ARTS/FARA

Office of Analysis, Research and Technical Support
Food, Agriculture and Resource Analysis

Preliminary

Strategic Framework for Agricultural Technology Development and Transfer in Sub-Saharan Africa

December 1992

Division of Food, Agriculture, and Resource Analysis
Office of Analysis, Research and Technical Support

USAID

Bureau for Africa
United States Agency for International Development
Washington, D.C. 20523

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Preface

This is a preliminary draft of the Africa Bureau's Strategic Framework for Technology Development and Transfer in Africa. It is preliminary because we expect many helpful and insightful comments from our reviewers. We expect these comments because the Framework presents a significant shift in the ways we view and intend to support agricultural research in Africa.

In the Framework, we look to research not only for technology generation but also for bringing about policy and institutional changes. We encourage this broader perspective so that research can have a major role in economic growth by assuring that key African commodities are more efficiently produced and moved to final points of sale. For this reason, we expect research to address the problems experienced by farmers and the constraints of others in the commodity system, including processors, marketing agents and consumers.

In supporting agricultural research, we encourage Missions to expand their policy dialogue and promote institutional reforms so that national technology systems can become more accountable, productive and sustainable. A technology system is defined broadly to include research, extension, the private sector, the universities, private voluntary organizations and the international agricultural research centers working in a country. In our support, we are mindful of the efforts made by the Special Program for African Agricultural Research (SPAAR) to reorganize and revitalize agricultural research on a regional basis in Africa.

We have and will continue to develop this framework in a participatory way. This takes time. We believe it is worthwhile to take time and produce a framework in which all those involved in technology development and transfer have the interest and confidence to help African agriculture move forward efficiently and effectively. We solicit and welcome your comments.

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Strategic Framework for Agricultural Technology Development and Transfer in Sub-Saharan Africa

1. Introduction

1.1 Overview

Support for agricultural technology development and transfer is critical to increase and sustain the contribution of agriculture to economic growth in sub-Saharan Africa. Over the past two decades, modest increases in agricultural productivity have been overwhelmed by population growth. Research investments are producing technologies that producers, processors, marketing agents and consumers can use to increase productivity and improve food security, but much more effort is needed. Creating, adapting and extending a technology is a major undertaking requiring a strong institutional and financial base and collaboration among public and private, local, regional and international institutions. This Strategic Framework guides the Africa Bureau and its Missions in supporting agricultural technology development and transfer in sub-Saharan Africa.

Recent studies commissioned by A.I.D. indicate that technology development and transfer has had an impact in improving the welfare of Africans. The studies show significant positive returns to investments in African agricultural research ranging from 15 percent to 135 percent. In addition, investments in agricultural research have resulted in increases in the quantity of output produced, increases in the productivity of land and labor, and increases in the quantity and quality of technology developed, released and used. In several cases, agricultural research has prevented a deterioration in agricultural production - for example, the rapid transfer throughout Africa of improved cassava varieties resistant to mosaic virus. Also, as output per agricultural worker increases, the non-agricultural sector grows too, and increases occur in the volume of goods exchanged between agricultural and non-agricultural sectors.

Over the past 20 years, A.I.D. has played a critical role in promoting and supporting technology development and transfer in sub-Saharan Africa. Building on this experience, the Strategic Framework recommends several changes in the approach to technology development and transfer, including a shift from supply-oriented development (focus on agricultural production) to demand-oriented development (focus on the demand for a commodity in domestic, regional and international markets). This shift may require agents and institutions--both public and private--to make major changes in modes of operation.

The Strategic Framework provides a structure for identifying key agents of the technology system and making decisions. It avoids prescribing what commodities, technologies or problems should be priorities because such decisions are unique to each country and commodity system. It views the products of research as contributions to technological, policy and institutional changes and emphasizes the importance of interdisciplinary approaches to address a broad range of needs throughout a subsector (commodity) system. It discusses institutional and policy reform measures that may need to be addressed to increase the contribution of research and technology to sustainable increases in agricultural productivity and economic growth in Africa.

Remaining sections in this chapter present background and lessons learned from A.I.D. experience. Chapter 2 defines terms and explains major concepts of the Strategic Framework. Chapter 3 outlines steps in designing and applying a demand-driven approach and clarifies A.I.D. roles and responsibilities.

1.2 Background

The Strategic Framework for Technology Development and Transfer supports and complements the Africa Bureau's strategic frameworks for Natural Resources Management, and Marketing Agribusiness. The three frameworks are all oriented to increasing agricultural productivity in sub-Saharan Africa. The Strategic Framework for Technology Development and Transfer replaces the Plan to Strengthen Agricultural Research and Faculties of Agriculture (1985).

The agricultural sector is the most significant sector in the economies of sub-Saharan African nations because it is the:

- Largest employer of labor,
- Major source of income, contributing a large share of Gross Domestic Product,
- Largest earner of foreign exchange,
- Greatest source of food needed to meet domestic demand, and
- Most important source of raw materials for the industrial (agro-processing) sector.

Given the importance of agriculture in Africa, economic growth is, and will continue in the immediate future to be, linked inextricably with the performance of the agricultural sector, including its informal and formal elements.

As illustrated in The Agriculture and Natural Resource Sector Objective Tree (Figure 1), sustained increases in agricultural productivity are achieved by:

- Greater utilization of profitable and sustainable technologies;
- More efficient marketing of agricultural commodities; and,
- Improved management of natural resources and the environment.

Sustainable growth in African agriculture is dependent on improved productivity in agriculture that leads to increases in income for individuals and the nation. The agriculture sector in Africa includes on-farm and off-farm activities, commercial and noncommercial aspects. It is the foundation of and the driving force in the economies of African nations.

1.3 A.I.D. Experience and Lessons Learned

Over the past 15 years, A.I.D. Africa Bureau financial support for agricultural research in sub-Saharan Africa has fluctuated, increasing to more than $50 million in 1984, and then declining to approximately $30 million in 1992. In general, the technologies that agricultural research activities have focused on are associated with:

- the production aspects of agriculture (with less attention to non-production aspects, such as inputs, markets and processing, or to research in related disciplines, such as markets and policy);

- basic staple-foods or "subsistence" commodities; and

- varietal improvement (with only limited attention to the soil and water resource base constraints).

Commodity Systems Research Centers

The main objective of this directory is to identify centers of information that can be contacted for information on the development of commodity systems. **Information is provided for the following commodities:**

Seafood

Fresh and frozen meat and meat products

Organic produce

Ruminant livestock

Floral/flowers (products)

Pharmaceuticals/Medicinal products

Temperate or off season fruits and vegetables

Nut crops

Poultry

Beverage

Tropical fruits and vegetables

Maize or corn

Rice

Location Guide

PRODUCTS	EA	IO	RCD	GRD	IRCD
Seafood	2		3		1
Fresh and frozen meat and meat products	2		2		4
Organic produce	5	2			
Ruminant livestock	3		5		1
Floral/flowers (products)	3	2		1	
Pharmaceuticals/Medicinal products	2	1	6		
Temperate or off season fruits and vegetables	1		7		
Nut crops	5	2			
Poultry	2		7		3
Beverage	4	5	2		
Tropical fruits and vegetables	1		3		5
Maize or corn	2		3		8
Rice	1	2	5		5

LEGEND:

EA - Encyclopedia of Associations
IO - International Organizations
RCD - Research Centers Directory
GRD - Government Research Directory
IRCD - International Research Centers Directory

2522
WESTERN STATES MEAT ASSOCIATION (WSMA)
P.O. Box 12944
Oakland, CA 94604
Rosemary Mucklow, Exec. Dir.
Phone: (415) 763-1533

2512
AMERICAN MEAT INSTITUTE (AMI)
P.O. Box 3556
Washington, DC 20007
C. Manly Molpus, Pres.
Phone: (703) 841-2400

2254
INRA JOUY EN JOSAS RESEARCH CENTER
(Center de Recherches de Jouy en Josas)
Domaine de Vilvert
78350 Jouy en Josas, France
Dr. Y. Demarne, Director
Phone: 34 65 21 21
Telex: 695431

Research Description: Principal objective is to increase animal production and improve the quality of animal products. Center comprises laboratories for research in: 1) quantitative genetics and animal breeding, factorial genetics, biochemical genetics, and blood group analysis; 2) nutrition and nutrition physiology, applied radiobiology, and feed technology; 3) animal physiology, lactation physiology, hair, fleece, and fur; 4) fish physiology; 5) biotechnology; 6) dairy and meat products, dairybacteriology, microbial biochemistry, microbial ecology, proteins, meats, and physical biochemistry; 7) small vertebrates; and, 8) acoustical physiology.

764
UNIVERSITY OF WISCONSIN - MADISON
BEEF CATTLE NUTRITION RESEARCH SECTION
OF MEAT & ANIMAL SCIENCE DEPARTMENT
1675 Observatory Dr.
Madison, WI 53706
Dr. Daniel M. Schaefer, Head
Phone: (608) 263-4317
FAX: (608) 262-5157

Research Activities and Fields: Beef production form Holstein steers. Maintains 24 large pens for group feeding and 48 pens for feeding individual cattle.

ORGANIC PRODUCE

1924
BIOLOGICAL CULTIVATION OF PLANTS
SOCIETY OF INDIA
(Organic Farming) (BCPSI)
c/o Pawan Kumar Singhania
Calcutta 700 001,
W. Bengal,
India
Pawan Kumar Singhania, Contact
Phone: 33 202297

1925
HENRY DOUBLEDAY RESEARCH ASSOCIATION
(Organic Farming) (HDRA)
Ryton on Dunsmore
Coventry, Warwickshire CV8 3LG
England
Alan Gear, Exec. Dir.
Phone: 203 303517

1926
INTERNATIONAL FEDERATION OF ORGANIC
AGRICULTURE MOVEMENTS (Organic Farming)
(IFOAM)
(Federation Internationale des Mouvements d'Agriculture Biologique)
c/o Bernward Geier
Okozentrum Imsbach
D-6695 Tholey-Theley, Federal
Republic of Germany
Bernward Geier, Gen. Sec.
Phone: 6853 5190

1927
NATURE FARMING INTERNATIONAL RESEARCH
FOUNDATION
(Organic Farming) (NFIRF)
9-1 Tamara-honcho
Atami 413, Japan
Shoji Mizuno, Sec.
Phone: 557 842240

1928
SOIL ASSOCIATION (Organic Farming) (SA)
86 Colston St.
Bristol BS1 5BB, England
George McRobie, Pres.
Phone: 272 290661

1929
SOIL AND HEALTH ASSOCIATION OF NEW
ZEALAND
(Organic Farming) (SHANZ)
P.O. Box 36-170
Northcote
Auckland 9, New Zealand
Perry Spiller, Pres.
Phone: 9 4806650

4330
NATURAL ORGANIC FARMERS ASSOCIATION
(Farming) (NOFA)
c/o Jerry Fix
63 Hanover St.
Yalesville, CT 06492
Jerry Fix, Pres.
Phone: (203) 269-9391

4331
ORGANIC CROP IMPROVEMENT ASSOCIATION
(Farming) (OCIA)
3185 Township Rd. 179
Bellefontaine, OH 43311
Betty Kananen, Admin. Dir.
Phone: (513) 592-4983

4621
ORGANIC FOOD ALLIANCE (Marketing) (OFA)
c/o James Holt
2111 Wilson Blvd., Ste. 531
Arlington, VA 22201
James Holt, PhD., Project Mgr.
Phone: (703) 276-9498

4622
ORGANIC FOODS PRODUCTION ASSOCIATION OF NORTH AMERICA
(Marketing) (OFPANA)
P.O. Box 1078
Greenfield, MA 01301
Frederick Kircashmann, Pres.
Phone: (507) 452-6332

RUMINANT LIVESTOCK

54
ALABAMA AGRICULTURAL AND MECHANICAL UNIVERSITY
INTERNATIONAL SMALL LIVESTOCK RESEARCH CENTER
P.O. Box 264
Normal, AL 35762
Dr. Steven D. Lukefahr, Coordinator
Phone: (205) 859-7011

Research Activities and Fields: Small livestock, which generally reproduce and grow rapidly to maturity and have low feed and land requirements, and their role in reducing world food shortages. Goat research areas include nutritional factors influencing milk and growth performances, silage utilization, and improved management techniques. Poultry studies include nutrition of turkeys and broiler chickens, genetics of egg-producing breeds of chicken, and growth and productive performance of guinea fowl and Coturnix quail. Other species of expertise include guinea pigs, rabbits, and sheep. *Special Resources:* Alpine, Anglo-Nubian, and La Mancha breeds of goat; Californian, Champagne d'Argent, Flemish Giant, and New Zealand White Breeds of rabbit; and Suffolk breed of sheep.

314
NEW MEXICO STATE UNIVERSITY
CLAYTON LIVESTOCK RESEARCH CENTER
Rte. 1
Box 109
Clayton, NM 88415
Dr. Michael Galyean, Superintendent
Phone: (505) 374-2566

Research Activities and Fields: Studies of stocker and feeder cattle, including problems and diseases associated with the stress of weaning, gathering, and marketing livestock, especially bovine respiratory disease complex, sometimes known as shipping fever. Associated programs study management and nutritional requirements of cattle and cattle grazing on wheat pastures.

810
USDA FORAGE AND LIVESTOCK RESEARCH LABORATORY
El Reno, OK 73036
Dr. William A. Phillips, Research Leader
Phone: (405) 262-5291

Research Activities and Fields: Beef cattle, swine, and sheep production, reproduction, and production utilization and evaluation of forage. *Special Resources:* Maintains 7,000 acresof land and fixed equipment owned by U.S. government, with livestock and operating equipment supplied by the government and University.

126
INTERNATIONAL LIVESTOCK CENTER FOR AFRICA (ILCA)
P.O. Box 5689
Addis Ababa, Ethiopia
Dr. John Walsh, Director-General
Phone: (1) 18 32 15
FAX: (1) 51 32 84

Research Description: ILCA was established: 1) to serve as a center for interdisciplinary research in order to promote the development and demonstration of improved livestock production systems; 2) to serve as a focal point for training activities designed to increase regional competence in the systems approach to livestock research and development; and 3) to function as a multidisciplinary documentation center serving the livestock industries of tropical Africa. Areas of research interest include: cattle milk and meat; small ruminant meat and milk; animal traction; animal feed resources; trypanotolerance; and livestock policy.

622
UNIVERSITY OF HAWAII AT MANOA
LIVESTOCK RESEARCH CENTER
56-160 Kam Hwy.
Haleiwa, HI 96712
C.W. Weems, In Charge
Phone: (808) 948-8295

Research Activities and Fields: Animal science, including studies on genetics, feeding, reproduction, growth and management of beef and dairy cattle, sheep, poultry, swine, and aquaculture species under soil, water, and climatic conditions prevailing on the islands. Also conducts cooperative studies in agronomy, soils, and entomology.

4615
LIVESTOCK MARKETING ASSOCIATION (LMA)
7509 Tiffany Springs Pkwy.
P.O. Box 901402
Kansas City, MO 64190
Phone: (816) 891-0502

14168
AMERICAN ASSOCIATION OF SMALL RUMINANT PRACTITIONERS
(Veterinary Medicine) (AASRP)
248 NW Garden Valley Rd.
Roseburg, OR 97470
Don E. Bailey, D.V.M., Sec.-Treas.
Phone: (503) 672-2829

4054
NATIONAL CATTLEMEN'S ASSOCIATION (NCA)
P.O. Box 3469
Englewood, CO 80155
Earl Peterson, Exec. V. Pres.
Phone: (303) 694-0305

177
IOWA STATE UNIVERSITY
BEEF NUTRITION EXPERIMENTAL FARM
Rural Rte. 4
Ames, IA 50010
Prof. Allen Trenkle, Leader
Phone: (515) 292-4445

Research Activities and Fields: Utilization of crop residues in beef cow wintering diets, protein and amino acid studies in growing and finishing beef diets, feed additive research in beef finishing rations, beef cattle growth studies, evaluation of feeds and by-products for beef cattle, and evaluation of grazing systems.

FLORAL/FLOWERS (PRODUCTS)

1914
INTERNATIONAL ASSOCIATION OF HORTICULTURE PRODUCERS
(Horticulture) (AIPH)
(Internationaler Verband des Erwerbsgartenbaues)
Bezuidenhoutseweg
NL-2594 AG The Hague,
Netherlands
Dr. J. Rotteveel, Gen. Sec.
Phone: 70 3814631

1915
INTERNATIONAL GARDEN HORTICULTURE INDUSTRY ASSOCIATION
(Horticulture) (IGHIA)
26 Pine St.
Dover, DE 19901
Le Roy Rench, Bd. Chm.
Phone: (302) 736-6781

4209
NEW ENGLAND WILD FLOWER SOCIETY
(Conservation) (NEWFS)
c/o Barbara Pryor
Hemenway Rd
Framingham, MA 01701
Barbara Pryor, Exec. Officer
Phone: (508) 877-7630

1378
SOCIETY OF AMERICAN FLORISTS (SAF)
1601 Duke St.
Alexandria, VA 22314
Betty O. Sapp, Exec. V. Pres.
Phone: (703) 836-8700

66
DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
BELTSVILLE AREA
BELTSVILLE AGRICULTURAL RESEARCH CENTER
PLANT SCIENCES INSTITUTE
FLORAL AND NURSERY CROPS LABORATORY
Beltsville Agricultural Research Center-West
Bldg. 004, Rm. 101
Beltsville, MD 20705
Roger H. Lawson, Research Leader
Phone: (301) 344-3570
FTS: 344-3570

Research Description: Activities of the Laboratory involve: collecting and evaluating new and improved lines of floral and nursery crops (nationally and internationally) and developing energy-efficient cultivation methods to increase the productivity of greenhouse growers and small farmers; carrying out studies of insect behavior and ecology which serve as a basis for development of pest control practices that help reduce pollution;conducting basic research on genetic modification utilizing methods of chromosome microinjection of protoplasts; studying metabolism associated with processes of differentiation in cell culture; and conducting hybridoma research and preparing monoclonal antibodies fore a range of plant viruses used in developing improved methods of virus detection.

