher level, accounting for 70% of the total by 1991. The CIMMYT study mentioned above confirms that there has been broad-based acceptance of these varieties, which it places at 30% of the total area in 1988.

Furthermore, a 1990 study carried out by the Ghana Grains Development Project, found that 58% of the surveyed farmers were planting improved varieties of maize in at least one of their fields. The main impediment to adoption was the unavailability of certified seeds.

The improved varieties of cowpea have similarly made impresive gains in their overall acceptance by the producers in terms of area and quantum produced. From 1982 to 1989, the share of the total taken by these varieties steadily grew from less than 1%, to more than half of the respective totals.

The same survey mentioned above, found that, in 1990, about 57% of the surveyed farmers planted improved varieties of cowpea in at least one of their fields.

The proportion of the total area taken by improved sorghum varieties have experienced a moderate increase over the study period, growing from about 10% in 1982 to almost 15% of the total in 1991. Similarly, the share of production increased from 12% to 20% of the total in the same lapse.

For Nigeria, the area data in Table IV-4 indicate that the relative importance of improved maize varieties has steadily increased from 1982 to 1990, reaching more than 95% of the total by the latter date. Similarly, production grew from 3 quarters of the total, to 97% in 1990. In contrast, the CIMMYT publication quoted earlier, only places the proportion of the area taken by improved maize varieties at 20% in 1988, which again raises the question as to the relative reliability of these two data sources.

The area planted to improved varieties of cowpea increased its share of the total moderately from 1982 to 1986, reaching 24%, and then remaining constant up to 1990, at about 21%. The production of this crop exhibited the same trend, growing initially from 20% to 35%, and then leveling off at 30% of the total, for the latter part of the period.

Table IV-3. GHANA

Relative Importance of the Improved Varieties of SAFGRAD Crops.

(% of Total)

CROP, AREA AND PRODUCTION	1982	1985	1987	1989	1991
MAIZE					
Area	20.3	30.0	35.0	55.0	55.1
Production	30.2	45.2	50.0	80.0	70.0
COWPEA					
Area	.3	20.0	30.0	50.0	N.A.
Production	.4	27.3	33.3	57.9	N.A.
SORGHUM					
Area	9.5	12.0	12.1	19.9	14.8
Production	11.9	15.1	15.0	25.1	19.9

Source: Table EC1 in the Annex.

Table IV-4. NIGERIA

Relative Importance of the Improved Varieties of SAFGRAD Crops.

(% of Total)

CROP, AREA AND PRODUCTION	1982	1986	1988	1989	1990
MAIZE					
Area	68.4	85.4	92.7	92.7	95.5
Production	75.0	90.0	95.0	95.0	97.0
COWPEA					
Area	11.1	24.4	20.5	20.5	20.5
Production	20.0	35.0	30.0	30.0	30.0
SORGHUM					
Area	32.7	42.3	51.9	51.9	51.9
Production	40.0	50.0	60.0	60.0	60.0
MILLET					
Area	65.1	80.9	75.0	75.0	75.0
Production	70.0	85.0	80.0	80.0	80.0

Source: Table EC1 in the Annex.

The proportion of the total area planted to improved sorghum varieties, increased steadily in the period, from 33% in 1982, to 52% in 1990. This trend was mirroed by the production from these varieties, which grew from 40% to 60% of the total in the same lapse.

The area planted to improved varieties of millet increased their share of the total, initially (1982-86) from 65% to 81%, and then declined to 75%, remaining at the latter level until 1990. Similarly, the quantum produced from these varieties increased its contribution to the total about 15 percentage points at the beginning of the period, leveling of 80% between 1988 and 1990.

2. Crop Production and Productivity Changes.

Burkina Faso.

a) *The basic production data provided (Table EC 1 in the Annex) refer to all of the varieties of the four main crops (maize, cowpeas, sorghum and millet), with no distinction made even between improved and non-improved, or "traditional" varieties.*

b) *Maize production almost triplicated over the study period, while the area planted to this crop expanded by 50%. SInce yields almost doubled in the same lapse, the implications are that most of the observed increases in maize production were due to real gains in productivity.*

c) *Cowpea production almost trebled from 1984 to 1991, while the area planted to this crop expanded by about 64%. Since the corresponding yields increased 2.6 times in the same period, it is apparent that most of the observed growth in production came as a result of gains in productivity.*

d) *Sorghum production doubled in the decade, while the area sown to this crop increased only slightly, about 5%. Since yields more than doubled in the same period, it can be concluded that nearly all of the increase in production was due to advances in productivity.*

e) *Millet production rose in the study period by a factor of 2.6, while the area planted to this crop expanded by about 83%. Since the corresponding yields increased by 44%, the implications are that most of the observed growth in production, came as a result of the expansion in the area planted, rather than a real gain in productivity.*

f) *The basic production data on the main competitive crops (Table EC2), reveal that the most important such commodity for Burkina is groundnuts, covering an area in 1991 at approximately the same order of magnitude than maize (about 176,000 has). Groundnuts production grew in the period by about 40%, while the area planted to this legume expanded only 14%. Since the corresponding yields grew moderately (about 23%), it is apparent that most of the increases in production reflect advances in productivity.*

g) *Rice production increased only slightly in the decade (by 2%), while the area planted to this grain shrunk about 23%. The resulting yields rose moderately (33%), indicating that a great deal of the small increase in production came as a result of productivity gains.*

h) *The data provided for green beans for 1989-91, reveal that production declined 32 percent, while the area planted to this legume remained stationary, around 400 hectares. The corresponding yields dropped by 26%,*

reflecting a moderate decrease in productivity.

i) Production of yam in the study period was almost halved, while the area planted to this root crop shrunk 28%. The resulting decrease in yields exactly matched the reduction in area, which indicates that most of the drop in production was brought about by a contraction in the area.

