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ZAMARE

A Success Story in Africa

The accomplishments of the Zambia Agricultural Research and Extension project (ZAMARE) have been lauded by both of its sponsors. The government of the Republic of Zambia described ZAMARE as an "example of success by which to measure other technical assistance activities." In the Congressional Presentations for FY87 and FY89, the United States Agency for International Development (USAID) praised ZAMARE as a success story in Africa.

ZAMARE's goal was to assist the Zambian government, through the Ministry of Agriculture and Water Development (MAWD), in

improving the welfare of small-scale farmers and increasing national food production by developing and adapting agricultural technology. Zambian and U.S. scientists implemented activities that strengthened the agricultural research capacity of MAWD and increased the effectiveness of the extension service in transferring technology to the farming community.

The University of Illinois at Urbana-Champaign led the six-year project, begun in 1982. Southern Illinois University at Carbondale and the University of Maryland-Eastern Shore collaborated on the project. The field component of ZAMARE ended in August 1988; the training component in December 1988.

Maize is the staple food of most of Zambia's rapidly growing population, and the most important crop in the country. It is the 600,000 small-scale farmers who must improve their agricultural production if Zambia is to meet its food needs.

Cover: The goal of the ZAMARE project was to increase food production and thus the welfare of small-scale farmers. This farmer was one of several hundred who participated in on-farm trials and demonstrations during the project.

Zambia today. Copper and cobalt mining are the basis of Zambia's economy and the source of more than 90 percent of its foreign exchange. Because of the importance of mining, its development previously overshadowed that of agriculture and other sectors of the economy. In the late 1970s, however, Zambia's economic situation deteriorated. Caused by Zambia's rapidly growing population, the inadequate expansion of its agriculture, drought, rapid increases in the price of petroleum, and a decline in world demand for copper and cobalt, this deterioration resulted in the current priority on agricultural

development, especially in the small-farm sector.

Nearly 45 percent of Zambia's six million people live in cities, the highest rate of urbanization of any country in tropical Africa. In contrast to most countries in Africa, land is not the limiting factor in agricultural production in Zambia; nearly half of the land area is considered arable — generally fertile with adequate rainfall in most cropping years. Much of the land, however, is fallow. Historically, agriculture has accounted for only 13 to 15 percent of the Zambian economy.

Zambia's principal crops are beans, cassava, cotton, groundnuts, maize, millet, sorghum, soybeans, sugarcane, and sunflowers. Livestock production includes cattle, goats, pigs, poultry, and sheep. The country does not produce enough food to feed its rapidly growing population; in recent years, agricultural production has only grown at a rate of 1 percent a year, whereas the population has increased at an annual rate of 3.4 percent. Although the 400 large-scale commercial farmers and 75,000 emergent farmers produce approximately half of the

Traditional farmers prepare land with hand hoes. This labor-intensive method limits the amount of land that can be cultivated and the amount of food that can be produced.

Small-scale farmers who have access to oxen are able to cultivate more land. When oxen are used, crops are frequently planted by dribbling seed in the plow furrow.

If more land is planted, more land has to be weeded and harvested.

food sent to market in the country, it is the 600,000 small-scale farmers who must improve their agricultural production if Zambia is to meet its food needs.

ZAMARE in action. ZAMARE's objectives were to

❖ strengthen the cereal grains commodity research team in maize and the oilseeds commodity research team in soybeans and sunflowers,

❖ establish an effective adaptive research planning team in the

Central Province of Zambia,

❖ enhance the capacity of the extension service to communicate appropriate technology to small-scale farmers,

❖ establish a facility to produce soybean inoculant.

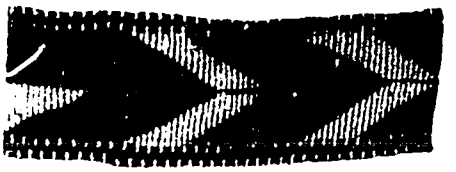
USAID project resources supported an intermediate-term consultant in microbiology and seven long-term experts: maize breeder, soybean breeder, sunflower agronomist, agricultural economist, farming systems agronomist, research-extension liaison officer, and a team leader. Other resources included 85 months of consulting time and sufficient funds for commodities, equipment, training, and transportation. The Zambian government and MAWD provided Zambian counterparts and staff, buildings and other physical resources, counterpart funds, and an infrastructure supportive of research and extension interaction.

Farm woman carrying water, with a typical method for storing maize shown in the background. Women play an integral role in African food production. A recent study by the United Nations showed that they grow 70 percent of the food, fetch 80 percent of the fuel and 90 percent of the water, process 100 percent of the food, and do all of the child care and cleaning.