652
INTERNATIONAL UNION OF FLOWER WHOLESALE TRADE (Florists)
(Union Internationale du Commerce de Gros en Fleurs - Union Fleurs)
Julicherstrasse 32
D-4000 Dusseldorf, Federal
Republic of Germany
Peter Moeller, Sec. Gen.
Phone: 211 441388

1380
WHOLESALE FLORISTS AND FLORIST SUPPLIERS OF AMERICA (WF&FSA)
5313 Lee Hwy.
Arlington, VA 22207
Archie J. Clapp. Exec. V. Pres.
Phone: (703) 241-1100

PHARMACUTICALS/ MEDICINAL PRODUCTS

6832
SOCIETY FOR MEDICINAL PLANT RESEARCH
(Pharmacy)
(Gesellschaft fur Arzneipflanzenforschung - GA)
Weismullerstrasse 45
D-6000 Frankfurt am Main 1,
Federal Republic of Germany
Dr. R. Carle, Sec.
Phone: 69 40012667

6013
ETHNOBOTANY SPECIALIST GROUP (ESG)
c/o Prof. Richard Evans Schultes
Botanical Museum
Oxford St.
Harvard Univ.
Cambridge, MA 02138
Prof. Richard Evans Schultes, Pres.
Phone: (617) 495-2326

13564
AMERICAN SOCIETY OF PHARMACOGNOSY
(Pharmacy) (ASP)
c/o Dr. William J. Keller
School of Pharmacy
Northeast Louisiana Univ.
Monroe, LA 71209
Dr. William J. Keller, Sec.
Phone: (318) 342-1690

5981
SOCIETY OF ETHNOBIOLOGY (SE)
c/o Catherine Fowler
Univ. of Nevada
Dept. of Anthropology
Reno, NV 89557
Catherine Fowler, Exec. Officer
Phone: (702) 784-4686

TEMPERATE OR OFF SEASON FRUITS & VEGETABLES

4452
UNITED FRESH FRUIT AND VEGETABLE ASSOCIATION
(Fruits and Vegetables) (UNITED)
727 N. Washington St.
Alexandria, VA 22314
George S. Dunlop. Pres.
Phone: (703) 836-7745

414
PENNSYLVANIA STATE UNIVERSITY
FRUIT RESEARCH LABORATORY
P.O. Box 309
290 Univ. Dr.
Biglerville, PA 17307-0309
Dr. K.D. Hickey, Scientist-in-Charge
Phone: (717) 677-6116

Research Activities and Fields: Pest control and production methods for apples, peaches, plums, and cherries, including a search for more effective and less injurious fungicides, insecticides, nematicides, and miticides. Studies methods that reduce pesticide usage, develops integrated pest management programs, evaluates pesticide application technology, seeks to identify and control virus diseases of apples and stone fruits, studies corking disease of apples as affected by nutrition, evaluates factors affecting low temperature injury to peaches, investigates cultural methods for fruits, develops economic injury levels and pesticide technology, and identifies and controls parasitic nematodes on orchard crops.

663
UNIVERSITY OF MARYLAND
LOWER EASTERN SHORE RESEARCH AND EDUCATION CENTER
Rte. 5, Quantico Rd.
P.O. Box 246
Salisbury, MD 21801
Dr. Henry M. Brooks, Head
Phone: (301) 742-1178

Research Activities and Fields: Vegetable research, including variety testing, trickle irrigation, breeding, nematodes, herbicides, and disease, insect, and weed control; agronomic research, including nitrogen management, no-tillage, hybrid performance, and row spacing and double cropping; and poultry research, including energy management, environmental/nutritional interaction, dead bird disposal, and broiler management, Crops studies included tomatoes, corn, squash, peppers, sweet potatoes, cucumbers, muskmelons, watermelons, corn, soybeans, and wheat.

387
OKLAHOMA STATE UNIVERSITY
VEGETABLE RESEARCH STATION
13711 S. Mingo
Bixby, OK 74008
Bruce Bostian, Superintendent
Phone: (918) 369-2441

Research Activities and Fields: Vegetable crops for fresh market trade and for processing. *Special Resources:* 105-acre tract.

455
RUTGERS UNIVERSITY
CREAM RIDGE FRUIT RESEARCH AND DEVELOPMENT CENTER
R.D. 2, Box 38
Cream Ridge, NJ 08514
Dr. J. Anthony Hopfinger, Director
Phone: (609) 758-7311

Research Activities and Fields: Breeding, production, and physiology of tree fruit, primarily apples, apricots, and peaches, including studies on breeding new varieties, improving cultural methods, cold hardiness, and control of diseases, pests, and injuries. Also engaged in varietal evaluations and cultural management of small fruits, including grapes, brambles, and strawberries. *Special Resources:* Maintains an international collection of peach varietal germplasm.

895
WASHINGTON STATE UNIVERSITY
TREE FRUIT RESEARCH AND EXTENSION CENTER
Wenatchee, WA 98801
Dr. Stanley C. Hoyt, Superintendent
Phone: (509) 663-8181

Research Activities and Fields: Phases of fruit production, harvesting, handling, storage, and marketing, including studies in entomology, horticulture, plant pathology, plant physiology, virology, soil science, and agrometeorology.

372
OHIO STATE UNIVERSITY
VEGETABLE CROPS BRANCH, OHIO AGRICULTURAL RESEARCH AND DEVELOPMENT CENTER
1165 County Rd. 43
Fremont, OH 43420
Charles Willer, Manager
Phone: (419) 322-5142

Research Activities and Fields: Vegetable crops, including tomatoes, cabbage, cucumbers, melons, sweet corn, sugar beets, peppers, and potatoes. Programs concentrate on cultural practices, plant breeding, soil damage, and weed and insect control.

536
UNIVERSITY OF ARKANSAS
FRUIT SUBSTATION
Clarksville, AR 72830
John R. Clark, Resident Director
Phone: (501) 754-2406

Research Activities and Fields: Plant breeding, including apples, apple rootstocks, blackberries, blueberries, grapes, peaches, peach rootstocks, and nectarines. Conducts cultural studies, programs on disease and insect control, and variety testing.

NUT CROPS

1921
AFRICAN GROUNDNUT COUNCIL (Nuts) (AGC)
(Conseil Africain de l'Arachide - CAA)
Trade Fair Complex
Badagry Expy., Km. 15
P.O. Box 3025
Lagos, Nigeria
Mour Mamadou Samb, Exec. Sec.
Phone: 1 880982

1922
INTERNATIONAL NUT COUNCIL (Nuts) (INC)
(Consejo Internacional de los Frutos Secos - INC)
Boule 8
Reus, Spain
Pino Calcagni, Pres.
Phone: 977 314700

1923
NORTHERN NUT GROWERS ASSOCIATION (Nuts) (NNGA)
RR 1
Niagara-on-the-Lake, ON, Canada
L0S 1J0
R.D. Campbell, Sec.
Phone: (416) 262-4927

4649
SOUTHEASTERN PECAN GROWERS ASSOCIATION (Nuts) (SEPGA)
c/o Mrs. Fred Beshears
Box 160
Monticello, FL 32344
Mrs. Fred Beshears, Sec.-Treas.
Phone: (904) 997-3458

4635
AMERICAN PEANUT RESEARCH AND EDUCATION SOCIETY (Nuts) (APRES)
Oklahoma State Univ.
376 AG Hall
Stillwater, OK 74078
J. R. Sholar, Exec. Officer
Phone: (405) 744-6421

4637
CALIFORNIA MACADAMIA SOCIETY (Nuts) (CMS)
P.O. Box 1290
Fallbrook, CA 92028
Jeannine T. Howell, Sec.-Treas.
Phone: (619) 728-8081

4638
CALIFORNIA PISTACHIO COMMISSION (Nuts) (CPC)
1915 N. Fine Ave.
Fresno, CA 93727
Karen Dahlinger, Pres.
Phone: (209) 252-3345

4655
WESTERN PISTACHIO ASSOCIATION (Nuts) (WPA)
517 C St. NE
Washington, DC 20002
William R. Koch, Exec. Officer
Phone: (202) 543-4455

POULTRY

218
KANSAS STATE UNIVERSITY
THOMAS B. AVERY RESEARCH CENTER
Call Hall
200 Marlapt
Manhattan, KS 66506
Myron Lawson, Superintendent
Phone: (913) 539-5041

Research Activities and Fields: Poultry science, including effects of cage design on performance and behavior of layers, effects of various rearing environments on future production and behavior, effects of selection methods on bird welfare and adaption of layers to artificial environments, development of new egg and poultry meat products, effects of various breeding systems on quantitative traits of chickens, and management problems. *Special Resources:* Maintains cage rearing facilities, a light-controlled force ventilation room, and time-lapse video equipment for behavior studies.

422
PENNSYLVANIA STATE UNIVERSITY
POULTRY DISEASE RESEARCH LABORATORY
Dept. of Veterinary Science
Wiley Laboratory
University Park, PA 16802
Dr. Donald G. Simmons, Head
Phone: (814) 863-0839

Research Activities and Fields: Avian influenza ascites, immunopathology, leg weakness in chickens, and urolithiasis layers.

2390
POULTRY EXPERIMENTAL STATION
(Station Experimentale d'Aviculture)
National Laboratory of Avian Pathology
B.P. 53
22440 Ploufragan, France
Dr. Bennejean, Director of Research
Phone: 96 94 21 66
FAX: 96 94 48 71

Research Description: Station conducts zootechnical and veterinary research on poultry (breeders, layers, broilers, guinea, fowls, ducks, and turkeys) and rabbit pathology. Station comprises four main research units: 1) Zootechnology, Statistics and Informatics; 2) Ecopathology and Parasitology; 3) Nutritional Hygiene and Product Quality; and 4) Rabbit Pathology and Bovine Epidemiology.

836
USDA POULTRY RESEARCH LABORATORY
R.D. 2, Box 600
Georgetown, DE 19947
A. Lee Cartwright, Location Coordinator
Phone: (302) 856-0046

Research Activities and Fields: Seeks to increase the efficiency of poultry production by reducing fat deposition and increasing skeletal muscle development with the aim of maintaining or improving the quality of lean tissue. Research involves biochemical, genetic, physiological, and nutritional mechanisms that regulate lipid metabolism and adipose deposition in relation to muscle development.

610
UNIVERSITY OF GEORGIA
POULTRY DISEASE RESEARCH CENTER
953 College Sta. Rd.
Athens, GA 30605
Dr. S. H. KLeven, Director
Phone: (404) 542-1904
FAX: (405) 542-5630

Research Activities and Fields: Poultry pathology, bacteriology, virology, and parasitology, especially disease problems and processes of greatest economic importance to poultry industry in Georgia.

6093
AFRC INSTITUTE FOR ANIMAL HEALTH
HOUGHTON LABORATORY
Houghton
Huntingdon, Cambridgeshire PE17
2DA England
Dr. L. N. Payne, Acting Head
Phone: (0480) 64101
FAX: (0480) 67870

Research Description: Laboratory conducts research into the causes and control of avian diseases, including infectious bronchitis, Marek's disease bacterial infections, and coccidiosis, Research is carried out in three Divisions: 1) Pathology and Immunology; 2) Molecular Biology; and 3) Environmental Studies.

4685
AMERICAN POULTRY ASSOCIATION (APA)
c/o Nona N. Shearer
26363 S. Tucker Rd.
Estacada, OR 97023
Nona N. Shearer, Sec.-Treas.
Phone: (503) 630-6759

844
USDA SOUTH CENTRAL POULTRY RESEARCH LABORATORY
P.O. Box 5367
Mississippi State, MS 39762
Dr. James Deaton, Director
Phone: (601) 323-2230

Research Activities and Fields: Poultry husbandry, physiology, chemistry, agricultural engineering, pathology, bacteriology, and blood analysis, with major emphasis on relation of management and environment to disease. Conducts basic and applied studies on effect of management and environment on growth, quality, feed utilization, mortality, off grades, and condemnation. Develops and evaluates methods of growth feed conversion and livability.

845
USDA SOUTHEAST POULTRY RESEARCH LABORATORY
934 College Sta. Rd.
Athens, GA 30605
Dr. Charles W. Beard, Director
Phone: (404) 546-3434

Research Activities and Fields: Avian infectious respiratory diseases, avian salmonella infections, avian immunology and genetics of disease resistance, and avian environmental engineering, with particular emphasis on specific diseases. *Special Resources:* Disease-free poultry flocks, bioengineering laboratory, and regulated environment chambers for study of disease under various controlled conditions of temperature, air movement, and other climatic factors.

6163
CVL POULTRY DEPARTMENT
Central Veterinary Laboratory
New Haw
Weybridge, Surrey KT15 3NB
England
Dr. G. A. Cullen, Department Head
Phone: (09323) 41111
Telex: 262318

Research Description: Principal subjects of research interest include; avian influenza, paramyxoviruses, infectious bronchitis, infectious bursal disease, mycoplasmosis, chlamydiosis, salmonellosis, and diseases of ducks and geese.

1944
WORLD'S POULTRY SCIENCE ASSOCIATION (WPSA)
(Association Universelle d'Aviculture Scientifique - AVI)
c/o Dr. Rose Marie Wegner
Peter-Schutze-Weg 11
D-3102 Hermannsburg, Federal
Republic of Germany
Dr. Rose-Marie Wegner, Sec.
Phone: 5052775

839
USDA REGIONAL POULTRY RESEARCH LABORATORY
3606 E. Mt. Hope Rd.
East Lansing, MI 48823
Dr. R. L. Witter, Director
Phone: (517) 337-6828
FAX: (517) 337-6776

Research Activities and Fields: Genetics, pathology, virology, immunology, epizootiology, molecular biology, and ultrastructure of viral induced neoplasms and other viral diseases of the chicken, including Marek's disease, lymphoid leukosis, and reticuloendotheliosis viruses. Also studies avian immunogenetics, gene transfer, genome mapping, and viral expression vector development.

BEVERAGE

664
COCOA PRODUCERS' ALLIANCE (Food) (CPA)
(Alliance des Pays Producteurs de Cacao)
8/10 Broad St, 11th Ft.
P.O. Box 1718
Lagos, Nigeria
I.S. Kamga, Sec. Gen.
Phone: 1 635574

601
UNIVERSITY OF HAWAII AT MANOA
HAWAII INSTITUTE OF TROPICAL AGRICULTURE& HUMAN RESOURCES
Honolulu, HI 96822
Chauncey T.K. Ching, Director
Phone: (808) 948-8131

Research Activities and Fields: Production, processing, preservation, distribution, and marketing of food and plant ornamental products. Conducts basic, applied, and developmental studies on tropical and subtropical problem areas, including studies on soil genesis, biological control of insect pests, genetic selection for adaptability to tropical and subtropical conditions, utilization of locally-produced feedstuffs and by-products for livestock and poultry and diseases of pineapple, banana, coffee, macadamia nut, papaya, guava, and mango crops.

1396
CHOCOLATE MANUFACTURES ASSOCIATION OF THE U.S.A. (Food) (CMA)
7900 Westpark Dr. Ste. A-320
McLean, Va 22102
Richard T. O'Connell, Pres.
Phone: (703) 790-5011

213
INTERNATIONAL COFFEE ORGANIZATION (Beverages) (ICO)
(Organisation Internationale du Cafe - OIC)
22 Berners St.
London, W1P 4DD, England
Alexandre Fontana Beltrao, Exec. Dir.
Phone: 71 5808591

656
ASSOCIATION OF CEREAL STARCH PRODUCERS IN THE EC (Food)
(Association des Amidonneries de Cereals de la CE)
1, avenue de la Joyeuse Entree,
boite 10
B-1040 Brussels, Belgium
Annette Jung, Sec. Gen
Phone: 2 2302031

6431
AMERICAN COCOA RESEARCH INSTITUTE (Food) (ACRI)
7900 Westpark Dr., Ste. A-320
McLean, VA 22102
Richard T. O'Connell, Pres.
Phone: (703) 790-5011

215
INTERNATIONAL TEA COMMITTEE (Beverages) (ITC)
(Comite International du The)
Sir John Lyon House
5 High Timber St.
London, EC4V 3NH, England
Peter Abel, CEO
Phone: 71 2484672

563
SPECIALTY COFFEE ASSOCIATION OF AMERICA (Beverages) (SCAA)
1101 14th St. NW, Ste. 1100
Washington, DC 20005
John Walsh Cassedy, Exec, Dir.
Phone: (202) 371-1347

550
COFFEE DEVELOPMENT GROUP (Beverages) (EATTA)
1400 I St. NW, Ste. 650
Washington, DC 20005
Mike Levine, Pres.
Phone: (202) 682-4034

208
EAST AFRICAN TEA TRADE ASSOCIATION (Beverages) (EATTA)
P.O. Box 85174
Mombasa, Kenya
Mark Radoli, Exec. Officer
Phone: 2 315687

558
NATIONAL COFFEE ASSOCIATION OF U.S.A. (Beverages) (NCA)
110 Wall St.
New York, NY 10005
Robert N. DeChillo, Sec.
Phone: (212) 344-5596

693
UNIVERSITY OF PUERTO RICO
ADJUNTAS SUBSTATION
HC01 Box 4508
Adjuntas, PR 00601-9717
Felix M. Roman Perez, Acting Administrator

Research Activities and Fields: Coffee, citrus fruits, and food crops. Operates a 190-acre farm at an elevation of 2,000 feet above sea level.