Cameroon

a) The basic production data for the main crops were only available for the quinquennium 1984-89 and refer to all varieties, with no distinction made by technological level. However, additional data, which made this distinction, were obtained from a different source and discussed in section c1 above.

b) Maize production rose slightly by 8%, while the area planted declined marginally by 1%. Yields for this cereal increased slightly (about 5%) in the same period, indicating that most of the relatively small growth of production was due to productivity gains.

c) Cowpea production increased slightly in the five-year period (4%), while the area planted to this crop declined about 4%. Yields rose moderately (28%), which implies that virtually all of the increases in production came as a result of corresponding gains in productivity.

d) Sorghum production increased by about 41% in the lapse, while the area planted to this grain rose 25%. The resulting growth in yields of 23%, implies that nearly all of the rise in production came from an expansion in the area sown to this crop, rather than from productivity gains.

e) *Rice production shrunk considerably in the five-year period (85%), which was matched by an equally drastic drop in area planted (86%). Yields, however, only exhibited a moderate decline (18%), which indicates that virtually all of the contraction in production was due to area cutbacks, rather than to real losses in productivity.*

f) *Groundnuts production contracted moderatly by about 28%, which was matched by a similar drop in area planted. Since yields remained stationary in the same lapse, it is apparent that the shrinkage in area was largely responsible for the decline in production, with no significant effect on productivity.*

g) *Yam production declined sharply in the quinquennium (40%), while area also shrunk, to a lesser extent (11%). Since the corresponding decline in yields was slightly greater than the contraction in production (44%), the implications are that the drop in production was due mainly to a reduction in productivity.*

h) *The figures for wheat show that production, hectareage and yields for this crop remained unchanged in the lapse, which means that productivity also stayed at the same level.*

Ethiopia.

a) *The basic crop production data obtained should be regarded with caution, particularly for the last three years of the series, given that prevailing insecurity situation in some parts of the country has significantly curtailed the collection of agricultural data. Thus, for instance, the figures for sorghum for 1990 and 1991 exclude production from Erithrea and Tigrey, which are important growing areas for this crop. To eliminate at least some of the resulting, spurious*

variations in the sorghum data, the period of reference used was 1982-89. The data given for the main crops being considered, do not distinguish between varieties.

b) *Maize production declined 10% in the decade, while the area planted to this crop rose moderately by 24%. Since yields also shrunk in the lapse (22%), it is apparent that nearly all of the contraction in production was the result of an actual drop in productivity.*

c) *Sorghum production contracted about 24% in the 7-year period, which was accompanied with a somewhat lesser drop in area planted (19%). The corresponding shrinkage in yields (24%), indicates that there was a real reduction in productivity.*

d) *Millet production shrunk sharply (36%) in the decade, while the area planted to this grain contracted 31%. The more moderate decline in yields (13%) observed in the same period, indicates that most of the drop in production was due to the contraction in area, rather than productivity, even though the latter also declined.*

e) *Tef is the most important competitive crop for Ethiopia, surpassing all of the other food crops being considered in hectareage, and running a close second to maize in tonnage. Tef production in the decade rose by about 11%, while area planted increased significantly more, by 42%. Since yields shrunk in the same period by 11%, the implications are that virtually all of the increases in production came about as a result of the expansion in area, while productivity dropped.*

f) *Wheat production shrunk in the period about 14%, while area planted to this crop also contracted, 15%. The corresponding yields declined only slightly (4%), which implies that practically all of the drop in production was the result of a contraction in area, rather than of a decline in productivity.*

Ghana.

a) *The basic production data provided, distinguish between all of the improved varieties vs all other, non-improved varieties, for the 4 SAFGRAD-mandated crops.*

b) *Maize production of the improved varieties increased eight-fold in the decade, while the area planted rose by a factor of six. Since yields increased only moderately in the same period, it is apparent that most of the observed increase in production was the result of the expansion in area, rather than of a growth in productivity.*

c) *Maize production of the non-improved, "traditional" varieties increased 52% in the period, while area planted rose somewhat less (24%). Since yields increased almost at the same rate than the area, the implications are that productivity rose only marginally, while the area expansion accounted for most the observed growth in production.*

d) *Cowpea/production of the improved varieties rose considerably in the period (more than 800%), while the area planted to this crop expanded astronomically (about 2,500%). Since yields were almost halved, it follows that virtually all of the growth in production came from the area expansion.*

e) *Cowpea production of the non-improved varieties shrunk about 34% in the lapse, while area planted contracted by 56%. Since the corresponding yields also dropped, but at a somewhat lower rate (29%), these changes indicate that most of the decline in production was caused by a reduction in area planted, rather than by a reduction in productivity.*

f) *Sorghum production of the improved varieties trebled in the period, while area planted rose about 70%. Since yields grew by about 89%, the implications are that real productivity increases contributed more to the growth in production, than the expansion in area planted.*