Maize is shelled by hand by traditional and small-scale farmers, then placed in burlap bags that hold 90 kilograms for delivery to local grain depots.

Commodity research. Commodity research teams, which were developed by MAWD for most crops grown in Zambia, conduct research at agricultural research centers throughout the country. Research focuses on overcoming yield constraints and on improving cultivars and management practices.

Cereal grains: Maize. Maize is the staple food crop of Zambia's large urban population and most of its rural population. When the ZAMARE project was designed in the early 1980s, drought, new diseases, and a limited selection of maize hybrids and open-pollinated



cultivars had depressed maize production below national requirements.

The maize research section is the largest section in the cereal grains commodity research team because of the importance of maize to national food needs. The broad needs of maize research in Zambia attracted three international donors: the Swedish International Development Agency, the Food and Agriculture Organization of the United Nations, and USAID. Each donor provided experts who cooperated on production problems.

ZAMARE maize breeders assumed the mandate of developing open-pollinated cultivars for the more extreme environments with low or high rainfall that require short-season or disease-resistant maize. Two open-pollinated cultivars of maize were developed and released by ZAMARE maize breeders: a short-season cultivar that matures in 100 days and is especially adapted to the drought-prone areas of Zambia, and a medium-season to long-season cultivar that matures in 150 days and is resistant to maize streak virus. By 1987 these cultivars

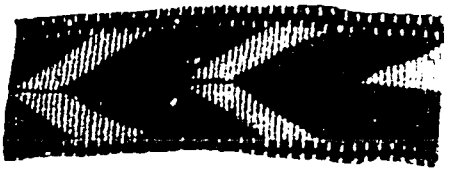
ZAMARE team member and counterpart (above) examine maize plants in a farmer's field that are infected with maize streak virus. This virus, which is the most destructive disease of maize in Zambia and can severely reduce yield, was one of the problems addressed by ZAMARE researchers.

The ZAMARE maize breeding program developed and released two open-pollinated cultivars (left). MMV 400 is a short-season cultivar that matures in 100 days and is especially adapted to the drought-prone areas of Zambia. MMV 600 is a medium-season to long-season cultivar that matures in 150 days and is resistant to maize streak virus

Farmers and an extension agent (above) evaluate yield and quality of new maize hybrids and open-pollinated cultivars grown and hand-harvested during on-farm trials. On-farm trials involved both short-term and long-term strategies to increase returns of the scarcest resources, cash and labor.

represented about 10 percent of seed sales and were grown on an estimated 50,000 hectares. The ZAMARE project also provided the improved, open-pollinated populations necessary for the future progress of the hybrid maize program and the resources to diffuse the results of research to the provinces and farmers.

Oilseeds: Sunflowers. Sunflowers have long been an important crop in Zambia, second only to maize on a hectare basis and third behind maize and cotton as a cash crop. Because sunflowers can be planted after maize and produce some cash return with few cash inputs, small-scale farmers grow most of the sunflowers.



The ZAMARE sunflower agronomist helped MAWD scientists develop more appropriate sunflower production technology for small-scale farmers.

Before the start of the ZAMARE project, the sunflower breeding program in Zambia had developed new composites and hybrids for potential release to farmers, but the program on cultivar testing and the research on seed production practices had been limited. Zambian and ZAMARE scientists were able to combine national testing with research on factors limiting sunflower production by small-scale farmers.

In addition to higher yields, the new composites and hybrids had higher percentages of oil, making them more valuable to the oilseed processing industry. ZAMARE resources purchased equipment to routinely measure the percentage of oil in small samples of sunflower seeds. Together with their Zambian colleagues, the ZAMARE sunflower experts convinced the oilseed processors to establish prices based on the percentage of oil content of the cultivars and thereby encouraged use of the improved cultivars.

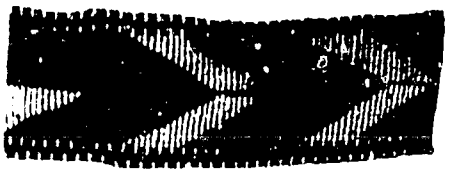
The director of the national oilseeds program (upper left), a ZAMARE short-term training participant, coordinates the development of appropriate technology in sunflower agronomy, cultivar improvement, and use. People with ZAMARE-sponsored training are in key positions within the Ministry of Agriculture and Water Development and are making significant contributions in research and extension.

As part of the national testing system for cultivars of sunflowers, this farmer (above) tested new hybrids and composites that had higher percentages of oil. These cultivars are more valuable to the oilseed industry and command a premium price.

Sunflower seed is winnowed before going to market.