1041
EAST AFRICAN TRADE ASSOCIATION - DIRECTORY (Tea Industry)
East African Tea Trade Association
Box 42281
Nairobi, Kenya
Phone: 2 337521

TROPICAL FRUITS & VEGETABLES

86
INTERNATIONAL CENTER FOR TROPICAL AGRICULTURE
(Centro Internacional de Agricultura Tropical - CIAT)
Apartado Aereo 6713
Cali, Columbia
Dr. John L. Nickel, Director General
Phone: (23) 67-50-50
FAX: (23) 64-72-43

Research Description: CIAT's primary objective is to work with national agricultural research organizations to develop improved agricultural technology to increase the quality and quantity of specific basic food commodities in the tropics of the Western Hemisphere, Africa, and Asia, The main crops of research interest are cassava, field beans, and rice. CIAT also conducts a large program in tropical pastures, focusing of the development of suitable pasture technology for the infertile, acid soil of Latin America.

1715
INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE
(Agriculture Science) (IITA)
(Institut International d'Agriculture Tropicale - IITA)
Oyo Rd.
Private Mail Bag 5320
Ibadan, Oyo, Nigeria
Dr. Laurence Stifel, Dir. Gen
Phone: 400300

90
CALIFORNIA RARE FRUIT GROWERS, INC.
Fullerton Arboretum
Fullerton, CA 92634
George A. Frickmann, President

Research Activities and Fields: Horticulture of tropical and subtropical edible fruits and nuts, particularly the hardiness, propagation, and growing requirements of rare fruits under California growing conditions.

4439
NATIONAL ROOT CROPS RESEARCH INSTITUTE UMUDIKE (NRCRI)
Private Mail Bag 7006
Umudike
Umuahia, Imo, Nigeria
Dr. L.S.O. Ene, Director
Phone: (88) 220188

Research Description: Institute conducts research on the production, storage, processing, and utilization of roots andtuber crops of economic importance; develops improved planting materials for farmers; and provides training and advisory services for government and private personnel. Crops studied include yams, cassavas, Irish potatoes, sweet potatoes. cocoyam, and ginger.

593
UNIVERSITY OF FLORIDA
FLORIDA AGRICULTURAL EXPERIMENT STATION
1022 McCarty Hall
Gainesville, FL 32611
Dr. J.M. Davidson, Director
Phone: (904) 392-1784

Research Activities and Fields: Agriculture, including food and resource economics, agricultural engineering, agronomy, animal and plant sciences, dairy and poultry sciences, entomology, and nematology, food science and human nutrition, forest resources and conservation, fruit crops, microbiology and cell science, ornamental horticulture, plant pathology, soils, vegetable crops, and veterinary medicine.

1720
TROPICAL AGRICULTURAL RESEARCH AND TRAINING CENTRE
(Agricultural Science) (CATIE)
(Centro Agronomico Tropical Investigacion y Ensenanza - CATIE)
Turrialba 7170, Costa Rica
Dr. Rodrigo Tarte Ponce, Gen. Dir.
Phone: 560169

724
UNIVERSITY OF PUERTO RICO
FOOD TECHNOLOGY LABORATORY
Agricultural Experiment Sta.
P.O. Box 21360
Rio Piedras, PR 00928
Fred Fernandez-Coll, Technical Director
Phone: (809) 763-0096

Research Activities and Fields: Chemistry, bacteriology, enzymology, dehydration, processing, storage and utilization of tropical fruits and vegetables, including juices and nectars from mangos, soursops, guavas, and papayas, and preparation of jellies, jams, and pastes, native-style soups, banana puree, and flour from bananas and plantains, Also studies freezing and canning of fruits and vegetables, controlled ripening of bananas, and development of new products. Provides information and technical assistance to Puerto Rican food-processing industry.

725
UNIVERSITY OF PUERTO RICO
FRUITS SUBSTATION
HC02 Box 7115
Juan Diaz, PR 00665-9601
Luis E. Rivera, In Charge
Phone: (809) 837-3905

Research Activities and Fields: Adaptation, propagation, culture, and economic potentialities of both native and imported fruits, including mango, avocado, sapodilla, soursop, and guava. Conducts other programs on truck crops, fertilizers, development of new varieties, sugar-cane variety improvement, and trickle irrigation for fruits and vegetables. Situated on 300 acres at an elevation of 68 feet above sea level.

620
UNIVERSITY OF HAWAII AT MANOA
HAWAII INSTITUTE OF TROPICAL AGRICULTURE & HUMAN RESOURCES
Honolulu, HI 96822
Chauncey T.K. Ching, Director
Phone: (808) 956-8131
FAX: (808) 956-6442

Research Activities and Fields: Production, processing, preservation, distribution, and marketing of food and plant ornamental products. Conducts basic, applied, and developmental studies on tropical and subtropical problem areas, including studies on soil genesis, biological control of insect pests, genetic selection for adaptability to tropical and subtropical conditions, utilization of locally-produced feedstuffs and by-products for livestock and poultry, and diseases of pineapple, banana, coffee, macadamia nut, papaya, guava, and mango crops.

1884
ASIA VEGETABLE RESEARCH AND DEVELOPMENT CENTER
(Fruits and Vegetables) (AVRDC)
P.O. Box 205
Taipei 10099, Taiwan
Dr. Emil Javier, Dir. Gen.
Phone: 6 5837801

MAIZE OR CORN

1715
INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE
(Agricultural Science) (IITA)
(Institut International d'Agriculture Tropicale - IITA)
Oyo Rd.
Private Mail Bag 5320
Ibadan, Oyo, Nigeria
Dr. Laurence Stifel, Dir. Gen.
Phone: 6 5837801

1716
INTERNATIONAL MAIZE AND WHEAT IMPROVEMENT CENTER
(Agricultural Science) (CIMMYT)
(Centro Internacional de Mejoramiento de Maiz y Trigo - CIMMYT)
Lisboa 27
Apartado Postal 6-641
Cuauhtemoc
06600 Mexico City, DF, Mexico
Dr. Donald L. Winkelmann, Dir. Gen.
Phone: 905 7613311

3632
EXPERIMENTAL INSTITUTE FOR CEREAL RESEARCH
(Istituto Sperimentale per la Cerealicoltura)
Via Cassia 176
00191 Rome, Italy
Prof. Dr. Angelo Bianchi, Director
Phone: (6) 329 57 05

Research Description: Institute's research program involves studies in: cereal genetics; breeding of varieties of wheat, maize, rice, and minor cereals; agronomic techniques of cultivation; and technology of products. Institute comprises four central sections: 1) Experiment Design Section is concerned with the application of statistical methods to genetic improvement studies; 2) Applied Genetics Section conducts research on durum wheat; 3) Agronomic Techniques Section conducts studies aimed at increasing cereals yield in the various environments of central and Southern Italy; and 4) Cereal Product Technology Section is concerned with the chemical-physical properties of durum wheat semolina in relation to the spaghetti-making process. Research is conducted in laboratories and greenhouses as well as in the field, and variety adaptation trials are carried out in various locations throughout the country.

4090
NATIONAL CORN GROWERS ASSOCIATION
(Commodities) (NCGA)
1000 Executive Pkwy., Ste. 105
St. Louis, MO 63141-6397
Jeffery W. Gain, CEO
Phone: (314) 275-9915

2291
INTERNATIONAL COOPERATION CENTER OF AGRICULTURAL RESEARCH FOR DEVELOPMENT
(Centre de Cooperation Internationale en Recherche Agronomique pour le Developpement - CIRAD)
42 rue Scheffer
75116 Paris, France
Herve H. Bichat, General Manager
Phone: (1) 47 04 32 15
FAX: (1) 47 55 15 30

Research Description: CIRAD's research and development program is concerned with: wood and forests; aquaculture, animal production and breeding; animal vaccines and pastures; coffee and cocoa; rice, corn, sorghum, and vegetables; sugarcane; rubber; cotton; pineapple, banana, citrus, mango, and other tropical fruits; and oil palms, coconut, and groundnut. CIRAD offers assistance with problems related to water and soil conservation; irrigation techniques; farm machinery; energy; food technology; cultivation and production systems; rural economics and agricultural policy; locusts and grasshoppers; and data processing and information training. CIRAD acts for the World Bank Group, the FAO, the FED, the Fund for Aid and Cooperation, and the Caisse Centrale de Cooperation Economique in the evaluation, study, realization, and control of agricultural development projects; and collaborates with numerous other organization engaged in bilateral or multilateral aid. CIRAD also assists numerous French and foreign development companies and has established temporary scientific missions in 40 tropical countries.

1399
CORN REFINERS ASSOCIATION (Food) (CRA)
1100 Connecticut Ave., NW, Ste. 1120
Washington, DC 20036
Robert C. Liebenow, Pres.
Phone: (202) 331-1634

118
INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE (IITA)
Oyo Rd.
Private Mail Bag 5320
Ibadan, Oyo, Nigeria
Dr. Laurence D. Stifel, Dir. Gen.
Phone: 413440

Research Description: IITA's objectives are to: 1) increase yields and improve the quality of food crops in the humid and subhumid tropics, with emphasis of development of high-yielding and insect and disease resistance plants: 2) distribute improvedplant materials to national research centers where they can be of significant value to breeding or improvement programs; 3) develop soil and crop management practices and farming systems for small farmers; 4) provide intensive training programs which will enable developing countries to solve their food production problems; 5) publish and disseminate research findings to agricultural scientists, policymakers, and extension workers in national programs, and through them to farmers worldwide; 6) operate an information center and library with a collection of the world's literature on tropical agriculture in both English and French for the use of the scientists and scholars; and 7) organize and conduct conferences, forums, and seminars which review new research, consider current problems, and discuss needs for the future. Institute has major programs for Cereal improvement, Grain Legume Improvement, Root and Tuber Improvement, and Farming Systems (the first and largest of its kind at an international center). In all four programs, the Institute follows a multidisciplinary team approach. Through farm studies and other means, agriculture economists assess the productivity and profitability of new varieties and farming methods under different local conditions; and evaluate new varieties for food value and consumer acceptance. Within the international network, IITA has responsibility for research on cowpeas, yams, and sweet potato crops. In addition, IITA has regional responsibilities within tropical and subtropical Africa for cassava, maize, rice, and soybean; studies are also concerned with cocoyams, plantains, and cooking bananas.

861
INSTITUTE OF AGRONOMY
(Instituto Agronomico - IAC)
Avda. Barao de Itapura 1481
13001 Campinas, SP, Brazil
Dr. Orivaldo Brunini, Director
Phone: 31-5422
Telex: 1059

Research Description: IAC conducts basic and applied agronomic research in the State of Sao Paulo. Areas of research emphases include plant breeding, soils, food crops, industrial plants, horticulture, and biotechnology. Activities are carried out through eight technical divisions (comprising 43 departments): 1) the Division of Basic and Scientific Activities carries out research in climatology, analytical chemistry, statistics, and phytochemistry; 2) the Division of Biology conducts research on economic botany, cytology, entomology, plant physiology, genetics and plant breeding, phytopathology, virology, and seed pathology; 3) the Division of Agricultural Engineering conducts research on power and traction machinery, seeding and tillage machinery, material testing and projects, rural constructions, harvesting and processing machinery, and pesticide sprayers; 4) the Division of Horticulture is responsible for studies on citrus, ornamental plants and floriculture, temperate climate crops, tropical climate crops, viticulture, and vegetable crops; 6) theDivision of Industrial Plants is responsible for studies on cotton, sugarcane, oilseed crops, aromatic plants and tobacco, fibrous plants, tropical plants, and fiber technology; 7) the Division of Soils conducts research in conservation, soil fertility and soil analysis, photo-interpretation, irrigation and drainage, soil microbiology, and pedology; and 8) the Division of Experimental Stations is responsible for 17 stations located in the different ecological and agricultural zones of the State of Sao Paulo. In addition, IAC maintains a regional agricultural office at Assis.

471
SOUTHEAST SOUTH DAKOTA EXPERIMENT FARM CORP.
Rte. 3, Box 93
Beresford, SD 57004
Dale R. Sorensen, Research Farm Manager
Phone: (605) 563-2989

Research Activities and Fields: Farmers' problems with an emphasis of the cost and benefits of each practice, including use of commercial fertilizer, chemical weed control, corn and soybean row spacing, long term rotations, cattle and swine nutrition, tillage, and variety testing. *Databases:* Corporate membership.

813
BOLIVIAN INSTITUTE OF AGRICULTURAL TECHNOLOGY
(Instituto Boliviano de Tecnologia Agropecuaria - IBTA)
Avda. Camacho 1471
Casilla 5783
La Paz, Bolivia
Heber Michel Duran, Director
Phone: (02) 374289

Research Description: Objectives of the Institute are: 1) to plan, direct, coordinate, and carry out research and agricultural technology transfer to farmers and agriculturists throughout Bolivia; 2) to formulate general guidelines according to national policies for private organizations carrying out research and extension services; 3) to make recommendations to the Minister of Agriculture and Campesino Affairs and to state agencies on technical matters, agricultural policies, and the use of agricultural technology; 4) to participate with other organizations in coordination and integrating nation, regional, and local services, in order to increase national production and productivity levels; 5) to integrate socioeconomic research with physico-biological research, and to apply the results; and 6) to plan and carry out educational programs (especially for the rural youth of Bolivia). Subjects of research interest include: oil bearing plants, tropical crops, plant and animal breeding, horticulture, Andean crops, maize, sorghum and beans, tuber crops, and wheat and minor crops. Research interests alsoinclude studies in rural sociology (usually in connection with extension activities).

Research and related activities are carried out nationally, regionally, and locally through experiment stations, nurseries, administrative centers, and extension agencies. Consult Country Index for listing of IBTA units described separately in this edition.

2287
INSTITUTE FOR TROPICAL AGRICULTURAL RESEARCH AND FOOD CROPS
(Institut de Recherches Agronomiques Tropicales et des Cultures Vivrieres - IRAT)
45 bis, ave. de la Belle Gabrielle
94736 Nogent-sur-Marne, France
Claude Charreau, Director
Phone: 44 39 44 34
FAX: 43 94 44 91

Research Description: Principal scientific mission involves agricultural research and development in tropical regions. Emphasis is placed upon food crops, including rice, sorghum, corn, sugarcane, cassava, and other plants. Areas of research include plan breeding, fertilizers, crop science, and improvement of both irrigated and rainfed farming systems.

81
INTERNATIONAL CENTER FOR MAIZE AND WHEAT IMPROVEMENT
(Centro Internacional de Mejoramiento de Maiz y Trigo - CIMMYT)
Lisboa 27
Col. Juarez
Apartado Postal 6-641
06600 Mexico, DF, Mexico
Dr. Donald L. Winkelmann, Dir. Gen.
Phone: (5) 4-21-00
FAX: (5) 4-10-69

Research Description: CIMMYT is a research development, and training center for the study of maize and wheat production.

2959
AGRICULTURAL RESEARCH INSTITUTE
(MTA Mezogazdasagi Kutatointezete)
Marx ter 1
H-2462 Martonvasar, Hungary
Prof. Laszlo Balla, Director
Phone: (26) 45 774
Telex: 224008

Research Description: Institute conducts basic and applied research in agriculture, with emphasis on maize and wheat. Principal areas of study include genetics, physiology, plant breeding. plant production, biotechnology, and soil productivity, and bread grain and feeder grain.

801
USDA CORN INSECTS RESEARCH LABORATORY
Box 45 B
Ankeny, IA 50021
Dr. L.C. Lewis, Research Leader
Phone: (515) 964-6664
FAX: (515) 965-7020

Research Activities and Fields: Corn insects, particularly biology and ecology of European cornborer and black cutworm, including developing methods of biological control and investigation of insect/plant interactions.

RICE

85
CALIFORNIA COOPERATIVE RICE RESEARCH FOUNDATION
P.O. Box 306
Biggs, CA 95917
D. Martin Brandon, Station Director
Phone: (916) 868-5481

Research Activities and Fields: Rice breeding for development of improved rice varieties for California. Also studies rice weed control, entomology, plant nutrition, and diseases. *Special Resources:* Maintains greenhouses, dry laboratories, and grain drying and storage facilities.

1762
WEST AFRICA RICE DEVELOPMENT ASSOCIATION (Commodities) (WARDA)
(Association pour le Developpement de la Riziculture en Afrique de l'Ouest - ADRAO)
01 Boite Postale 2551
Bouake 01, Cote d'Ivoire
Dr. Eugene R. Terry, Dir. Gen
Phone: 634514

4095
RICE COUNCIL FOR MARKET DEVELOPMENT (Commodities) (RCMD)
P.O. Box 740123
Houston, TX 77274
Bill Goldsmith, Exec. V. Pres.
Phone: (713) 270-6699

241
LOUISIANA STATE UNIVERSITY RICE RESEARCH STATION
Box 1429
Crowley, LA 70527-1429
Joseph A. Musick, Resident Director
Phone: (318) 783-4373

Research Activities and Fields: Breeding and improvement of rice, including studies on effects of fertilizer constituents, weed control, and water planting methods of rice seeding. Conducts varietal testing and produces forage and miscellaneous crops that can be used in combination with rice culture. Also produces foundation seed rice for supplying seed growers. Also conducts research on soybeans, wheat, grain, sorghum, aquaculture, and forage crops. *Special Resources:* Collection of 8,000 varieties of rice, grown and evaluated for potential use in development of new varieties.