g) *Sorghum production of the non-improved varieties more than trebled in the decade, while the area planted rose only marginally (2%). Since yields also trebled, it follows that virtually all of the increases in production came as a result of real productivity gains. Hence, the non-improved varieties of sorghum feared considerably better than the improved ones, with respect to productivity.*

h) *Millet production, all of it from non-improved varieties, declined slightly in the period (about 7%), which was exactly matched by the drop in hectareage. Since the corresponding yields remained stationary, this indicates that there were no significant changes in productivity and that the reduction in production was fully brought about by the shrinkage of the area planted.*

i) *Yam constituted the most important competitive crop in Ghana with respect to the above 4 commodities, both in terms of quantity produced and hectarage covered. Yam production grew in the period by a factor of 4.7,*

while area planted more than doubled. Since the corresponding yields rose about 56%, it can be inferred that most of the increase in production was due to the expansion in area, albert there were also some moderate gains in productivity.

j) Rice production trebled in the period, while the area planted to this gains doubled. SInce yields also almost doubled, it follows that the observed increases in production were virtually everly asaibable to the expansion in area and in productivity.

k) The production of groundnuts increased significantly in the lapse (about 41%), while the area planted to this legume rose slightly (10%). Since yields declined also slightly (8%), it follows that most of the rise in production came as a result of area expansion, rather than from any significant productivity gain.

Kenya.

a) The basic production data which were provided refer to all of the varieties of the main 4 crops being considered, with no distinction made by technological level.

b) Maize production grew slightly in the period, (12%), at a marginally higher rate than the area planted (10%). Since yields contracted (about 11%) in the same lapse, it follows that all of the observed production increases came as a result of the expansion in area.

c) Cowpea production rose from 1986 to 1991 about 66%, compared to an areal expansion of 32% in the same period. Since the corresponding yields dipped 20%, it can be conclucted that all of the increase in production was due to the growth in area planted, while

productivity declined.

d) *Sorghum production increased slightly (7%), for 1983-91, while the area planted to this grain shrunk about 7%. Since yields declined 26%, it is apparent that there was a significant contraction in productivity in the period.*

e) *Millet production almost trebled between 1983 and 1991, while the area planted to this grain shrunk by 8%. Since yields grew by a factor of 3.7, it follows that virtually all of the increase in production was due to real productivity gains.*

f) *Green beans constitute the most important competitive crop in Kenya, with respect to the above 4 commodities, (in terms of area planted), having reached the level of more than 1.1 million hectares in 1990, compared with 1.8 million for maize, which is the main staple. Production of green beans in the period from 1983 to 1990, more than doubled, while the area planted grew by 92%. Since yields also rose significantly (44%), the implications are that most by the increase in production was due to the expansion in area planted, albeirt there was at least some productivity increase.*

g) *Rice production rose in the decade about 15%, while area planted shrunk slightly (about 8%). Since the corresponding yields grew significantly (52%), it is apparent that all of the growth in production came as a result of real productivity gains.*

h) *Production of groundnuts increased in the decade by 40%, while area planted rose somewhat less (11%). Since yields also grew (26%), it follows that a significant portion of the observed rise in production*

was attributable to real gains in productivity, and to a lesser extent to the expansion in the area sown to this crop.

i) Wheat production declined slightly in the study period (5%), compared to moderate increase in the area planted (26%). Since the corresponding yields shrunk appreciably (24%), it is apparent that there was a contraction in productivity for this commodity.

Mali.

a) The basic production data provided refer to all of the varieties of the main 4 crops being considered, without distinguishing between improved and non-improved varieties.

b) Maize production grew about 69% in the decade, while the area planted to this crop almost doubled. Since yields fell significantly (39%), the implications are that all of the increase in production was the result of the expansion in area, while productivity actually declined.

c) Cowpea production rose substantially (79%) from 1983 to 1991, while area planted almost doubled. Since yields increased in the same lapse about 41%, it is apparent that most of the production increase came from the expansion in area, while there were also some productivity gains.

d) Sorghum production grew about 41% in the study period, while the area sown to this grain more than doubled. Since there was a drop in yields of about 32%, it follows that all of the increase in production was due to the area expansion, with no gain in productivity.

e) *Millet production remained almost stationary in the decade, while the area planted rose moderatly, about 12%. Since yields fell about 14%, the implications are that a significant contraction in productivity actually took place.*

f) *Rice comprises the most important competitive crop with respect to the above four commodities, surpassing maize both in terms of area and quantity produced. Rice production in the decade increased 83%, while the area planted rose more moderately, at 29%. Since yields grew at 71%, it follows that a great deal of the observed rise in production was due to gains in productivity, while the area expansion contributed somewhat less.*

g) *Groundnuts' production rose 73% in the period, while the area planted to this crop increased 27%. The corresponding gain in yields of 19%, signifies that the production increase was caused both by a moderate gain in productivity and to a greater extent by the expansion in area that took place.*

h) *Production of green beans for the lapse 1982-90, halved, while area planted shrunk 63%. Since the corresponding yields rose 60%, the implications are that there was a significant gain in productivity, in spite of the dampening effects of the area contraction on production.*

i) *Yam production for 1983-91, contracted slightly (3%), while the area planted experienced a larger drop (25%). Since yields rose moderately (13%), it is apparent that there was some growth in productivity, which affected production to a greater extent than the countervailing area contraction.*

j) *Wheat production during 1985-91 declined 33%, while area planted contracted 41%. Since the corresponding yields fell 12%, it follows that there were some gains in productivity, that partially offset the negative effects that the area contraction had on production.*