Village-scale processing of sunflower oil helps alleviate the shortage of cooking oil in rural areas, and the sunflower cake produced as a by-product of oil extraction can be used for animal feed or sold for cash to commercial farmers. Research on the feasibility and acceptability of such village projects was supported by ZAMARE in cooperation with MAWD, Village Industry Services, Volunteers in Technical Assistance, and the B'hai Institute.

Oilseeds: Soybeans. Soybeans are a relatively new crop in Zambia. Demand for soybean oil and cake is high, and soybeans have moved into



the traditional and subsistence farms in response to favorable government pricing policies.

Soybeans require the presence of nitrogen-fixing bacteria for normal growth. These bacteria are usually added as an inoculum to the seed at planting. ZAMARE soybean researchers identified and released a freely nodulating, nitrogen-fixing cultivar, solving in part problems of producing, maintaining, and distributing inoculum to small-scale farmers. In addition, the ZAMARE program provided resources to establish broader national testing, which helped to demonstrate the wide adaptability of soybeans in Zambia.

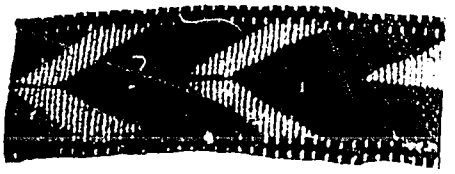
Although the initial emphasis by MAWD and ZAMARE was on breeding soybeans, increased use of soybeans soon became an important objective. Through in-country workshops, short-term trainee programs, and the visits of consultants, the practice of consuming soybeans to improve family nutrition has spread around the country.

Field day showing promiscuous (freely nodulating) soybean cultivars developed for small-scale farmers.

Increasingly, traditional and small-scale farmers are growing soybeans for home consumption and as a cash crop. Hand threshing involves pounding the soybeans to separate the beans from the pods before storage or sale.

Soybean inoculum.

ZAMARE supported an intermediate-term expert, consultants, and financial resources for establishing a production unit for soybean inoculum. Under a subcontract from ZAMARE, the NifTAL project at the University of Hawaii provided a microbiologist and an inoculant-production specialist. These researchers supplied technical assistance in research, production, and distribution of *Rhizobium* inoculants to meet expanding demand. The process used locally available peat and lime instead of imported materials. By the end of the project, the laboratory was run without outside help, and



production of soybean inoculum expanded by 300 percent to meet the needs of the commercial-farming sector. Research is under way on long-lived inoculum for use by small-scale farmers.

Adaptive research.

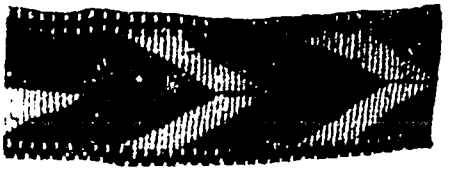
Supported by ZAMARE, the adaptive research planning team (ARPT) in Central Province was the first ARPT to be established in any of the nine provinces of Zambia. The role of adaptive research, often called farming systems research, is to identify the problems of small-scale farmers, to design experiments that may provide solutions to these problems, and to conduct trials on farmers' fields under typical conditions. If the technology remains technically and economically sound and is accepted by the farmers, then it is approved and recommended within the area by extension officers.

Extension worker demonstrating soy-based recipes at a field day for farmers held by the adaptive research planning team in Central Province. More farm families are consuming soybeans to increase the level of protein in their diets.

The nutritional content of nshima, a traditional dish made from corn meal, can be improved by the addition of soy flour

ARPTs generally consist of an agricultural economist, an agronomist, and a research-extension liaison officer.

ZAMARE project members worked with Zambia's extension personnel to establish a program for farm-level testing of cultivars and experiments on crop management practices. On-farm agronomic trials were carried out in all representative farming systems in Central Province. The on-farm trial program involved both short-term and long-term strategies aimed at increasing returns of the scarcest resources: cash and labor. In 1982, the first year of the ZAMARE project, the ARPT surveyed farmers to define their priorities and conducted two



on-farm agronomic trials on 16 farms. In 1988, the last year of the project, the team conducted fourteen on-farm agronomic experiments and demonstrations on 107 farmers' fields on seven major crops: beans, groundnuts, maize, millet, sorghum, soybeans, and sunflowers.

It takes nearly five years from the time a problem is identified to the time a solution is approved for recommendation to the farmers. Two agronomic practices introduced by the ZAMARE ARPT, zero-tillage maize and weeding and topdressing maize at 20 centimeters, were approved for recommendation to small-scale farmers. In addition, the ZAMARE ARPT was able to gain approval and recommendation for the use of the bean cultivar Carioca.