541
UNIVERSITY OF ARKANSAS
RICE RESEARCH & EXTENSION CENTER
P.O. Box 351
Stuttgart, AR 72160
Dr. John F. Robinson, Director
Phone: (501) 673-2661

Research Activities and Fields: Breeding of rice, soybeans, and small grains, including studies on cultural practices, control of insects, diseases, and weeds, effect of microclimate on rice quality and disease severity, fertilization, chemistry of submerged soils, and rice physiology.

4568
RICE RESEARCH INSTITUTE DOKRI
District LarkanaPhone: (501) 673-2661
Dokri
Sind Pakistan
Dr. K.K. Baloch, Director
Phone: (501) 673-2661

Research Description: Principal fields of interest include: rice breeding, plant physiology, and pathology, agronomy, entomology, agriculture chemistry, soil science, and rice technology. Institute also carries out studies of chickpea, lathyrus, and lentil crops.

241
WEST AFRICA RICE DEVELOPMENT ASSOCIATION (WARDA)
01 B.P. 2551, Bouake 01
Côte d'Ivoire
Dr. Eugene Terry, Director General
Phone: (225) 632395/634514/633242/632396
Fax: (225) 634714
Telex: 69138 ADRAO CI, BOUAKE

Research Description: WARDA's primary goal is to increase rice production in West Africa through the systematic development of improved varieties and farming systems adapted to the region's agroclimatic, social, and economic conditions. WARDA's research activities extend to postharvest aspects of rice production, including grain storage and processing, and marketing of rice for both domestic consumption and export. To ensure the controlled introduction of pure, disease-free seed of new rice varieties for its research programs and for the region, WARDA serves as the sole importer and distributor of seed from outside West Africa through its Seed Storage and Processing Laboratory, located at the University of Liberia's College of Agriculture in Fendall. Samples of all exotic materials are submitted to the Regional Plant Quarantine Station (ibadan, Nigeria), which has expanded with WARDA's support to facilitate the safe introduction of breeding materials into West Africa. WARDA is also concerned with technology development and transfer. WARDA's Development Department works closely with the development agencies of member countries on all aspects of the rice industry, including land use and development, production, processing, and marketing; works with financing institutions to identify, design, supervise, and evaluate rice projects; produces seeds of improves varieties for distribution to member countries; maintains a catalogue of proposed and ongoing projects; and serves as an intermediary between prospective financial institutions and member countries.

660
UNIVERSITY OF MANITOBA
WILD RICE LABORATORY
Dept. of Botany
Winnipeg, MB, Canada R3T 2N2
Dr. David Punter, Director
Phone: (204) 474-9813
FAX: (204) 275-7615

Research Activities and Fields: Wild rice studies, emphasizing seed testing, soil and sediment analysis, tissue analysis, seed quality, mechanization techniques, and lakes for rice production.

136
INTERNATIONAL RICE RESEARCH INSTITUTE (IRRI)
P.O. Box 933
Manila 1099, Philippines
Dr. Klaus J. Lampe, Dir. Gen.
Phone: (2) 88-78-69
FAX: (2) 817-84-70

Research Description: IRRI conducts research on all phases of rice production, management, distribution, and utilization, for the major rice-growing areas of the world. Its programs include: 1) Genetic Conservation and Evaluation, including a diverse germplasm connection maintained by the International Rice Germplasm Center (IRGC); 2) Germplasm Enhancement, including the International Rice Testing Program (IRTP) which provides world access to varietal diversity and a mechanism through which breeding lines can be tested; 3) Crop and Resource Management by which soil, nutrients, and water can be used to produce rice more efficiently; 4) Pest Management, particularly ecological methods; and 5) Rice Farming Systems, including the use of modelling to expand interpretation of experimental results.

483
TEXAS A&M UNIVERSITY
AGRICULTURAL RESEARCH AND EXTENSION CENTER AT BEAUMONT
Rte 7, Box 999
Beaumont, TX 77713
Dr. James W. Stansel, Resident Director
Phone: (409) 752-2741
FAX: (409) 752-5560

Research Activities and Fields: Rice and soybean production, with emphasis of improvement of agriculture under soil and climatic conditions prevalent on Texas Gulf Coast, including studies on rice genetics and breeding, biotechnology, insects in stored rice, crop rotation and cropping systems, insect disease and weed control, soil and plant nutrition, soybean management and breeding, fertilizer rates and timings, quality and varietal testing, and irrigation water management and quality. *Special Resources:* Maintains a regional rice quality testing laboratory and produces foundation seeds of varieties developed.

86
INTERNATIONAL CENTER FOR TROPICAL AGRICULTURE
(Centro Internacional de Agricultura Tropical - CIAT)
Apartado Aereo 6713
Cali, Colombia
Dr. John L. Nickel, Dir. Gen.
Phone (23) 67 50 50
FAX: (23) 64 72 43

Research Description: CIAT's primary objective is to work with national agricultural research organizations to develop improved agricultural technology to increase the quality and quantity of specific basic food commodities in the tropics of the Western Hemisphere, Africa, Asia. The main crops of research interest are cassava, field beans and rice. CIAT also conducts a large program in tropical pastures, focusing on the development of suitable pasture technology for the infertile, acid soils of Latin America.

1759
INTERNATIONAL RICE COMMISSION
(Commodities) (IRC)
(Commission Internationale du Riz - CIR)
Food and Agriculture Orgn. of the U.N.
Via delle Terme di Caracalla
I-00100 Rome, Italy
Trinh Ton That, Agricultural Officer
Phone: 6 57975765

4086
INTERNATIONAL WILD RICE ASSOCIATION
(Commodities) (IWRA)
7200 Sawtelle Ave.
Yuba City, CA 95993
Carlos Zambello, Pres.
Phone: (916) 673-3020

Annex B

SEAFOOD

789
DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL MARINE FISHERIES SERVICE
OFFICE OF TRADE AND INDUSTRY SERVICES
INSPECTION SERVICES DIVISION
NATIONAL SEAFOOD INSPECTION PROGRAM
1825 Connecticut Ave., Rm. 1027
Washington, DC 20235
Richard Cano, Program Manager
Phone: (202) 673-5875
FTS: 673-5875
Established: 1956

Research Description: The National Seafood Inspection Program conducts a voluntary seafood inspection and grading program on a fee-for-service basis (available to interested processors, brokers, importers, exporters, institutional and supermarket buyers, and restaurateurs). Inspection involves the examination of seafood products as well as equipment, plant, and food-handling personnel. Products that pass inspection can display the federal inspection statement "Packed Under Federal Inspection" or PUFI mark on the label and/or carton. Grading is the additional step after inspection that determines the quality level. Only products that have and established grade standard can be graded. (Industry uses the grade standards to buy and sell products; consumers rely on grading as a guide to purchasing products of high quality.) The Program also supports the development of new grade standards for ungraded products.

3358
INTERNATIONAL INSTITUTE OF FISHERIES ECONOMICS AND TRADE (Seafood) (IIFET)
Oregon State Univ.
Office of Intl. Research and Development
Snell Hall 400
Corvallis, OR 97331
Ann L. Shriver, Exec. Dir.
Phone: (503) 737-2228

1930
UNIVERSITY OF RHODE ISLAND INTERNATIONAL CENTER FOR MARINE RESOURCE DEVELOPMENT (ICMRD)
126 Woodward Hall
Kingston, RI 02881
Dr. Spiros Constantinides, Deputy Director
Phone: (401) 792-2479
FAX: (401) 789-3342

Research Activities and Fields: Development of programs to aid smallscale, capture fisheries in developing countries. Activities focus on fisheries stock assessment, coastal resources management, marine policy, marketing of fisheries products, socioeconomic and sociocultural aspects of fisheries development,role of women in fisheries development, post harvest fishery product technology, and fishery resource development and enhancement. *Databases:* Small scale fisheries development.

1417
OREGON STATE UNIVERSITY OREGON SEA GRANT COLLEGE PROGRAM
Administrative Services Bldg-A 500
Corvallis, OR 97331
Prof. Robert E. Malouf, Director
Phone: (503) 737-2714
FAX: (503) 737-2400

Research Activities and Fields: Fisheries resources and technologies, aquaculture, fisheries products and processing, fish and shellfish diseases, ocean productivity, coastal resources and processes, coastal engineering, and marine and coastal policy and regulations. Coordinates research, education, training, and advisory and extension activities in three major multidisciplinary program divisions concerned with food from the sea, coastal zone environment, and public policy. Produces educational films for NOVA and National Geographic.

1252
MASSACHUSETTS INSTITUTE OF TECHNOLOGY MIT SEA GRANT COLLEGE PROGRAM
292 Main St.
Cambridge, MA 02139
Chryssostomos Chryssostomidis, Director
Phone: (617) 253-7041
FAX: (617) 253-8000

Research Activities and Fields: Marine and coastal sciences, engineering, technology, and policy. Seeks to solve critical technological, economic, ecological, social, and political problems in marine resources utilization and coastal zone development caused by increasing and conflicting uses of the sea. Programs include creation of new and improved technologies for using oceans and their resources, search for opportunities and solutions to problems in extracting the sea's mineral resources, application of technology to expanding and improving the harvesting and utilization of living marine resources, and creation of technology and policy perspectives needed for proper coastal zone development. Cooperative studies of Institute faculty members are conducted in coastal engineering and mathematical modeling of hydrodynamics and biochemistry of coastal waters; fisheries engineering, health benefits of seafood, and use of underutilized species; marine biotechnology, including industrial use of chitin and its derivatives, angiogeneses inhibitors from shark cartilage, and marine polymer use in controlled release of drugs; environmental and economic effects of offshore oil mining; and offshore structures, particularly risers, cables, moorings, open-ended piles, waveforces, and the development of remotely operated, unmanned, underwater work vehicles.

3350
AMERICAN SEAFOOD DISTRIBUTORS ASSOCIATION (ASDA)
1525 Wilson Blvd., Ste. 500
Rosslyn, VA 22209
Lee J. Weddig, Exec. V. Pres.
Phone: (703) 524-8880

3351
AMERICAN SEAFOOD RETAILERS ASSOCIATION (ASRA)
P.O. Box 1500
Cos Cob, CT 06807
Phone: (203) 661-2959

920
ALASKA FISHERIES SCIENCE CENTER
7600 Sand Point Way NE
BIN C15700
Seattle, WA 98115
Dr. William Aron, Science and Research Director
Phone: (206) 526-4000
FAX: (206) 526-4004

Research Activities and Fields: Marine fish and shellfish, marine mammals, and international fisheries issues in the northeastern Pacific Ocean, particularly in the Bering Sea, the Gulf of Alaska, and the U.S. west coast. Studies include resource surveys monitoring variations in abundance and distribution of fish, shellfish, and marine mammals; the biology, ecology, and utilization of marine resources to assist in the development and management of U.S. and foreign fisheries; habitat investigations; entanglement studies; and the effects of environmental contaminants on the life process of marine fish, shellfish, and mammals. Projects are carried out through four divisions: Auke Bay Laboratory, National Marine Mammal Laboratory, Resource Assessment and Conservation Engineering Division, and the Resource and Ecology and Fisheries Management Division.

1062
CANADIAN INSTITUTE OF FISHERIES TECHNOLOGY
1360 Barrington St.
P.O. Box 1000
Halifax, Nova Scotia, Canada B3J 2X4
Dr. Marvin A. Tung, Director
Phone: (902) 429-8300

Research Description: Institute is a specialized resource center for research and graduate education in fish process engineering and seafood science. Principal emphasis is on fisheries engineering, protein and post-mortem biochemistry, marine oils, process technology, and packaging.

FRESH AND FROZEN MEAT AND MEAT PRODUCTS

841
USDA ROMAN L. HRUSKA U.S. MEAT ANIMAL RESEARCH CENTER
P.O. Box 166
Clay Center NE 68933-0166
Dr. D.B. Laster, Director
Phone: (402) 762-4100
FAX: (402) 762-4148

Research Activities and Fields: Development of new technology for meat animal production. Located on a 35,000-acre tract 4.5 miles west of Clay Center, which provides facilities for comprehensive multidisciplinary genetics and breeding, reproduction, nutrition production systems, meats, animal health systems, and biological engineering experiments. *Special Resources:* 13,000 head of cattle, 11,000 sheep, and 2,000 swine.

1876
DANISH MEAT RESEARCH INSTITUTE
(Slagteriernes Forskningsinstitut)
Maglegaardsvej 2
DK-4000 Roskilde, Denmark
Dr. D.B. Laster, Director
Phone: (2) 36 12 00
FAX: (2) 36 48 36

Research Description: Areas of research interest include raw material production and utilization, methods for measuring meat quality parameters, mechanization and automation, and use of information technology. Institute also provides consultancy services for Danish slaughterhouses and meat manufacturing plants.

1836
MEAT INDUSTRY RESEARCH INSTITUTE
(Vyzkumneho Ustavu Masneho Prumyslu)
Palackeho 1-3
612 00 Brno. Czechoslovakia
Dr. Petr Gayer, Director
Phone: 743031
Telex: 62627

Research Description: Areas of interest include meat processing technology, slaughtering techniques, meat production, industry hygiene and sanitation, and biochemistry of meat production.

4247
SCHOONOORD RESEARCH INSTITUTE FOR ANIMAL PRODUCTION
(Instituut voor Veeteeltkundig Onderzoek "Schoonoord")
Driebergseweg 10 DFAX: (03404) 15144
3700 AM Zeist, The Netherlands
Dr. W. Sybesma, Director
Phone: (03404) 29611
Postbus 501

Research Description: Institute conducts applied research and development in the field of animal production. Research teams conduct studies in a number of related subjects: 1) livestock management and care, including transportation conditions and animal handling in the slaughterhouse, reaction of the animal with regard to health and welfare, and improvement of working conditions in animal husbandry; 2) slaughter quality, including influence of feeding level and genetic background in growth, methods of carcass classification, and meat quality problems (e.g., boar taint of entire male pigs and influence of electro-stimulation on meat quality); 3) reproduction, including improvement of deep freezing of boar semen, development of methods for early diagnosis of pregnancy, improvement of the genetic constitution of the animal, investigations in selection and crossbreeding, and elimination of undesirable side effects of selective breeding.

- Intellectual property rights facilitate appropriation of benefits of research and technology on a fair and equitable basis;
- Policy body in place with significant representation by technology users and associations of firms involved in stewardship of technology;
- Specific conditions governing incentives for the private sector (repatriation of profits, property rights, contract law, patents, plant variety protection, taxation);
- Tax incentives for applied/adaptive research; and,
- Policies and markets support investment in the use of technology.

ARTS/FARA

Office of Analysis, Research and Technical Support
Food, Agriculture and Resource Analysis

Preliminary

Strategic Framework for Agricultural Technology Development and Transfer in Sub-Saharan Africa

December 1992

Division of Food, Agriculture, and Resource Analysis
Office of Analysis, Research and Technical Support

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Bureau for Africa
United States Agency for International Development
Washington, D.C. 20523

Annex A

Stages of Commodity System Development and Related Constraints

The attached table presents the projected relationships between the components of a generic commodity production/marketing system with respect to the five stages of economic development projected in A.I.D.'s Strategic Framework for Promoting Agricultural Marketing and Agribusiness Development in Sub-Saharan Africa.

The attached table shows that agricultural production/marketing systems become increasingly complex and more articulated as a country progresses through successive stages of development. It also postulates the increasing strength and dependency between components as a commodity system moves from a state of simple technologies and production, primarily for household consumption, to an increasingly commercial orientation.

In Stage I, there are often only weak backward and forward linkages between on-farm productions processes and components concerned with provision of agricultural inputs and with the marketing of outputs. This is reflective of the fact that production operations in this stage of development use very limited quantities of purchase inputs; that the quantities of marketed flows and qualities of harvested output are highly variable both spatially and over time; and, that a large majority of harvested commodities are prepared by family labor and consumed within the farm household. Very limited sales occur and they are confined almost entirely to local markets.

By Stage III, farm businesses have emerged to the point where most output is intended for commercial markets and on-farm operations use significant quantities of purchased inputs. The evolution increases the importance of efficient component linkages for producers both at the enterprise and household levels. It also means that actions and performance of many other economic actors must now be considered in the commodity system.

Stages IV and V represent descriptions of commodity production/marketing systems generally found only in middle and high income developed countries. While relevant to the complete evolution of commodity systems, these stages of system development are seen as beyond the current state of most sub-Saharan African economies. The only economy in sub-Saharan Africa which currently has a significant number of commodity production/marketing systems meeting most of the criteria in Stages IV and V is the Republic of South Africa. And, even in this case, the state of systems development varies significantly depending on which populations of producers and marketing agents are being addressed.