Niger.

a) *The basic production data obtained refer to all of the varieties of the 4 main crops under consideration, with no distinction made by technological level.*

b) *Maize production shrunk 67% in the decade, while the area planted similarly contracted by 64%. Since the corresponding yields only fell slightly (6%), it can be concluded that there were some gains in productivity, which partially offset the larger negative effect of the area contraction on production.*

c) *Cowpea production rose 22% in the study period, while the area planted increased substantially (87%). Since yields moved in the opposite direction, contracting about 12%, it follows that all of the observed increase in production was due to the expansion in area, while productivity declined.*

d) *Sorghum production grew 17% in the lapse, while the area planted rose considerably (82%). Since the corresponding yields shrunk 14%, it is apparent that virtually all of the production increase came as a result of area expansion, rather than from productivity gains.*

e) *Millet production increased 41% in the decade, while the area planted also rose about 45%. Since yields declined slightly (3%), indications are that all of the increase in production was the result of the area expansion, with no productivity increases being in*

evidence.

f) *Groundnuts constitute the principal competitive crop with the above 4 commodities, of which millet is not inclucted in the SAFGRAD networks, albeirt the latter is the most important grain crop in Niger. Groundnut production shrunk 64% in the study period, while area planted contracted 47%. Since yields also fell, to a lesser extent (26%), it follows that there was a decline in productivity.*

g) *Rice production shrunk considerably in the period (80%), while the area planted contracted somewhat less (68%). Since the corresponding yields rose 31%, it is apparent that there were significant gains in productivity, although these were more than offset by the stronger negative effect that the area contraction had on production.*

h) *Wheat production more than doubled in the period, but the absence of corresponding area figures, curtails the productivity growth analysis for this crop.*

Nigeria.

a) *The basic production data provided, distinguish between all of the improved varieties, and the non-improved ones, for the four SAFGRAD-mandated crops.*

b) *Maize production of the improved varieties almost trebled in the period 1982-90, while the area planted grew about 2.5 times. Since yields advanced only moderately (20%), it follows that most of the increase in production was the result of the area expansion, albeirt there was a slight gain in productivity.*

c) *Maize production of the non-improved varieties shrunk considerably (57%), which was accompanied by a greater*

drop in the area planted (61%). Since the corresponding yields rose slightly (9%), the implications are that there was a small gain in productivity, which had little countervailing impact on the dampening effect of the area on production.

d) *Cowpea production of the improved varieties, more than trebled in the nine-year period, while the area planted grew 2.5 times. Since the corresponding yields advanced moderately (25%), it is apparent that, while most of the increase in production was due to the area expansion, there was also some gain in productivity.*

e) *Cowpea production of the non-improved varieties, almost doubled, while the area planted rose 28%. Since there was a significant growth in yields (51%), it follows that most of the increase in production was the result of real gains in productivity.*

f) *Sorghum production of the improved varieties rose 61% in the period, while the area planted increased about 42%. Since yields grew by 14%, the implications are that, while most of the increase in production came as a result of the area expansion, there was also some gain in productivity, to a lesser extent.*

g) *Sorghum production of the non-improved varieties shrunk 28% in the period, while the area planted contracted 36%. Since the corresponding yields rose about 13%, it is apparent that there was a slight gain in productivity, which had little effect on the negative impact exerted by the area contraction.*

h) *Millet production of the improved varieties rose 44% in the lapse, while the area grew by 20%. Since the increase in yields was also in the order of 20%, it*

follows that most of the rise in production was due to the area expansion, rather than to productivity gains, albeit the latter also rose slightly.

i) *Millet production of the non-improved varieties shrunk 20% in the period, while the area planted contracted by about 10%. Since the corresponding yields experienced a 13% growth, all indications are that there was a slight gain in productivity, which had little effect on the negative impact that the are contraction exerted on production.*

j) *Groundnuts comprised the most important competitive crop compared to the 4 main ones above, covering more than 1.0 million hectares in 1991. Production of this legume grew 2.7 times in the study period, while the area planted increased 74%. Since yields rose 53%, it follows that, while most of the increase in production was due to the area expansion, a significant gain in productivity also took place.*

k) *Rice production expanded 3.7 times in the period, while area planted grew by 59%. Since the corresponding yields almost trebled, it is apparent that most of the observed increases in production, were the result of real productivity gains.*

l) *Yam production over the period 1982-90, rose 58%, while the area planted increased 74%. Since yields advanced only about 12%, the implications are that most of the increase in production was due to the expansion in area, albeit there was a slight contribution afforded by productivity gains.*

m) *Wheat production experienced an explosive growth in the period (nearly 1,000% rise), while the area planted grew only slightly (8%). Since the correspon-*

ding yields also underwent a rapid, near ten-fold expansion, it follows that virtually all of the observed increase in production came as a result of substantial productivity gains.

3. *Livestock Production and Productivity Changes.*

Some limited, basic production data were collected pertaining to the main livestock enterprises in the sub-region (cattle, sheep and goats), in an attempt to ascertain their relative importance and performance compared to the main crops under scrutiny. These data were obtained for all of the sample countries, at various degrees of completeness, and are recorded in Table EC3 of the Annex.

a) *Burkina Faso.*

The size of the herd of all three types of livestock expanded substantially in the period, especially for sheep and goats, that almost trebled. The value of sales rose 55% for cattle and by a factor of 4 for sheep, which, together with the considerable greater off take of the latter (as well as for goats), indicates that there has securlarly been a higher proportion of commercialization and dynamism in the marketing of small ruminants than of cattle. Note, for instance, that in 1990, the offtake was only about 6% for cattle, compared to 37% for sheep and 57% for goats. Furthermore, in 1989, the total value of sales of the small ruminants were each four times greater than that of cattle. These differences tend to suggest that in the market place, in terms of the propensity to sell and the ability to generate short-to-medium-term revenue, small ruminants are more competitive than cattle, with the four crops being examined.

b) Cameroon.

The size of the cattle herd shrunk about 13% in the period, while the number of sheep increased 16% and that of goats remained stationary. The value of sales for all three types of animals fell significantly, reflecting a combination of stationary unit prices and secularly low rates of offtake. For instance, in 1990, only 15% of the cattle, 8% of the sheep and 11% of the goats were commercialized. Thus, these figures suggest that in the market place, these livestock enterprises would tend to pose a relatively low level of competition, as revenue generators, to the four main crops.

c) Ghana.

The size of the herd grew significantly in the period for all 3 types of livestock, 24% for cattle, 46% for sheep and 81% for goats. Since these animals normally graze together in the same pasture land, the imputation of the total permanent pasture area to each of them, in turn, yield estimates of their relative productivity, with respect to the factor land. Thus, in 1989, sales of cattle yielded 1,079 Cedis per ha. of pasture land, compared to 289 Cedis for sheep and 192 Cedis for goats. These figures reflect the prevailing relatively low levels of commercialization of these animals, considering the rapid growth in the value of sale, which increased nearly six-fold for cattle, and more than doubled for sheep and goats in the period. Note, additionally, that offtake rates only reached 11% for cattle and 4% for sheep and goats in 1991. A comparison of the above sales per unit values with the total value of production for the 4 crops under analysis, reveals, for 1989, the following: i) the unit value of production for the improved

varieties of maize was 87,000 Cedis, compared to 28,090 Cedis for the non-improved varieties; ii) the corresponding values for cowpea were 19,734 and 16,867 Cedis respectively; iii) for sorghum, these values were, in order 79,120 cedis and 59,221 Cedis; iv) for millet, the comparable figure (only for non-improved varieties) amounted to 84,856 Cedis. Thus, the foregoing suggest that all crops, and particularly the improved varieties, (ostensibly so for maize), yield substantially higher values per unit of land than the livestock enterprises. This relative gross "productivity" performance remains unchanged even after discounting 50% from the crops' values, to approximate the per unit value of sales.

d) Ethiopia.

The cattle herd increased about 16% in the period, while the numbers of sheep and goats rose only slightly, 2%. The value of sales per hectare rose moderately for cattle (28%) and somewhat less for sheep and goats (13%), in the lapse 1990-92. The latter reflect a moderate increase in unit prices, for cattle (25%) and for sheep and goats (20%), as well as the prevalence of relatively low offtake rates, especially for cattle. Note, for instance, that in 1991, only 7% of the cattle were sold, compared with 29% of the sheep and goats. In the same year, sales per hectare of pasture land amounted to 26 Birr for cattle, for an animal weighing 136 kg. The comparable figures were: for 15 kg sheep, 12 Birr, and for a 12.5 kg goat, 7 Birr. In contrast to the above gross "animal value productivity" estimates, in 1989, the total value of production per hectare was 937 Birr for maize, 672 Birr for sorghum and 546 Birr for millet. Adjusting the latter figures to account for the 15% level of commercialization of these crops, yields gross "crop

value productivity" estimates of 140 Birr for maize, 101 Birr for sorghum and 82 Birr for millet. Thus, it seems that all of these crops generate substantially more gross sales revenue per unit of land, than livestock, since the least "productive", crop (millet), generates 3 times the amount of the most productive livestock enterprise (cattle).

e) Kenya.

The cattle herd increased slightly during the decade (3%), while the populations of sheep and goats experienced considerable higher expansion, growing at 48% and 41% respectively. The value of sales for 1982-86, rose 15% for cattle, quadrupled for sheep and more than doubled for goats, indicating higher dynamism in the commercialization of small ruminants. The rates of offtake for 1986 tend to confirm the latter, since they stood at 13% for cattle and goats and 24% for sheep. THus, the implications are that the sheep enterprises are more likely to be tapped as a source of short-to-medium-term revenue than the other two types of livestock, and sheep would therefore tend to be more competitive with the crops being examined, at the market place, ceteris paribus.

f) Mali.

The cattle herd shrunk significantly (25%) during the 1982-90 period, while the populations of sheep and goats remained virtually static. The value of sales rose appreciably for all three types of livestock, reflecting a combination of higher unit prices, -- which grew 35% for cattle, 16% for goats and 8% for sheep -- and a greater degree of commercialization of all types of livestock, as judged by offtake rates that doubled for cattle and increased 48% for sheep

and 40% for goats during the period.

g) Niger.