System Components/Stage of Development	Stage I	Stage II	Stage III	Stage IV	Stage V
Acquisition of Capital Resources	Command of capital resources limited to managerial skills adapted to very site-specific situations; some investment in livestock; land tenure, water and grazing rights often obtained through communal arrangements; land use may involve shifting cultivation with no capital investments; mitigation of risk through livestock/crop enterprise diversification and reciprocal social relationships	Command of capital resources still limited more investment in livestock probable largely a mechanism for storing small amounts of capital accumulated from crop "surplus"; land tenure and other resource access still determined largely by communal mechanisms; crop cultivation more reliant on fallow system with an capital investment the result largely of human labor - i.e., dug wells, livestock corrals, field ridges, etc; mitigation of risk through diversification of on-farm enterprises and access to non-agricultural activities on and off-farm, including wage labor	Command of on-farm capital resources increases significantly; livestock enterprises emerge as commercial activities; access to land, water and grazing increasingly secure and controlled by sales or long-term lease agreements; increased ownership/control of capital resources permits greater access to formal credit markets; resource-enhancing improvements and capital equipment acquisitions - tractors, field equipment, vehicles - increasingly a function of long-term capital investments; growing investment capacity in development of entrepreneurial and management skills	Active commercial markets exist for acquisition of land and resource use rights; capital equipment and infrastructure funded primarily from equity capital and formal financial institutions; great emphasis on investment in development of human capital in all aspects of agriculture and agribusiness; property and use rights secured by access to strong legal system; risks increasingly mitigated through insurance or other farm income guarantee programs; acquisition and management of capital assets becomes an important factor in farm business viability	High levels of equity and external capital funding required to maintain and enlarge farm business; capital acquisition facilitated by growing equity holdings in land, breeding and tree stocks, and infrastructure; high levels of human capital engaged in farm business planning/management; investment governed by increasingly rigorous financial criteria; investments in resource conservation increasing to sustain farm enterprise over time; farm operations become large-scale, capital-intensive business
Mobilization of Annual Inputs	High Dependencies on family labor, no (or very limited) use of purchased seeds, plant materials, fertilizers, agricultural chemicals; tools limited to hoes and similar implements produced by the household or local artisans; short-term credit, if any, obtained through informal channels; use of animals for transport	Predominant input is still family labor; limited use of purchased seeds, plant materials, and fertilizers available through public agencies; broader range of tools used with more purchased from local artisans; access to short-term credit from formal institutions increasing with initiation of cash crop/livestock enterprise; limited use of hired labor for weeding and harvest	Adoption of new enterprise technologies for both food and cash rops brings increased use of higher potential seeds and plan materials, fertilizers, agricultural chemicals, and veterinary/livestock production inputs; inputs supplied increasingly by commercial firms; access to off-farm services for equipment maintenance and operations, storage, etc. improves	Farm business secure virtually all necessary inputs from commercial firms as needed and on demand; employment of both permanent and temporary wage labor for farm enterprise is the norm; government role in input markets is reduced largely to enforcing product standards and safe handling/use regulations for potentially dangerous agricultural chemicals	Farm businesses are required to adopt and maintain state-of-the-art technologies to ensure continuing decreases in unit production costs; on-farm enterprises increasingly must accomodate to public concerns on environmental and other issues; increased dependency on external supply and support services in maintenance of farm operations
Production Processes	Crop, livestock, and/or forestry enterprises largely oriented toward provision of household food, fiber and other requirements; little or no access to or adoption of improved crop/livestock technologies; farmers may use manures, crop residues or bush burning as practices to maintain soil fertility	On-farm enterprises still largely devoted to satisfying household needs; limited cash crop enterprises; involvement in cash cropping leads to introduction of animal traction use; increasing awareness and use of improved technologies related largely to cash crop and livestock enterprises; labor availability an increasing problem with out-migration of younger household members; improved seeds and fertilizers available in limited quantities and often delivered in an untimely manner	On-farm enterprises oriented principally toward production for commercial sales; farm households increasingly act as consumers in all markets; enterprise input allocations based on profit maximization criteria, not household consumption requirements; producers actively seek out, evaluate and adopt financially viable technologies; size of individual farming enterprises increases with out-mgration of rural households to occupations in major urban and secondary centers and into agricultural services, processing and marketing enterprises	Virtually all viable farm businesses seek out and use improved seeds, plant materials, fertilizers and agricultural chemicals at near financially optimal levels; knowledge of new technologies is obtained increasingly in contacts with commercial input suppliers; most on-farm operations are mechanized in response to rising labor costs and output volumes; farm concentration accelerates with out-migration from rural areas and increasing urbanization of the national economy	All farm operations are fully mechanized; increasing use of customized services; farm managers are highly specialized and maintain close links with firms and public institutions in developing new technologies; use of computer and specialized software widespread in both enterprise and overall business operations; on-farm production enterprises are increasingly planned to conform to contractual requirements with both private sector firms and government support programs; production is also intimately linked with consumer demand requirements

Annex C

Illustrative Indicators and Selection Criteria

Level 5: **Improving The Potential for Long-Term Increases In Productivity and Income**

Criteria. Indicators should identify change in productivity (of land, labor and capital), and income that are the underpinnings of the agricultural sectors contribution to sustained improvements in food security and economic growth. Indicators should capture broad based change.

Benchmarks.

- Value of agricultural production per land unit;
- Value of agricultural production per labor unit;
- Value of agricultural production per capital unit;
- Value added per unit of capital in agro-industry; and,
- Value added per unit of labor in agro-industry.

Level 4: **Biophysical or Environmental Change**

Criteria. Indicators are intended to identify broad-based change in the status of the natural resource base resulting from adoption of. practices, commodities, technologies, processing or business operations.

Benchmarks.

- Soils fertility - soil organic matter levels, soil pH, levels and balance of plant nutrients;
- Soil conservation - tons soil loss/ha, textural changes, structural changes, stream turbidity;
- Forest/range - density and composition of species; and,
- Water - salinity, ppm of pollutants.

Level 3: **Utilization of Agricultural Technology**

Criteria. Indicators should describe broad-based change in the adoption of agricultural technology. Broad-based use means that a sufficiently large proportion of the population or area within the boundaries of a region or nation are affected, such that the accumulated changes will effect changes in national level accounts. The proportion of men versus women adopters is an important indicator for monitoring differential effects on household productivity and income. It may be necessary to use more than one indicator to capture broad-based utilization when there is an additional parameter such as equity.

Benchmarks

- Proportion of Area Under a Commodity Using Technology;
- Proportion of HH's, Firms, Farms or Population in Area Using Technology; and,
- Amount of Technology (inputs) Used.

Level 2: **Accelerated Development and Transfer of Agricultural Technology**

Criteria. Indicators should identify and describe progress in improving the quantity and quality of technology available at: release and pre release stages; manufacture/multiplication centers; distribution/sales points. Indicators should also identify and describe conditions necessary for users to access the technology and achieve the levels of productivity change projected by suppliers (e.g., research and input firms).

Benchmarks.

- The operation of farming systems research and similar approaches to constraint analyses applied to increase involvement of technology users in the adaptation and verification research;
- Number of technologies certified and registered (such as fertilizers, processing equipment, seeds, fungicides, and pesticides);
- Number of technologies released;
- Number of technologies at pre-release stage;
- Amount of new of inputs available by multiplier/manufacturer;
- Number and amount of new technologies available at sales points; and,
- Proportional increase in productivity expected over existing technology.

Level 1: **Capacity to Develop and Adapt Technology**

Criteria. Indicators should identify and describe changes in: human resource and institutional performance; The technology base; The policy and business environment.

Benchmarks.

- Number of technologies tested on station per discipline;
- Number of technologies tested on farm or firm;
- Success rate of trials/experiments (no. established, no. harvested, no. with statistically analyzable data set, no. with statistically significant differences);
- Development funding per scientist per year;
- Increased financial contributions by clients to research efforts;
- Financial systems facilitate contracting with private sector to develop or finance technology adaptation;
- Increased attention to subsector and market analyses to identify demand for new technological products;
- Within the public sector, elements of technology systems include:
    - *a promotion system based on performance,*
    - *work plans that encourage client linkages,*
    - *research contract linking research objectives to client needs,*
    - *an organization which encourages linkages with national, regional and international organization, and*
    - *the establishment of contracting and financial mechanisms that will facilitate buy-ins and procurement among and between institutions and organizations.*

Examples of Subsector Development

Commodity system analysis is an integrating device and provides information of the following key question: ***At which stage is the process of producing and moving commodities to final points of sale will technological and other supporting interventions yield the greatest returns from research and technology transfer?***

There have been several outstanding examples where research programs have broadened their approach to address this question. **They have done this by investigating demand conditions and alternative marketing channels in a commodity system to identify the most appropriate policy, institutional and technological interventions:**

► **Reform of the Maize Economy in Malawi**

An integrated set of interventions has transformed the maize subsector from 'failure' to qualified success in less than five years. ***Key price and nonprice interventions included:***

- privatization of the National Seed Company of Malawi (NSCM). Cargill, which now owns 55 percent of the NSCM, has helped to dramatically increase the supply of hybrid (dent) maize seeds for larger, commercial farmers -- an important channel in the maize subsector.

- technology for flint maize, grown by most smallholders in a different channel, because of its unique processing and storage requirements, had lagged behind hybrid dent technology. However, multi-disciplinary research teams, working closely with CIMMYT, have developed new flint varieties, and started to distribute them through NSCM, with yields as high as those of hybrid dents.

- raising maize prices to producers in real terms has given farmers incentives to produce surpluses for the market.

- an aggressive extension campaign is encouraging farmers to plant both improved dents and flints.

Thus, compared to the 1986/87 crop year when only 5 percent of Malawi's farmers used hybrid or improved flint varieties, now - only five years later, the rate of adoption of new maize technology has increased to 15 percent. As improved flint varieties are accepted by smallholders, it is estimated that adoption rates could exceed 50 percent within the next five years.

- **Reform of the Rice Economy in Madagascar**

The reform of the rice economy in Madagascar in the 1980s is commonly cited as one of the most important policy program successes in any sub-Saharan nation. The transformation of this commodity system is am excellent example of how a dedicated group of public officials can use quality commodity research to conceptualize and implement an effective program to transform a rigidly controlled sub-sector into a more open and participatory production/marketing system.

Further information on the program can be found on Ahlers (1984) and AIRD (1985).

- **Reform of Foodgrain Markets in Mali**

The process of reform in foodgrain markets in Mali is another excellent example of a sustained effort in commodity systems analysis and policy implementation. The process, specific policy actions, and the impacts of reforms are well documented in several documents. These include:

Atwood and Elliott (1989); D'Agostino and Staatz (1989); Dembele and Dionne (1986); Dembele, Dionne and Staatz (1986, 1986); Dembele and Staatz (1989); Dione (1986, 1990); Dione and Staatz (1987); Staatz (1989); and Staatz, Dione and Dembele (1989).

- **IFPRI Studies on Commodities and Regional Markets in West Africa**

Work by IFPRI researchers on foodgrains and export crops in West Africa has made major contributions to revising national and donor perspectives. This body of research has had major impact in dampening enthusiasms for ill-conceived regional commodity protection schemes and in evaluation the realistic possibilities for development of certain commodity system. It has also focused attention of the linkages between regional marketing systems and food security. This work has been documented in a series of papers by Badiane (1989; Delgado (1989, 1990); Reardon (1989, 1990); Reardon, Matlon and Delgado (1988); and Reardon, Thiombiano and Delgado (1989).

- **Country and Regional Livestock Production and Marketing Studies in Africa**

Several studies of livestock systems in West Africa have contributed to a reorientation in perspectives on the realistic production potential and the importance of regional market arrangements in West Africa. They include Breman (1986, 1986, 1987) on livestock production systems in Niger, Burkina Faso an Mali; and Center for Research on Economic Development (1979-1980) studies on regional livestock marketing in Cote d'Ivoire, Liberia, Ghana, Togo, Benin, Niger, Burkina Faso, and Mali.

In addition, useful studies on dairy product processing and marketing have been contributed by Burton, Eriksen and Pulgar-Vidal (1987) for Niger; Chouchene et al (1990 for Tunisia and von Massow (1985) for Mali.

► **Cotton Studies on West Africa**

The success of cotton industries on certain African countries and the reasons for failures in others have been documented in research by Lele, Van De Walle and Gbetibouo (1989); and Operations Evaluation Department (1989).

► **Rwanda Commodity Storage Research**

An example of collaborative research on post-harvesting handling techniques, improved storage and processing methods for foodgrains and grain legumes in Rwanda is documented in Ministry of Agriculture, Animal Husbandry, and Forestry (1988).

► **Rapid Appraisal of Marketing Systems**

Information on the methodology for rapid appraisal of commodity marketing systems can be found in Holtzman, Martin and Abbott (1988) and as example of the implementation of the methodology for a cowpea production/marketing system can be found in Rassas et al (1989).

► **Tunisia Agricultural Policy Implementation Project**

Finally, an example of how A.I.D. - funded commodity research can be successfully linked to a World Bank/government agricultural sector adjustment program can be found in the USAID/Tunisia Agricultural Policy Implementation Project. In this project, commodity systems studies on foodgrains, dairy products and export crops) olive oil, citrus, wines) were specifically targeted to facilitate implementation of agricultural sector adjustment program. The studies individually and collectively had major impacts on decision-makers' thinking on how to implement government commitments to sector reforms agreed to at higher levels.

Project documentation for the APIP can be obtained for USAID/Tunisia and individual commodity systems studies can be obtained from Abt Associated and/or Ithaca International Limited.

Domestic Market Sale/Consumption	Domestic market sales to the extent they occur sporadically are largely driven by farm household requirements; high degree of heterogeneity in commodities traded; exchanges largely directed at local consumers; public or private market agent intermediation essentially non-existent; market information plays little or no role in influencing production patterns; a few periodic - i.e., weekly - markets may exist in the area; direct face-to-face negotiated sales are the norm	Increasing urban consumer demand for food commodities and processed products; cash crops increasingly marketed through narrow public or parastatal agency channels; market outlets develop at wholesale and retail levels; market flows are increasingly responsive to demand from urban marketing agents; access to market information becomes more important in influencing production patterns, particularly with respect to supply of credit and production inputs; regional communications, primarily by telephone, are improving among market intermediaries	Commodity production and marketing patterns derived increasingly from consumer demands in both domestic and export markets; marketing channels for all commodities expand with growth of private sector agro-business; public and parastatal firm participation in commercial activities declines sharply as trade is increasingly based on competitive efficiency in markets; well-articulated structure of specialized markets in place; public intervention in markets is increasingly confined to enforcement of grades, standards, and public health practices, promotion of incentives for commercial enterprises, increasing flows of market information throughout the production/marketing chain; need for direct face-to-face transactions declines; increasing use of formal contracting between producers and processors; increasing resort to legal means in settling contractual disputes; national and international communications linkages improve greatly an diversify with FAX, telex and other means	Growing consumer demand fueled by rising disposable incomes and urbanization; farm households are fully integrated in all markets as consumers; firm concentration begins at wholesale level while retail outlets proliferate to serve consumers; both vertically and horizontally organized processing and marketing firms become significant in commodity chains; uniform grades and standards allow the majority of bulk commodity sales to be impersonal and at arms length; increasing use of auction markets, commodity exchanges, and futures markets; production/marketing information flows are increasingly accurate and timely from both public and private sources. processing/marketing margins generally exceed 50 percent of the total cost for processed commodities; unit costs throughout the production/marketing chain, however, continue to decline; government regulation of markets directed at maintenance of competitive conditions, enforcement of market standards, and strengthening business climate	Domestic marketing is fully integrated on both a national and international basis; marketing of high value products often linked with imports to extend market availability; strong movements toward increasing firm concentration at all levels within the commodity chain and between chains; food conglomerates are vertically and horizontally integrated in assembly, processing, storage, distribution and retailing functions and dominate many commodity chains; operations are driven by consumer demand but firms have increasing capacities to affect consumer preferences through product development and media advertising; brand name and generic food products compete in all retail markets; high levels of disposable income allow consumers to pay premium prices for convenience, quality and off-season supply in products; many niche markets and marketing windows develop
Export Market Sale/Consumption	Essentially no sales to export markets	Increasing export market activities centered on cash crops; increasing localized cross border sales of food commodities as permitted by local surpluses but such transactions are sporadic and market intelligence is not available on a regular basis; government may attempt to curb such sales in the interest of "national food self-sufficiency" but such efforts are generally ineffective	Opportunities for export marketing are actively pursued by commercial firms; government facilitated gathering of market information and actively promotes both interregional and international export trade; government adopts trade and investment practices and maintains competitive conditions in export markets; international firms are actively encouraged to participate in all aspects of market development; sales occur on basis of international grades and standards at world market prices; extensive use of forward contracting and initiation of futures markets; international communications linkages are greatly improved and diversified	Specialized information gathering/analysis units developed to identify and exploit export markets; government seeks to actively negotiate in international forum and in bilateral relations to lower trade barriers and facilitate mutually-beneficial relationships; domestic export market operations increasingly integrated with international partners and in worldwide communication networks	High concentration of firms in export markets; firms apt to have extensive multinational linkages in finance, marketing, operations, product development and promotion, etc; high international standards and firm innovation are required to maintain and increase international market share; government may be increasingly concerned that firm concentration and multinational relationships supersede national interests and "loyalty"; in some cases, export market sales may become so important as to constitute "the effective economy of the country with respect to foreign exchange earnings and the like"

Harvest/Offtake	High labor requirements in all harvesting and crop assembly operations; poor roads limit possibility for transport of commodities out of local environment	High labor requirements in all harvesting and crop assembly operations may force use of hired labor and animals; improved road network facilitates better local and regional commodity distribution	Harvesting and crop assembly operations increasingly mechanized and/or accomplished with hired labor; greatly improved transport network and agro-industrial infrastructure facilitates prompt evacuation of most commodities to off-farm markets and/or processing plants	Harvesting and crop assembly largely mechanized, except where commodity demands special hand harvesting; essentially all commodities enter commercial channels after harvest unless retained on-farm for speculative reasons	Harvesting and crop assembly operations closely linked with commodity standards and processing schedules; government marketing orders play important role for many high value commodities
Direct Farm Household Processing/Consumption	Very high percentage of commodities produced are prepared and consumed by farm household	High percentage of food commodities processed and consumed on-farm; developing markets for cash crops largely through public agencies	Direct on-farm processing and consumption of commodities is greatly reduced; retention of farm commodities becomes a household option, not a necessity	On-farm processing and direct farm household consumption become insignificant as factors in the commodity production/marketing chains	On-farm processing and farm household consumption is no longer a factor
Commodity Assembly/On-farm Storage	Very high human labor input in core assembly operations; most commodities produced stored in on-farm facilities; storage losses can be high; marketed surplus is incidental and often a consequence of favorable weather conditions	Increasing use of animals and carts in crop assembly; food crops still stored primarily on-farm; wider use of phytosanitary products in commodity storage; high percentage of cash crops evacuated to local markets and/or parastatal storage facilities	Commodity assembly increasingly done with vehicles; use of animal transport off-farm declines sharply; on-farm storage becomes a commercial option and a speculative activity; improved post-harvest commodity handling and phytosanitary practices greatly reduce storage losses	Commodity assembly fully mechanized on-farm and motorized between the farmgate and markets; high standards of post-harvest commodity handling and storage prevail both on-farm and in transit	Very high standards required for commodity handling, storage and transport operations; on-farm storage may increase for some commodities to facilitate scheduled deliveries and to optimize net returns to the farm business
Commodity Preparation	Very limited off-farm commodity sales and preparation; transactions involve low volumes exchanged locally; little value-added in preparatin and distribution	Increasing use of grading standards and sorting for all commodities; small-scale preparation of food commodities for local market consumption	Widespread use of sorting and grading standards makes non-face to face market transactions possible; more sophisticated commodity preparation techniques are adopted in response to higher consumer expectations; use of cold storage/refrigeration growing for perishable produce and livestock products; commodity packaging is introduced at wholesale and retail levels in response to rising effective consumer demand	Specialized commodity treatment and storage methods in wide use for fruits, vegetables and livestock products; packaging increasingly specialized and used to advertise as well as protect produce; forward contracting and delivery scheduling becomes common for many high value commodities	Many specialized commodity treatment and storage methods may be carried out at the farm level as adjuncts to strictly production operations; speed and timeliness are essential in meeting consumer demand requirements for fresher and high quality commodities; preparation, packaging and distribution operations for commodities are state-of-the-art
Product Processing	Very limited off-farm commodity processing, marketing or distribution; processed products generally cannot be stored	Cash crops increasingly enter regional processing facilities; off-farm storage infrastructure developing; some custom processing of food products in local flour mills, oil extraction plants; marketing costs and margins rise as a percent of total product costs with increased off-farm processing and distribution operations	Majority of cash and food crops produced enter commercial processing facilities; commercial storage and distribution networks expand beyond urban centers; processing and marketing costs constitute greater percent of total commodity costs to consumers but greater commodity flows allow for increasing economies of scale in agro-business operations	Processing plants are larger and more efficient; consolidation driven by scale economies and facilitated by improved transport network; proper packaging/labeling and product safety standards; export commodity processing is conducted in accordance with international standards	Commodity processing is state-of-the-art and is highly innovative in product development for niche markets, convenience foods; strong movement toward frozen food products, often with extensive preparation and packaging requirements; changes in consumer preferences and dietary habit must be accomodated rapidly

Annex D

Figure 3. FRAMEWORK FOR ORGANIZING AGRICULTURAL TECHNOLOGY DEVELOPMENT AND TRANSFER INDICATORS

PROCESS INVOLVES

Capacity to Develop/Adapt Technology	*Accelerated Development and Transfer of Ag. Technology*	*Adoption of Technology*	*Biophysical Change*	Improving Potential for *Long-term increases in productivity and income*
Level 1 →	***Level 2*** →	***Level 3*** →	***Level 4*** →	***Level 5***

INDICATORS IDENTIFY AND DESCRIBE

ENABLING ENVIRONMENT	INTERMEDIATE CHANGE	INTERMEDIATE CHANGE	INTERMEDIATE CHANGE	IMPACT
Changes in Human Resource and Institutional Performance Technology Base, Policy and Business Environment.	*Changes in the Availability of and Access to Technology (Technology available from Research, Quantity/Volume available, Agents and Outlets Distributing Technology).*	*Changes in Behavior and/or Broad Based Adoption of Technology by End Users (Producers, Processors, Storage).*	*Changes in Soil, Vegetation and Animal Parameters of the Resource Base.*	*Changes in Incomes Productivity and Food Security.*

Annex E

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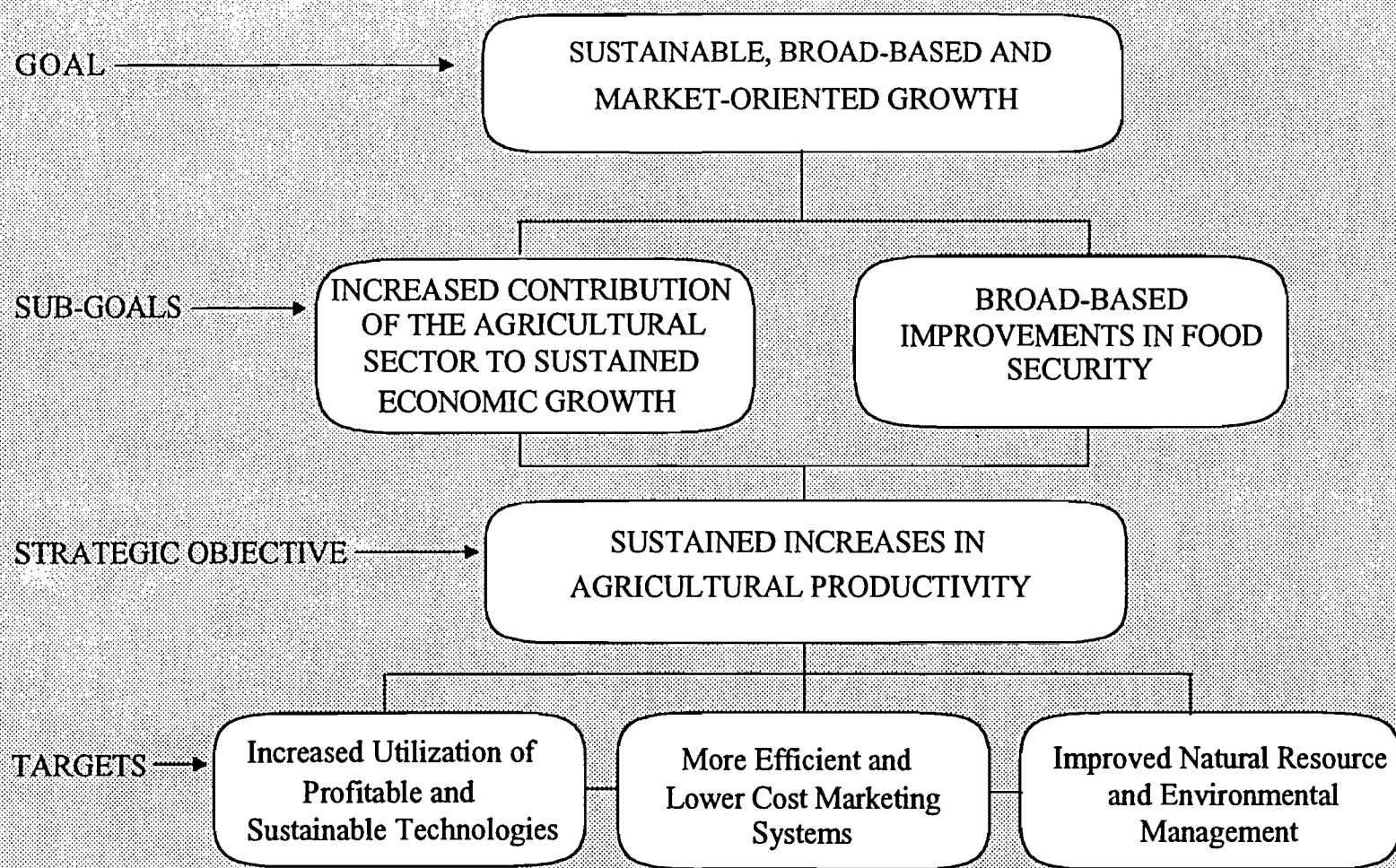
Figure 1. OBJECTIVE TREE: Agriculture and Natural Resource Sector



With regard to institutional capacity, A.I.D. assistance to agricultural research in Africa in the past 10 years has focused on:

- the transfer of technology by public research institutions (with little or no collaboration with the private sector);
- human resource development and, in particular, higher degree training in technical fields;
- integrating participatory adaptive research (i.e. farming systems research) into public sector research systems;
- establishing regional linkages among public research systems and International Agricultural Research Centers (IARCs) to use research resources more efficiently.

Until recently, A.I.D. has given little attention to broader institutional reform issues with regard to public sector research systems. And in general, the policy-technology-market aspects of agriculture have been addressed separately rather than in tandem.

Since 1985, when the Africa Bureau approved the *Plan For Supporting Agricultural Research and Faculties of Agriculture in Africa*, many changes have taken place. The remainder of this section identifies those changes and explains the rationale behind the modifications embodied herein.

1.3.1 Structural Adjustment

Over the past decade many African countries have undertaken structural adjustment programs with the goal of improving the performance of the agricultural sector in support of economic growth. In line with these reforms, research and extension have increasingly been called upon to achieve growth objectives. According to a recent World Bank review of the experience with the policy adjustment lending, lags in response from the agricultural sector to policy changes were attributable to non-price factors, such as weak infrastructure and a lack of productivity-increasing technologies.

The tools of structural adjustment and reform are intended to reduce public sector expenditures and control aggregate demand. As public sector cutbacks affect research expenditures, the supply of potential technology could be reduced. But structural adjustment can also affect the demand for technology, especially technology that supports income generation and earnings from adding value and exporting. To respond to new opportunities for increasing the utilization of specific agricultural technology requires a clear understanding of both market structures and the behavior associated with different commodities that are in demand. Thus, **agricultural research must examine markets as well as policies, and the economic concerns of specific commodities systems that it is assisting, to develop in order to link its efforts more closely with economic growth and development.**

1.3.2 Food Security and Agricultural Technology Development

The Africa Bureau of A.I.D. defines food security as adequate access by all people at all times to sufficient food and nutrition for a healthy and productive life. Agricultural technology development has an important role to play in improving food security in Africa. Technology

development and transfer (TDT) activities that generate increases in agricultural productivity contribute to augmenting food supplies (food availability) as well as household purchasing power (food access). In order to bolster household food security, however, TDT activities must be complemented by efficient agricultural input, storage, processing, and marketing systems that ensure adequate access of the population to food.

Increases in staple food output due to the development and adoption of profitable technologies contribute to the availability dimension of food security. TDT activities may also contribute to improving food access through strengthening household purchasing power. The 1980s research conducted by Michigan State University, the International Food Policy Research Institute and others demonstrated that rural African households are not solely producers of staple food crops, but rather, diversify their agricultural activities to include cash cropping and off-farm income generating activities. Studies have shown that a large proportion of rural households in Africa are net purchasers of food. In a recent study on technology development and household food security, Michigan State University notes that technology development and transfer activities that result in lower unit costs of production reduce the real cost of food to both urban and rural consumers, thus augmenting purchasing power (Staatz and Bernsten, 1992). MSU further notes that increases in agricultural productivity--increases in output per unit of factor input--may allow farm households to shift resources from staple food crop production to other income generating activities, thereby strengthening their access to food (Staatz and Bernsten, 1992).

1.3.3 Human Resource and Institutional Base

A principal product from the last twenty years of investment in agricultural research systems in Africa is an enlarged and more competent human resource base. The number of African agricultural scientists has increased from 1,841 (full-time equivalents) research staff in the 1966-70 period to 4,491 (full-time equivalents) in the 1981-85 period (ISNAR, 1991). However, several factors have adversely affected research productivity, including the financial instability of research systems (decreasing resources per researcher) and the restrictive institutional and policy environment.

In general, neither agricultural research nor extension systems have been well-supported and well-managed. Frequently, units working on research or extension have been used as enclaves for special projects, distancing local decision makers from key implementation experiences. Also, inadequate attention had been paid to documenting and analyzing the impact of research. For example, many evaluations note that impacts could not be measured because accurate baseline data were lacking, and actual figures for research productivity and technology utilization were not reported. Hence, the basis for understanding what levels of support are necessary to achieve broad-based impact from investment in research in Africa has been missing.

Thus, **increasing the contribution of agricultural research to economic growth requires investments in the institutional base for research as well as a focussed effort to document and analyze the impact of technology development and transfer activities.**

1.3.4 Approaches To Agricultural Research

Since the mid-1970s, Farming Systems Research (FSR) has documented farmer constraints to production. Research oriented to actual farm conditions (on-farm research) introduced the concept of **clientele** and the importance of being responsive to its needs. Social scientists became engaged in the research process and used FSR to help shape research and extension as tools to

achieve equity objectives, for example, by focusing efforts on food crops, marginal areas and the problems of resource poor farmers.

Conducting FSR was difficult because researchers often lacked vehicles and operating funds for transportation and because conditions varied from one location to another. But numerous constraints were documented, including farmer attempts to minimize risks (rather than maximize production). While making significant contributions to the understanding of the whole farm enterprise, in many cases the farming systems research activities did not integrate or link production constraints with the other vertical components of the agricultural sector that significantly affect adoption and income generation: markets, policy, manufacturing/ multiplication capacity.

Emerging from these experiences with adaptive research and extension is a lesson about factors affecting utilization of agricultural technology. **Adaptation of technology to local circumstances requires a broad understanding of the whole farm enterprise. And, local adaptation is a necessary but not sufficient condition for utilization. A demand for the technology must also exist--and that demand is influenced by the demand for agricultural products and commodities.**

1.3.5 The Natural Resource Base

Research on soils, integrated pest management, and agroforestry has documented that the natural resource base is deteriorating, jeopardizing the sustainability of agriculture in sub-Saharan Africa. **Improving the natural resource base requires that both researchers and producers take steps to integrate resource-conserving practices and inputs into the production-marketing system.**

1.3.6 Technology and Produce Markets

A recent review of A.I.D. research programs and projects (C. Christiansen, Economic Research Service, USDA) points out that research planners have underestimated the importance of two factors: unfavorable producer prices and inefficient input supply systems. Each of these factors significantly limits farmers' ability to adopt new technologies and reduces their incentive to do so. Thus, **a necessary condition to increase the utilization of agricultural technology is the operation of efficient marketing systems.**

1.3.7 Eco-Regional Collaboration

Evaluations of regional research and networking activities suggest significant returns to regional collaboration among National Technology Systems (NTS) and International Agricultural Research Centers (IARC). Achieving impact is easier when a NTS is strong. To revitalize agricultural research in Africa, a Special Program for African Agricultural Research (SPAAR) Initiative is actively promoting the strengthening of national technology systems in regional contexts. African scientists and research directors are leading the initiative to strengthen national systems. They recognize that national technology systems must be the basic building blocks and that a regional perspective can encourage each NTS to focus on what it does best, relative to other systems in the region.

1.3.8 Development Fund for Africa: Impact and Accountability

Since 1988, USAID's African development initiatives have been financed through the Development Fund for Africa (DFA). The DFA provides clear goals and objectives and requires that progress toward these goals and objectives be monitored and reported. Consequently, the DFA has encouraged efforts to assess the impact of research and the contribution of research to sustainable increases in economic growth.

With increased delegation of authority to the field under the DFA, field Missions must demonstrate to Congress that the activities they fund are having an impact. Since the impacts of investments in technology systems are complex and distributed over time, Missions tend to prefer investments that have an immediate and direct impact. In health, for example, there is general agreement that immunization rates and child mortality rates are closely correlated and that increasing immunization rates will decrease mortality. For agricultural technology systems, the relationship between inputs (trained researchers, operating funds, research programs) and outputs (increased agricultural production, productivity and food security) is not well-understood. What is needed is a series of intermediate indicators to show whether investments in agricultural technology systems are producing promising results.

2. The Strategic Framework: Technology Systems, Agents and Concepts

2.1 Purpose

The purpose of the Strategic Framework for Technology Development and Transfer is to guide the Africa Bureau and its Missions in supporting technology development and transfer in sub-Saharan Africa.

Support for agricultural technology development and transfer is critical to increase and sustain the contribution of agriculture to economic growth. Agricultural technologies that are both profitable and sustainable permit increased output of commodities while maintaining the natural resource base. Development, adaptation and transfer of technologies requires an efficient technology system with links to broader social and economic interests including commodity systems. The Strategic Framework presents guidance for supporting institutional, technical and policy initiatives leading to the creation, adaptation and extension of profitable and sustainable technologies.

2.2 Agricultural Technology Systems

An **agricultural technology** is defined as any method, process or policy that increases the efficiency (reduces unit costs) in the system through which agricultural commodities are produced and flow to final consumers. An agricultural technology may combine policy, institutional and technical changes. Since countries and commodities are in different stages of development, different technologies are appropriate in different settings. Furthermore, as technology development and transfer systems evolve, technological, managerial and financial needs change and the actions needed to improve the performance of technology systems also change.

A **technology system** is a combination of agents (actors, organizations, institutions) all of which have interests, roles and responsibilities in the development, transfer and use of technology. A technology system includes both public and private sector agents, operating for both profit and nonprofit motives to meet market, social and political interests. Defined this way, a National Technology System (NTS) is broader than traditionally implied under the term National Agricultural Research System (NARS).