The cattle herd and that of goats contracted 18% and 22% respectively during the period, while the number of sheep remained unchanged. The value of sales for 1989-91 rose 69% for cattle and 22% for sheep, while declining 9% for goats. These changes reflect the relative growth in unit prices for these products -- which rose 23% for cattle, 28% for sheep and 7% for goats -- considering the low rates of offtake for the three types of animals, which only amounted to 6% for cattle, 18% for sheep and 12% for goats. Thus, sheep were the most dynamic type of animals and the most likely to compete with crops as a source of short-to-medium term revenue.

h) Nigeria.

The cattle herd grew 38% during the decade, compared to a 63% increase for goats and a doubling of the number of sheep. The rates of offtake were estimated at 9% for cattle, 20% for sheep and 25% for goats, which indicate that small ruminants are twice as likely to be commercialized as a source of short-to-medium-term revenue, than cattle. These figures also tend to suggest that cattle are more likely to be used as a means of savings (stored capital), than small ruminants.

4. Profitability of Production.

This section will examine the relative profitability of production for the crops under consideration, based upon the partial cost-benefit data compiled in Tables EC1, 2, 4 and 5. The discussion that follows will refer, in turn, to Ethiopia and

Nigeria, which were the only two countries that provided the required cost data.

a) Ethiopia.

The data on average yearly expenditures on the main production inputs (Tables EC 4 and 5), reveal that hired labor constitutes the most important single outlay, for all the 5 crops examined. In 1989, for instance, expenditures on hired labor accounted for: 72% of the total for maize; 80% for sorghum; and 63% for millet, tef and wheat. In contrast, the expenditures on seeds represented 5% of the total for sorghum, and 12% for all the other crops.

The combination of the figures on value of production per crop (Tables EC 1 and 2) and those on expenditures on inputs, yields estimates of gross and net partial returns per crop per year. Over the period 1982-89, net returns from maize grew about 11%, reaching 726 million Birr by the latter date. In contrast, net returns from sorghum and millet enterprises declined slightly, 7% and 4% respectively. The comparable figures for the main competitive crops with respect to the forgoing 3, show that net returns from tef rose in the period 14%, reaching 633 million Birr by 1989, while those for wheat grew by 7%, to the level of 334 million Birr in the latter year.

Table IV-5 summarizes the findings on the relative profitability of all five crops -- of which only sorghum and millet are included in the SAFGRAD networks -- based on their changes in net returns per hectare planted per year. From the latter table, the following picture emerges:

i) *the per unit profitability of all 5 crops rose over the period, albeit there were some fluctuations in the intervening years. No single crop showed a continuous ascending trend in net returns per hectare;*

ii) *in 1987 and 1989, maize constituted the most profitable crop per unit of land, yielding 590 and 895 Birr per hectare, respectively;*

iii) *in 1982 the highest per unit profitability was attained by sorghum, while in 1985, wheat outperformed all the other crops in this regard;*

iv) *the per unit profitability of millet was the lowest among the five crops in all but one of the four years examined;*

v) *the greatest amount of competition, in terms of per unit profitability -- and the implied alternative utilization of the same productive resources -- appears to take place between maize, sorghum and wheat, especially in the latter years of the study period.*

The obvious implications of the above, are that future agricultural network research activities in Ethiopia, should seriously consider the feasibility of incorporating alternative or supplemental commodities such as maize and wheat.

b) *Nigeria.*

In this case, the expenditure data provided make the distinction between all improved varieties and the non-improved ones, for the four main crops, although only three types of expenditures are reported. For all the seven crops examined, hired labor constituted the highest single

Table IV-5.

ETHIOPIA

Net Returns per Hectare for Selected Crops.

(Birr)

CROP	1982	1985	1987	1989
MAIZE	528	596	590	895
SORGHUM	556	369	568	645
MILLET	329	571	338	479
TEF	418	560	450	560
WHEAT	459	701	522	701

Source: Tables EC 4 and 5 in the Annex.

yearly cost outlay, accounting, in 1990, for 62% of the total expenditures for improved maize and millet, up to 76% of the total for non-improved sorghum. Among the competitive crops, groundnunts' enterprises spent 81% of their total outlays for inputs in labour, compared to 72% for rice and 67% for wheat. In contrast, the proportion of the total taken by seed expenditures ranged only from 10% to 23%, in the same year, across all seven commodities.

Over the period 1982-90, net returns from improved varieties of the four main crops increased cnsiderably, ranging from 166% for maize to over 900% for cowpea, with both sorghum and millet more than trebling their gross levels of profitability. In contrast, net returns from non-improved maize varieties fluctuated wildly during the period, contracting 65% by 1990. The non-improved varieties of the other 3 main crops feared much better than maize, as shown by net returns which rose by over 50% for cowpea, 35% for sorghum and more than doubled for millet. Thus, in all cases the improved varieties yielded considerably higher net returns than their non-improved counterparts. Net returns for the main competitive crops grew astronomically during the period, by more than 4,000% for rice, 2,500% for

groundnuts and 5,900% for wheat, which reflects the substantial gains in productivity experienced by these commodities (as discussed in Section C above), especially in the case of wheat.

Table IV-6 summarizes the estimates of the relative profitability of the seven crops being examined, per unit of land. The findings from the scrutiny of this table, are the following:

i) the profitability per hectare of improved maize, cowpea, sorghum and millet, was significantly higher in every year, than the corresponding one for the non-improved varieties. The differences between these two types of technologies, were considerably narrower for sorghum and millet, than for maize and cowpea;

ii) the per unit profitability for all varieties of the four main crops, rose substantially between 1982 and 1988, and then declined between the latter date and 1990. This contraction at the end of the period was substantial for maize and sorghum and moderate for cowpea and millet;

iii) throughout the whole period of observation, the improved varieties of cowpea recorded the highest net returns per hectare than any variety of the other 3 crops;

iv) maize exhibited the lowest per unit profitability among all four crops, in all but one of the years examined;

Table IV-6.

NIGERIA

Net Returns per Hectare for Selected Crops

(NAIRA)

CROPS	1982		1986		1988		1990	
	IMP.	OTHER	IMP.	OTHER	IMP.	OTHER	IMP.	OTHER
MAIZE	212	165	215	168	2,163	1,328	182	184
COWPEA	548	224	955	522	2,567	1,355	2,084	1,188
SORGHUM	299	226	321	250	1,570	1,266	690	481
MILLET	354	298	409	314	2,019	1,487	1,170	836
RICE	762		3,578		11,107		15,282	
GROUNDNUTS	400		2,171		2,318		3,926	
WHEAT	87*		625		5,896		4,015	

* The figures given is for 1984

Source: Tables EC 4 and 5 in the Annex.

v) *throughout the study period, net returns per hectare of planted rice were considerably higher than those of the most profitable variety of any of the four main crops. For instance, in 1988, rice out performed improved cowpea in this respect, by a factor of four;*

vi) *groundnuts also outperformed all varieties of the four main crops in 1986 and 1990 and ran a close second to cowpea in 1988, which yielded only 10% more per hectare;*

vii) *from 1988 to 1990, wheat also recorded considerable higher net returns per hectare than all varieties of the four main crops. For example, in 1990, the per unit profitability of wheat was almost double that of cowpea.*

From the foregoing, it follows that, rice and wheat, and to a lesser extent groundnuts, provided a strong competition to the four main commodities -- especially in the last five years -- in terms of their ability to generate short-and medium-term income per unit of land. Thus, this implies that future agricultural network research activities in Nigeria, should give due consideration to the feasibility and relative effectiveness of providing support for alternative (or suplemental) commodities such as rice, wheat and groundnuts.

5. *Disposal of Production.*

This section will examine what happens to production of the main crops immediately after the harvest, by reference to the principal destinations, in an attempt to obtain some insight into the final end use of these commodities. The discussion that follows will refer, in turn, to Ethiopia, Kenya and Nigeria, which were the only three countries that provided the required data in Table EC 6.

Table IV-6.

NIGERIA

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CROPS	1982		1986		1988		1990	
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a) *Ethiopia.*

The data gathered refer to all varieties of maize, sorghum and millet, with no distinction made by level of technology. The implied total production obtained from the aggregation of all types of disposal given, over-states (for all crops and years), the corresponding totals given in Table EC 1, even though no figures were provided for "losses and gifts". In spite of this data inconstistency, it is possible to arrive at estimates of the proportional distribution of production, among the main types of disposal, considering that post-harvest losses would tend to range from 10 to 20% of production, in a "normal" year.

Over the study period, on-farm consumption of maize (for human and animal use), accounted for nearly three fourths of all disposals, which underscores the importance of this commodity as a basic staple food. In contrast, all maize sales were estimated to represent about 15% of production, while retained seeds accounted for 13% of the total.

On-farm consumption of sorghum amounted to 72 percent of all disposals, indicating the preferred use of this crop as a basic staple. The estimated level of commercialization of this grain was 15% of production, while retained seeds accounted for 13% of the total.

The pattern of disposal of millet production was estimated to be identical to that of sorghum, with 72% consumption on farm, 15% total sales and 13% retained for seeds.

b) Kenya.

The data provided refer to all varieties of maize, cowpea, sorghum and millet, with no distinction made by the level of technology. The aggregate disposal figures were generally higher than the corresponding production totals (from Table EC 1) for maize. In the case of sorghum the reverse was true, except for the period 1989-91. For cowpea and millet, the difference between these totals were virtually non-existent.

Over the study period, it is estimated that half of the production of maize is consumed on the farm, as human and animal food and as retained seeds for the next planting season. Sales accounted for 40% of all disposals, which was the lowest level of commercialization among the four crops examined. Post-harvest lossess and gifts were estimated to take up the remaining 10% of the total.

The estimated differential disposal of sorghum mirroed that of maize, with 50% of the total dedicated to on-farm consumption, while 40% was sold and 10% was lost or given away.

For all but two of the years in the lapse 1983-91, about 40% of the sorghum produced was consumed on place at the farm. Sales ranged from 50 to 55 percent, with the mode occurring at the upper level of the distribution. Thus, this constituted the most commercialized of the four crops under scrutiny, which reflects the on-going efforts in Kenya towards expanded industrial utilization of this commodity, e.g., in the manufacture of bread and beer. Sorghum lossses and gifts hovered around 5% of total production.