Since countries and commodity systems are in differing stages of development, the mix of initiatives to improve the performance of technology systems and to increase the impact from technology will differ, depending on the stage of development. The development of technology systems requires increased differentiation of roles and activities and the evolution of more efficient mechanisms to coordinate the increasingly complex systems.

In sub-Saharan Africa, most producers are smallholders, participating in commodity systems that are at relatively low levels of development. A subsector or commodity system includes a wide range of functions such as production, processing, marketing, storage, transport and the distribution of inputs and services. Each function has unique constraints that may limit

development of the whole system. A subsector approach to agricultural technology development and transfer (TDT) requires analysis of a specific commodity or group of closely-related commodities over time. Research focuses on a succession of constraints (policy, institutional or technological): as one is released, others assume primary importance--but the emphasis is on identifying intervention points which yield the highest returns and impact from research and technology transfer.

The implications of subsector development for agricultural TDT are that as subsector systems develop:

- Research acquires an expanding range of clients whose needs must be met to sustain growth;
- The complexity of linkage mechanisms and partnerships increases because the range of agents involved in technology development and transfer increases; and,
- The range and amount of research required to maintain the system increases.

Technology systems are themselves influenced by the policy, trade and regulatory environment within which they must operate. To facilitate and support the evolution of technology systems requires a policy environment that stimulates interest and investment in the commodity system that is being targeted. It also requires an enabling environment that facilitates efficient transactions between the agents in the technology system. Basic production units in any agricultural technology system are the laboratories, the experiment stations, research/extension institutes, farms and firms to multiply and manufacture the technology for broad based use, and distribution networks. The research units are mechanisms for transforming intellectual and physical capital into new knowledge and technology. This knowledge is made available in research papers, books, bulletins, and information releases and in consultations with scientists, research administrators, extension workers and producers of agricultural inputs and industrial products.

The continuum of research activities, extending from basic to more applied activities, is as follows:

- At one end of the continuum, basic research generates new scientific knowledge, with no attention to eventual commercial application.
- Then comes strategic research, intended to solve particular problems, or to develop new techniques.
- Further along the continuum, applied research aims to create new technology, with an eye to commercial application.
- Finally, adaptive research, which includes trials and feedback, adjusts the technology to specific environments and circumstances, so that innovation can occur and the technology becomes a commercial reality.

A majority of the basic and strategic research necessary to build the technological foundation for change is completed by the international agricultural research community. Such research is too costly and time-consuming for most African countries. By linking with the international community, African technology systems can focus on the research they can do best.

At the present time, African technology systems focus primarily on applying and adapting agricultural technology for African agriculture. In the short term, Africa can significantly benefit from linking with existing knowledge and technology while concurrently building an African foundation for more strategic and basic research.

In these research activities, the Strategic Framework stresses the need to focus on the generation and release of technology that will improve market prospects for the goods and services produced. The emphasis is on the performance of subsector systems, and development of linkages among them to promote increased utilization of agricultural technology.

Achieving a balance between the demand for and the supply of agricultural technology is a key step in increasing the utilization of profitable and sustainable agricultural technology. Achieving balance requires strengthening of the four agents of the technology system. (See Figure 2 The Technology Development and Transfer Objective Tree). The **agents** of a technology system are:

The **users of agricultural technology** who are involved in the full range of efforts needed to achieve development and reform of the commodity system including: production, processing, storage, and marketing.

The **policy makers and the regulatory agents** that affect technology development, transfer and use, and help determine the incentives available to the technology system participants.

The **institutions** developing, adapting and verifying the performance of agricultural technology.

The **agents involved in stewardship** (manufacturing/multiplying, marketing and extending) of technology.

Subsequent sections discuss each of the agents in turn.

2.2.1 Users of Agricultural Technology

Traditionally, **farmers** have been viewed as the users of agricultural technology. But within the technology system, many other groups must also be viewed as users: **individuals and firms involved in processing; consumers; marketing agents; manufacturers that transform technology into inputs; service industries engaged in developing the commodity system; and policy makers.** Thus, users of agricultural technology are those individuals and firms whose options and behavior are significantly influenced by the technology; and whose attitudes and behavior significantly influence the demand for technology.

Technologies are more likely to fit the intended use and perform effectively when users are involved in the process of adaptation and verification. Thus, on-farm and other participatory approaches to research are important.

Vallaeys, G. et al. "Development and Extension of Agricultural Production Technology" in Mellor, J.W., C.L. Delgado and M.J. Blackie (eds.). (1987). Accelerating Food Production in Sub-Saharan Africa. The Johns Hopkins University Press, Baltimore, Maryland.

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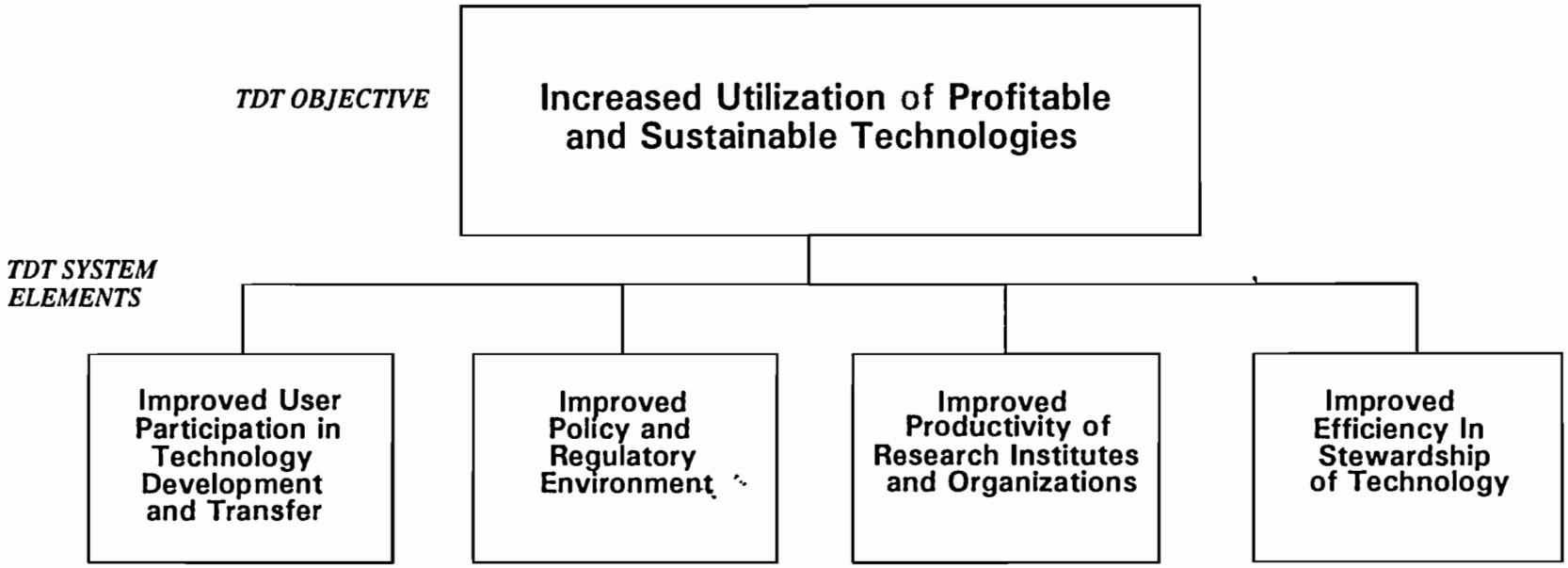
Williams, S. 1985. Kenya Canner Ltd.: A panoply plantation and cannery in Kenya. In Agribusiness and the small-scale farmer. A dynamic partnership for development. Eds. S. Williams and R. Karen. Boulder: The Westview Press.

World Bank. 1986. World Development Report. Oxford University Press.

World Bank. 1982. World Development Report. Oxford University Press.

Figure 2: TECHNOLOGY DEVELOPMENT AND TRANSFER OBJECTIVE TREE



Typically, the users of technology have not been involved up front in (public sector) NARS decisions determining which commodities to support, or in determining which technologies to develop. Increased participation in the system means greater involvement in making such decisions as well as greater attention to proxies that serve as strong interests of users, e.g. market characteristics. The marketing system, through its signals of relative prices, helps identify goods that can be produced, are in effective demand, and can justify an investment in technology.

2.2.2 Policy Makers and Regulatory Agents

The policy and regulatory environment affects the extent to which researchers, farmers, processors, marketing agents and others become active partners in developing and transferring technology. National government policies and regulations have a strong effect on industries that invest in the development and stewardship of technology and individuals and firms who are technology users. The policy environment must offer incentives to potential users of technology to invest in the production of technology.

There are two broad groups of policy that are of particular concern. First, there are policies that govern, or set the ground rules, for the technology system. These include:

- legislative mandates of the research institutions,
- intellectual property rights and patent laws,
- rights of government agents to enter into contracts,
- tax regulations related to manufacture and multiplication necessary to commercialize technology, and
- financing and granting mechanisms that encourage competition for research resources and help leverage resources.

In many sub-Saharan African countries, the private sector has had little involvement in agricultural research. To encourage private sector participation and investment, certain policies and regulations may need reforms.

Second, there are sectoral and macro economic policies that indirectly affect the technology system through their impact on the profitability of the productive activities in the subsector the technology system is assisting to develop. Research institutions and government policy makers need to integrate this information into the criteria used to set priorities for research, and through analysis of the policies inform the policy dialogue. This requires capacity that many governments and research institutes in Africa do not currently have.

2.2.3 Institutions Developing and Adapting Technology

Within each country, the institutions that participate in developing and adapting agricultural technology make up the national technology system. Included are: **public and private (commercial and non-commercial) institutions engaged in the development, adaptation and transfer of agricultural technology.** Historically, only public sector institutions have been involved in technology development and transfer. In the future, benefits will accrue from involving both the public and private sectors in the funding and in the implementation of agricultural research.

The national technology systems in Africa, as elsewhere, require linkages with the international research community, including: International Agricultural Research Centers (IARCs), agribusiness firms, foundations, Non-Governmental Organizations (NGOs), Universities and government research systems in other countries. These linkages provide African national technology systems with access to knowledge and technology to strengthen the technological foundation and help build African leadership, management and financial capacity. In the long run, African participation in the international agricultural research community decreases dependence on foreign technical assistance and donor finance.

While research institutions and organization are the cornerstone of the national technology system, the performance of many national research institutions in Africa (largely dominated by the public sector) needs to be improved. This may entail:

- reform of the research institutes as well as the legislative mandates governing them,
- establishing efficient planning, financing, contracting and monitoring mechanisms,
- developing a sustainable level of financing, and
- policies, procedures and partnerships that speed up the development, adaptation, review, release and commercialization of profitable technologies.

(Refer to the chapter on applications for a discussion of measures being undertaken by the Special Program for African Agricultural Research to strengthen national research institutes and monitor support.)

2.2.4 Agents Involved in the Stewardship of Agricultural Technology

The stewardship of agricultural technology involves ensuring that technology is available to users. Stewardship encompasses the multiplication, distribution, marketing and extension of agricultural technologies. It focuses on placing a profitable product in the hands of the technology user.

Stewardship involves both public and private sectors. Previous A.I.D. efforts have focused on the public sector, but significant potential exists to increase the level of private sector involvement. In extension, public and private sectors can play complementary roles. Thus, new opportunities exist to enhance private sector involvement in the stewardship of agricultural technology.

To strengthen stewardship of technology may require: changes in the policy environment to stimulate investment in the commercialization of technology; increased attention to financial mechanisms especially designed to support manufacture/multiplication, distribution and use of the technology; improved training and information exchange; and closer linkages between public and private agents to increase the potential for and likelihood of commercialization of technology.

2.3 Strategic Framework Concepts

Concepts are characteristics of the approach recommended by the Strategic Framework. Each of the concepts affects the performance and efficiency of technology system and thereby influences the utilization and economic impact of agricultural technology. This section explains six

concepts and offers recommendations for incorporating these concepts into technology development and transfer activities.

2.3.1 Demand

To facilitate understanding of the term **demand**, this section explains how demand operates for institutions; the market economy; and consumers.

For **institutions**, demand, or demand-driven means that the user of the research product (client) has significant input into the research agenda and the research process. Strong client/researcher linkages can take many forms, including research contracting by the client. Clients may be individuals, groups, enterprises, organizations or institutions.

In a **market economy**, a research product may or may not be in demand. Demand can be articulated by a client who pays for and uses a research product. The better the market prospects for a commodity, the more clients will pay for and use appropriate technologies and research products. Demand can also be articulated by a client who uses, but does not pay for the research product. When the use of a research product has broad social benefits, but clients cannot afford to pay for it, a strong case exists for public sector research. Focusing on the demand for research products in a market economy draws attention to the emphasis on commodities in this Strategic Framework. The commodities that rural people sell and buy link them to the market, the economy and to growth.

For **consumers** of agricultural commodities, demand draws attention to what consumers want and how much. Research can focus on the quality, taste, or other characteristics of a commodity. Meeting (or changing) consumer preferences can improve market prospects. For example, research on sorghum, as a potential substitute for rice, is demand-driven research. A strong public good argument can be made for this type of research when it helps develop markets for commodities grown by the resource poor and reduces environmental degradation.

Attention to demand focuses the research effort. Not all research in Africa can be demand-driven or market oriented. Nor should it be. African governments will have legitimate interests in research that is socially desirable but not commercially profitable. Donors will continue to exert their influence on the research agenda. Scientists will always have strong individual research interests. At issue is the manner in which research priorities are determined, the need for all agents in the technology system to cooperate, and the benefits which could accrue from flexible, decentralized national technology systems that are productive, accountable and sustainable.

A **demand-driven** approach focuses on linking the interests of society and individual consumers with initiatives to develop, manufacture, transfer and use technology. One premise of this approach is that in order for technology development and transfer to contribute successfully to economic growth, the supply of technology must emanate from and be linked to the demand for technology. And, demand for agricultural products is a principal determinant of the demand for technology.

Demand for agricultural commodities and technology is derived. In other words, through analysis, the interests of society and individual consumers are estimated and described. At

present, many research programs do not have market information available; or have not been able to factor market information into priority setting analyses. Thus, research is based on estimates of farmer interests determined from a review of what farmers are doing, for example, the area in sorghum or the number of people that are being fed with sorghum. Market information may suggest a different scope for research: a potential to increase demand for sorghum, for example, by promoting sorghum as a substitute for rice. Demand is both market-driven and client-driven.

The **demand-driven** approach places emphasis on the economic and market demand signals for a commodity, derived from an assessment of local, regional and international markets and the economic environment of these markets. Using a demand-driven approach will lead to a better balance between the market demand for agricultural products and the supply of them and, in turn, will provide more opportunities for linking production and income generation, a link that is essential for food security and economic growth.

Indicative economic criteria that may serve to establish links with markets and technology development and help rank commodity research include:

- The demand for the commodity in domestic, regional, and/or international markets and projected demand over 5-10 years;
- The estimated economic rate of return for the proposed research program (given demand for commodity);
- The potential for increasing total revenue flows and multiplier effects within the national economy;
- The projected direct and indirect effects of the research on national food security; and,
- The potential growth of agri-business and other private sector enterprise involvement in the commodity production/ technology marketing system.

This Strategic Framework recommends that National Technology Systems allocate resources to research on the basis of an assessment of the demand for commodities.

Applying economic criteria to force closer links with markets, such as those listed above, will involve:

- Evaluating all components of commodity systems and assessing articulated demand;
- Assessing linkages between a commodity system and the national economy;
- Promoting active collaboration between technical specialists and social scientists to encourage attention to social interests from research conceptualization through implementation; and,

- Being selective at the design stage and rejecting proposals that do not meet relevant criteria.

The challenge is to establish an appropriate balance between research that focuses on production and supply, and research that focuses on market and demand. Previous research has given considerable attention to production, and less attention to factors related to consumption, factors that might be modified to increase consumer demand.

2.3.2 Sustainable

A **sustainable** approach focuses on developing and transferring technologies that: continue to contribute to economic growth over time, without depleting the natural resource base; and build a sound financial base for technology development and transfer activities.

Technologies must stimulate productivity increases--but not at the expense of destroying the natural resource base. A sustainable approach to agricultural development must strike a balance between sustainable agricultural production and short-term economic growth. Investments that destroy the natural resource base and lead to over-cultivation, erosion, and forest depletion may offer short-term gains, but these gains are not sustainable over time.

Further, levels of investment in the technology system must be sustainable. Agricultural technology development and transfer is a long-term enterprise. Building a sound financial base for the technology system requires that the technology system deliver, i.e., contribute to broad-based increases in agricultural productivity through the increased use of profitable and sustainable technologies. Of particular concern in Africa is the financial sustainability of the public sector research institutes, as they are currently shaped. Improving the financial status of the public sector research institutes may entail restructuring in ways that lead to performance-based financing. For example, more attention may need to be given to competitive granting and contracting mechanisms that make researchers and research program leaders more directly responsible and, in turn, accountable for support they receive.

The Strategic Framework encourages the development of sustainable initiatives that: develop performance based financing mechanisms; and integrate natural resource enhancing characteristics into agricultural technologies. For example, sustainable initiatives:

- Identify the optimal levels of inputs to commodities systems to enhance long-term productivity;

- Apply biological control, for example, on cassava production, where significant impact has been demonstrated;

- Use a participatory approach to ensure close collaboration between research clients and scientists;

- Research factors related to resistance and tolerance of agricultural commodities with a view to ensuring that levels of inputs required are within the capacity of producers;

- Address equity in the utilization of technology, for example, to ensure use by women producers;

- Monitor the impact of technology on soil and vegetative cover to understand better the implications of technology use on the natural resource base; and,

- Identify and support the development of naturally occurring plants that have a potential for a wider market (e.g., gums, oils, forage, cosmetics, construction and fuel) and that protect the natural resource base.