About 40% of the millet production is estimated to

remain in use on the farm, compared to 54% sold and 6% lost or given away. Thus, this basic food grain also enjoys a relatively high level of commercialization which reflects its preferred disposal as a source of short-term income.

c) *Nigeria.*

The data provided distinguish between all the improved varieties and the non-improved ones for maize, cowpea, sorghum and millet. The aggregate disposal figures for maize were generally slightly higher than the corresponding production totals given in Table EC 1. For cowpea and sorghum, both production totals were virtually identical over the entire study period, which inspires a higher degree of confidence in the data. In the case of millet, the implied total production aggregates from Table EC 6 were slightly lower than those corresponding totals obtained in Table EC 1.

For 1982-90, it is estimated that 42% of the production of all varieties of maize was commercialized, compared to 32% consumed on the farm. The proportion set aside as seeds, amounted to about of 3% of the total. The level of commercialization of maize was the highest among the four crops examined, which implies that this commodity is preferentially tapped as a source of short-term income. Losses and gifts took up the remaining 23% of total production.

On farm consumption of all varieties of cowpea accounted for about 58 percent of total production, compared to 32% sold, on the average. Some 4% of the total was set aside for seeds, while the remaining 6% was sold or given away.

In the case of sorghum, accross all varieties, more than two-thirds of production was consumed on the farm, compared to 17% being commercialized. The portion retained for seeds only amounted to 5% of all disposals, while losses and gifts took up 10% of the total.

Some 58% of all varieties of millet was dedicated to human and animal food on the farm, compared to about 20% sold and 3% set aside for seeds. Losses and gifts accounted for one-fifth of all disposals of production.

D) *Implications of the Findings from the Economic Analysis.*

1. *Respecting the nature of Future Agricultural Research in the Sub-Region.*

The foregoing analysis suggests that donors such as USAID, should seriously examine the feasibility of altering the mix of commodities being supported through agricultural research. This would involve incorporating into the network research activities, relatively profitable crops such as maize and wheat in East Africa and rice, wheat and grounduts in West Africa. Furthermore, livestock enterprises, particularly cattle and small ruminants -- which have secularly constituted an integral component of the prevaiting production systems -- should be incorporated into network research activities, as natural complements to the commodities being supported. The strengthening of livestock research activities and their integration with the current food crop efforts, would contribute substantially towards the development of sustainable, combined crop-livestock systems in the sub-regions.

There might be a need to re-examine -- at least in some of the countries of the sub-region -- the particular types of technologies that are currently emphasized. This may call for a conscious shift in research efforts, for instance, from the development of new high-yielding, early-maturing varieties of the four crops being supported, towards developing or improving local cultivars which are well adapted to the prevailing, below - normal rainfall conditions and traditional, low-level technological farming practices. The latter would require, for example, fostering research activities for commodities such as millet in Niger, which is well adapted to climatic conditions and agronomic practices and is performing at relatively high levels of efficiency.

More emphasis shoud be given to research into appropriate farming practices followed by the peasant and small-scale producers, in the simultaneous pursuit of food security and risk avoidance. An understanding of the motivations for and the actual techniques being used by the producer, is essential for the improvement of his/her efficiency.

2. Respecting Agricultural Development Policy.

One of the most important lessons garnered from this assessment, is that new agricultural technologies are not automatically transferrable from the research station level to the producer's fields. The process of disseminating these technologies, oftentimes is rife with obstacles that impede, retard or lessen the impact of innovations. Outstanding among the factors that exert a negative impact on adoption, are found; a) the price and availability of key inputs, such as commercial fertilizers and seeds; and b) the effectiveness of the Extension Services and of the corresponding linkage between the agricultural researcher and the producer.

Considerable more efforts should be devoted towards discerming and analyzing the impact that agricultural development and macro-economic policies, have on the adoption of new technology and by implication, on rural development. It is particularly crucial to examine the workings of governmental policies that impinge on: a) access to production inputs; b) the profitable disposal of production; c) the availability and price of credit; and d) the agro-industrial transformation of agricultural commodities.

The continuation of effective agricultural research activities in the sub-region, necessitates clear, unequivocal and sustained governmental guidance and support, as would be exemplified by providing adequate financial and human resources thereof. In turn, the link between the agricultural researcher and the policy-maker, would be enhanced and made more effective, if the mechanisms are created and implemented, which would ensure the continuous monitoring and evaluation of the impact of agricultural research. Governments can also play a determining role, in strengthening the crucial link between the researcher and the producer, as a means of fostering technological adoption.

3. Respecting the Applicability of the Results to the Other SAFGRAD Member Countries.

As discussed in the Methodology section of Chapter I and in the Annex, the eight countries chosen for in-depth analysis were deemed as a representative sample of the 26 SAFGRAD member countries. That being the case, the findings and conclusions reached herein would be applicable to all of these countries, albeit with variations of degree, rather than of substance.

The only major variant that should be observed -- and which was kept present throughout this assessment -- is that between the countries in West and Central Africa vs those in East Africa, which would account, for instance, for significant differences in the relative importance of the basic commodities scrutinized

and their principal competitors. Nevertheless, the latter does not detract from the general applicability of the findings discussed in points 1 and 2 above, with respect to the rest of the SAFGRAD member countries.

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ECONOMIC ANALYSIS OF THE PROCESS OF ADOPTION OF TECHNOLOGICAL INNOVATIONS AND THEIR IMFMCT, A CASE STUDY OF EIGHT SAFGRAD COUNTRIES

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