Long-term increases in labor productivity require a gender-differentiated approach to the problem, because women as producers have a double labor burden in having to perform household chores and agricultural labor. In spite of this condition, empirical evidence shows that women frequently produce higher yields per unit of their own labor than men but are less frequently beneficiaries of new technologies. Further, in terms of productivity of land, women whose land use rights are typically less secure than men's, often lose access to part of their land with the promotion of higher-productivity methods. In short, increased levels of land and labor productivity will only translate into higher, more sustainable income and consumption levels (impacts) if technology development treats productivity as gender-specific and makes the links between access to and control over technology, land, labor, output, and income.

2.3.3 Subsector (Commodity Systems) Development

Subsector (Commodity Systems) Development refers to viewing technology development and transfer within a broad system that includes policies, all phases of production, post-harvest handling and marketing, and a series of logical steps to identify and resolve constraints. Developing a subsector involves improving all parts of the subsector--the production, storage, processing and utilization of a commodity. Each part of a subsector is relevant to efforts to increase productivity and income. Each part has limiting constraints that can be addressed.

Subsector development calls for research on a specific commodity or group of closely-related commodities over time, with attention to the broad context of social, economic and political relationships. As research releases one constraint, others assume primacy, but the emphasis is on continually increasing profitability through increases in efficiency. In other words, for research to contribute effectively to the development of the subsector, and in turn the agricultural sector, it needs to: (a) consider all components of the commodity system--marketing, processing, transport, policy and regulatory environment; and (b) shift the priority of efforts over time to address the most binding constraints.

In sub-Saharan Africa, as elsewhere, the stage of development of a subsector is greatly affected by the status of the economy within which it operates. Annex B describes the relationships between the components of a generic subsector, with reference to the five stages of economic development summarized in A.I.D.'s A Strategic Framework for Promoting Agricultural Marketing and Agribusiness Development in Sub-Saharan Africa (January, 1991).

Subsectors become increasingly complex through successive stages of subsector and country development. In Stage I, weak backward and forward linkages exist between on-farm production processes and components concerned with the provision of agricultural inputs and the marketing of outputs. Production operations use very limited quantities of purchased inputs. Sales are confined almost entirely to local markets. In Stage II, increased amounts of purchased inputs are used. By Stage III, farm businesses have emerged to the point where most output is intended for commercial markets and on-farm operations use significant quantities of purchased inputs. Stages IV and V represent descriptions of subsectors generally found only in middle and high income developed countries.

The differences that exist between commodity groups in Africa have often been summarized by researchers and others as simple dichotomies, for example, subsistence versus marketed crops, food versus cash crops, crops versus livestock, and domestic versus export commodities. Such distinctions are of questionable value in assessing research priorities because the commodity systems rarely remain static as economies develop and mature. For example, sorghum, maize or upland rice are often judged to be primary subsistence crops in a Stage I economy but major market crops in a Stage III economy. The relevance of the food versus cash crops dichotomy to issues like food security also blurs as national structural adjustment efforts lead to more open economies. In some situations, increasing foreign exchange receipts from successful commodity export programs may be more important than increasing the production of food crops for which low-cost substitutes are readily available in international markets.

Within a particular country, the level of development varies from subsector to subsector. A country may both produce and adapt technology in certain subsectors and only adapt technology in others. Thus, the Strategic Framework abandons the terms technology-producing and technology-adapting, used in the 1985 Bureau Plan for Agricultural Research.

The Strategic Framework encourages Missions to support subsector development and analyses that enhance understanding of how subsectors develop.

2.3.4 Comparative Advantage

Comparative Advantage emphasizes the benefits from building on relative strength(s) that exist or may be developed. In the context of technology development and transfer, comparative advantage is used in regard to:

- The production-marketing of a commodity--as a criterion to select priority commodities for research. Emphasis is placed on enhancing commodities with existing comparative advantage and exploring potential opportunities to develop comparative advantage of a commodity;

- Institutional capacity to develop, adapt, verify, and/or steward the technology--as criteria for identifying the role and complementary relationship of various organizations--public and private, national and international--in the technology system; and,

- Specialization in an eco-regional context--as a criterion identifying prospective complementary foci and/or roles within the eco-region of NTS, leading to increased efficiency in technology development.

Development of the agricultural and natural resource sector in Africa must occur by building on strengths. The identification of areas of comparative advantage within a country and within a region offers a focal point for Missions and donors to concentrate effort and resources on local strengths.

The Strategic Framework recommends that National Technology Systems build upon existing comparative advantage, and explore potential areas where comparative advantage can be developed in the local commodity and technology systems.

2.3.5 Accountability

Accountability refers to the responsibility to ensure that the benefits of research justify the investments. Throughout the life of an activity, attention to accountability helps establish priorities that increase impact--linking investments to factors that improve adoption and promote increases in income.

Improving accountability involves shifting the behavior (or mode of operation) of the institution and individuals within it to be more responsive to social interests and opportunities to influence economic growth. Accountability touches on:

- the way research links to its clients and users;
- the rights and mandates of research (e.g., to enter into contracts, to commercialize technology, to establish linkages with regional and international groups, to address constraints besides production);
- the way resources are allocated within the research system (e.g., through entitlement versus competitive financing mechanisms, on market versus nonmarket oriented technologies);
- the responsibility for use of resources (e.g., decentralization to programs and researchers attracting finance through competitive grants);
- the role and capacity of management and financial systems to support a new way of doing business (e.g., transparent accounting and contracting, decentralization of authority to spend resources, capacity to do strategic planning to set criteria for financing, capacity to monitor performance and impact); and,
- relating promotion and incentives to performance (e.g., salary based on ability to attract financing, promotion based on productivity and quality of work).

Accountability applies to the full range of activities within the technology system, including those undertaken by NTS, eco-regional research networks, international agricultural research centers, CRSPs, and other organizations.

The Strategic Framework recommends that National Technology Systems improve their accountability.

2.3.6 Collaboration

Collaboration refers to open discussion and cooperation to ensure that both public and private sectors participate in technology development and transfer and that input from the private sector is maximized. Collaboration encourages the commercialization of technology and the leveraging of resources (financial, technical, management, political) by both public and private sectors to increase the utilization of profitable and sustainable technology.

Collaboration promotes the commitment of resources by all parties and mutual agreement on targets and objectives. In Africa, agricultural research has been handled predominantly by public research institutions--domestic and international--with support provided largely by external donors. Private-public sector collaboration in technology development and transfer has several benefits, including:

- Promoting partnership among several NTS within a region to foster sharing of research programs, costs and results;
- Reducing pressure on governments to finance all research (basic, strategic, applied and adaptive) relating to every commodity of importance;
- Allowing governments to concentrate public sector resources on areas of public good that will not always be covered by the private sector; and
- Increasing the efficiency with which technology is distributed and made available, resulting in increased utilization of technology.

Several mechanisms facilitate public-private sector collaboration:

- National science and technology councils, or foundations acting as intermediaries between the sectors. These councils could develop a national plan defining public and private-sector priorities and creating a broad base of support for agricultural research;
- Contracts and joint ventures between public and private sector organizations;
- Foundations, associations or agreements that leverage resources (providing public or private agents with access to new resources)
- Legislation that establishes and enforces intellectual property rights and patents;

- Efficient markets that ensure vertical integration of production, processing and marketing activities to decrease transaction costs involved in commercializing technology; and,

- Legislation that facilitates the commercialization of technology (for example, allowing public sector researchers to negotiate with private firms on proprietary rights to technology).

The Strategic Framework recommends that National Technology Systems promote increased public-private sector interaction as a major step toward establishing a balance between the demand for and supply of agricultural technology.

Collaboration between two or more groups with similar or overlapping interests raises questions about the specific role that each should play. In regard to technology development and transfer, it is clear that government has an overriding role to establish the enabling environment necessary for the technology system to operate efficiently. However, the roles of the public and private research organizations operating within the technology system cannot be determined *a priori*. The roles will change as the country and the technology system progress through the various stages of development. In general, roles will vary depending on the relative strengths and interests of the agents involved and specialization will occur over time as collaboration continues.

Nonetheless, given the profit motives of the private sector it is unlikely that there will be significant private sector attention to countries and commodities that are at low levels of development. (By definition these countries and commodity systems have few linkages with markets and, therefore, few possible sources of profit). In this context, the public sector has the role of developing and adapting technologies to assist the country and commodity system in the transition to higher levels of development, in which specialization accelerates and purchasing power increases. At higher levels of development, the roles of the public and private sectors in research have tended to be reversed from those at lower levels (where the public sector tends toward the basic research issues and the private sector tends toward the applied issues or product development).

3. The Strategic Framework: Application

This chapter outlines steps for designing and applying a demand-driven approach to technology development and transfer and clarifies A.I.D. roles and responsibilities. The Strategic Framework represents a significant shift in the way the Bureau views African agricultural research and intends to support it in the future. The major aspects of the Strategic Framework are:

- A subsector (commodity) systems focus;
- A research agenda in which the products of research help promote changes in policy, institutions and technologies, and address natural resource and environmental concerns;
- A user base for research encompassing all agents involved in moving commodities from production to final points of sale; and
- A capacity to supply research products using all agents involved in a technology system (including the private sector, non-government institutions, universities, extension systems) and to link these agents in a coordinated fashion to all possible support.

Taken together, these aspects of the Strategic Framework indicate that there is a big job for research and much capacity to get the job done.

3.1 Designing and Applying a Demand-Driven Approach

In applying the Strategic Framework, Missions must decide how to support agricultural and natural resources research. The following section presents three steps and specific guidance to assist Missions in decision making.

3.1.1 Determine the Demand for Agricultural Technology and the Constraints to Supplying that Demand

Identifying the demand for agricultural technology (and agricultural and natural resources products) involves gathering and assessing data on specific subsectors and setting priorities for specific research and TDT activities. Possible activities include:

- Assemble existing data and analyses (for example, CPSP, research master plan) and identify which commodities are most important to the economy;
- Conduct subsector analysis to assess research demand and determine where an intervention (policy, institutional, technological) is needed and to establish direct links with potential users of research;
- Identify and accept criteria for selecting commodities and sharing responsibilities among public and private sector representatives for the analysis, dialogue and policy decisions that are needed to set priorities;

- Estimate the impact of particular technologies and the costs associated with achieving that impact.

One of the ways to identify priorities for technology development is through the establishment of a research policy body to engage the private sector (investors, producers, marketing agents and agribusiness firms) and the public sector (researchers, extension agents, legislators and treasury officials) in open negotiations to reach decisions about research priorities, policies, plans and funding. The National Agricultural Research Board in The Gambia and a similar organization in Uganda currently undertake such activities. Research policy bodies can identify effective demand for products through analysis of relevant data and through dialogue with relevant groups, such as public interest groups, farmer organizations, consumers, industries, trade associations, legislatures, government ministries and research institutions.

Analyses may be undertaken through short-term studies, or through developing the capacity of existing agricultural research systems in policy analysis, performance monitoring and impact assessment.

3.1.2 Support Organizational and Management Changes that Assist in the Development, Adaptation and Supply of Technologies Necessary to Meet Articulated Demand

Specific organizational and management changes can facilitate the shift to a demand-driven agenda and enhance the performance and productivity of research systems. Possible activities for Missions include:

- Support for collaborative regional research networks and ongoing efforts to sustain their activities (including the SPAAR Initiative and its policy of devolving management and financial responsibility for regional research programs to national level institutions);

- Determine feasibility of establishing Consolidated Programming and Budget Mechanisms (CPBM), an instrument for coordinating all research activities within a national technology system in order to provide adequate, stable and sustainable funding of priority agricultural research activities;

- Establish economic and policy analysis units at research stations to facilitate regular assessment of performance and impact;

- Link users of technology with researchers;

- Develop contracting and financial mechanisms to facilitate buy-ins and procurement among private organizations and public institutions;

- Establish patent and other procedures for the protection of intellectual property rights for both public and private sector researchers and institutions;

- Develop mechanisms that facilitate linkages and contracts with regional and international researchers and support the spillover of suitable technology;

- Develop guidelines for technology development and release, to expedite the flow of technology from the research system;

- Support donor coordination, to ensure adequate collaboration among donors at the national level;

- Use non-project assistance (NPA) and policy dialogue to support overall reform of national technology systems;

- Experiment with innovative approaches to funding that promote the accountability of research and the commercialization of technology;

- Develop creative project assistance activities that build strong vertical linkages within subsectors and promote complementary development of policies, production systems, markets and agribusinesses, while maintaining the natural resource base.

In each area, **the Strategic Framework recommends that Missions give specific attention to gender issues because of the influential role women play in the production, processing and marketing of food commodities.**

3.1.3 Design Support for the Stewardship of Technologies (Multiplication, Distribution, Marketing And Extension) to Develop and Reform a Subsector

To achieve impact from research, technology must be adopted by producers, processing firms and other clients of research and translated into benefits for people, institutions and the society as a whole. Stewardship encompasses the distribution, marketing and extension of agricultural technologies for use in the development and reform of a subsector. Possible activities for Missions include:

- Promote investment in stewardship by the private sector (local and international), for example, by modifying tender documents to specify stewardship or by improving the business climate for investment;

- Assist public efforts to modify policy and market strategies in order to increase demand for technology;

- Increase collaboration between public and private sectors to extend information about new products (with involvement of non-governmental organizations, trade associations, farmer associations, consumer groups and other social interest groups);

- Strengthen linkages between manufacturing, distribution, marketing and extension activities;

- Assist the development and application of specifications (quality, technical, health and safety) for agricultural and natural resource products.

- Promote the commercialization of profitable technologies to increase their use.

3.2 A.I.D. Roles and Responsibilities

A.I.D. can perform several important functions in support of technology development, transfer and use in sub-Saharan Africa, including:

- conduct analyses;
- support reforms leading to the establishment of a policy, institutional and regulatory environment that will enable individuals and organizations (public and private) to efficiently meet the articulated interests and needs of society;
- provide technical assistance to public and private sectors in order to increase the technical, analytical, and managerial capacity to implement reforms and increase the access to and availability of technology; and,
- provide training to public and private participants to increase analytical, managerial and scientific capacity over the medium to long term.

The initial analyses completed by a Mission as part of the CPSP, identify which commodities are most important to the economy. Subsector analyses reveal the extent to which policy, technological and institutional constraints are an impediment to the development of the commodity system and, therefore, to agricultural and economic growth. Institutional analyses reveal which elements of the technology system are and are not functioning well and why.

A.I.D. Missions have primary responsibility for determining what, if any, technology development and transfer activities they wish to support. Each **Mission** has primary responsibility for conducting the institutional analyses of the technology system upon which interventions are to be based. **AID/W** can provide assistance in subsector analyses and during design leading to submission of appropriate documentation, such as the PAIP or PID.

Missions also have primary responsibility for oversight as well as monitoring and evaluation. Technology development and transfer activities will need technically competent analysts and managers to be responsible for project/program oversight. Inter-disciplinary skills may be helpful.

AID/W has responsibility to share experiences from other countries and support Missions as they conduct their analyses, design their interventions and establish relevant performance and impact indicators. This document is part of the process of providing that support.

Several offices within A.I.D./Washington provide technical and programmatic assistance to Missions. These include:

AFR/ARTS/FARA - analytical and technical assistance during the development and evaluation of project and non-project assistance;

AFR/ARTS/EA - economic analysis to link technology development and transfer issues to the macroeconomic performance of the nation;

AFR/DP - social soundness analysis and assistance with monitoring and evaluation;

REDSOs - assistance during the initial analysis or design of technology development and transfer initiatives and assistance with mid-term and final evaluations;

AFR/ONI - assistance in implementing policy reform, establishing linkages with agribusiness firms, providing resources for human resource development, and advising on gender issues;

R&D Bureau - technical support during the analysis and design of technology development and transfer initiatives.

3.2.1 Monitoring and Evaluation

Under the DFA, **monitoring and evaluation** deserve special attention because of their importance and value in modifying and improving projects and programs already underway.

The Strategic Framework encourages Missions to monitor and evaluate program and project assistance continually during implementation. Technology development and transfer is a dynamic process, not a static activity. Evaluating the immediate and medium-term impact of A.I.D.-funded activities on both the technology subsector goals and on the broader sectoral objective facilitates understanding of the process underway and enables changes to be made to increase the likelihood of achieving desired impacts. Monitoring and evaluation systems should retain some flexibility so they can respond to changing conditions as technology systems evolve and as new research areas on key commodities are identified.

Monitoring and evaluation (M&E) systems are designed by Mission teams having responsibility for oversight. The M&E plan should be structured so as to provide Missions and host countries with performance and impact indicators that are realistic, manageable and cost effective. Useful indicators:

- Determine whether the targets, objectives and goals of TDT initiatives are being met;
- Determine the impacts of TDT initiatives on individuals, firms, institutions and the environment; and
- Capture lessons learned on an ongoing basis, to modify and improve performance and impact.

The Strategic Framework recommends that Missions select indicators that are related to the strategic objectives of the Mission and the conditions that have been identified to achieve the objective(s).

Figure 3 presents a framework for organizing indicators and illustrates how conditions at each level build on conditions at lower levels. For example, in order for an indicator to capture the adoption of a technology (level 3), the technology must exist and be accessible (level 2), and the human, financial and management capacity to develop and adapt technology must be in place (level 2).

To assist Missions with indicator selection, criteria and illustrative indicators are summarized in Annex C for each of the five levels of the organizing framework (Figure 3).

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