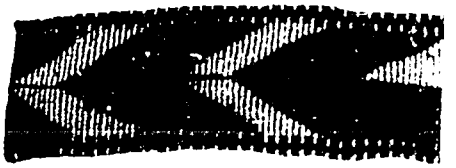
The Central Province ARPT was linked to extension activities through field days for both farmers and extension officers, extension training meetings and workshops, and a regular newsletter. As a result of in-service training, Zambian extension personnel have more confidence in their ability to provide training and assistance to farmers. Farmers in turn are increasingly

Adaptive research planning teams conducted surveys to identify the constraints faced by small-scale farmers and then used this information to develop an on-farm research program.

Farmers and adaptive research planning team members worked together to plant, weed, harvest, and evaluate on-farm trials and demonstrations. After being tested and approved, appropriate technology is recommended and extended to farmers in a given farming system.

seeking advice and assistance from extension agents. The impact of this training was evident by 1986, when more than 4,400 farmers attended local meetings.

Over the life of the project, field days for farmers, extension workers, and other agricultural workers increased in number and were well attended. These were an excellent in-service training tool and were very cost effective. Separate field days were held for women in 1987 and 1988. In 1988, 923 men, 528 women, and 180 male and female students from secondary schools and technical colleges — a total of 1,681 people — attended the ARPT field days.



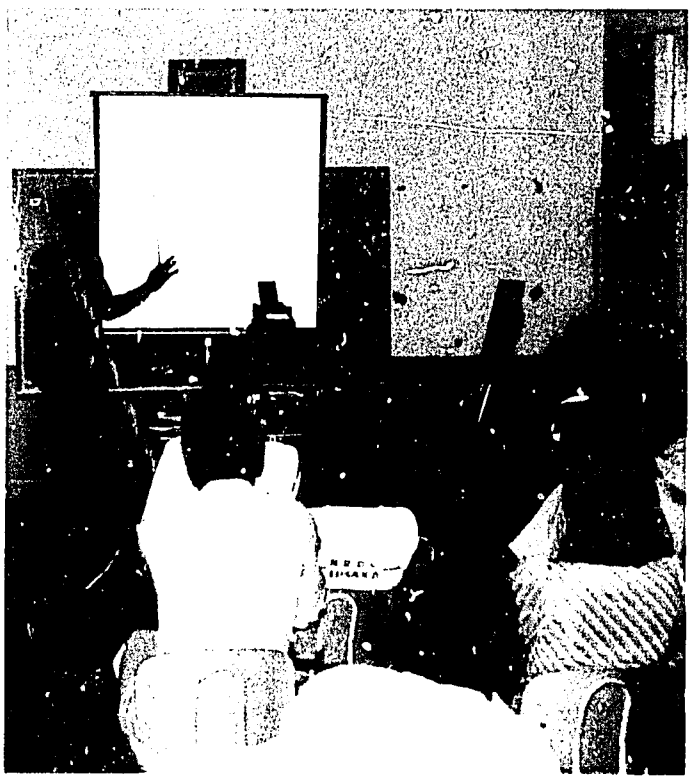
Consultants.

Early years, consultants were helpful in developing procedures and providing guidance on procurement, records, and operations involving the USAID mission, ZAMARE, MAWD, and the contractor's home office. Administrative consultants addressed issues identified by reviews and the team leader.

Throughout the ZAMARE project, experts were consulted on various topics: entomologists for management of pests on maize, microbiologists for inoculum production, library scientists for library services and collection development, and food scientists for soyfood use.

Workshops.

ZAMARE supported a number of workshops and conferences. With the International Soybean Program (INTSOY) and the Canadian International Development Agency, ZAMARE cosponsored workshops on soybean use for industry and for health professionals working at the home and village



Members of the adaptive research planning team regularly assisted in training extension workers by providing updated information on appropriate technology. Extension workers then conduct educational programs for the traditional and small-scale farmers in their home districts.

Field days for women were developed to address the issues faced by female-headed households and increase their participation in extension activities.

level. Since these workshops, small-scale industries have accelerated the processing of soybeans for cake and oil, and health and extension workers are helping homemakers make better use of soybeans in their diets. During 1988, workshop participants trained more than 500 individuals, and extension workers demonstrated soybean use at farmers' field days.

ZAMARF conducted workshops for researchers, administrators, and clerical staff on operating and maintaining microcomputers. Researchers participated in a workshop to review the basics of statistics and the preparation of reports for presentations and publication. To

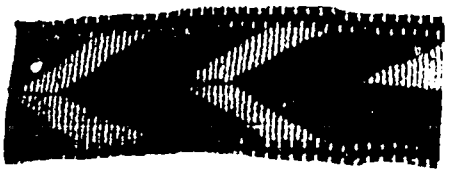
complete the computer educational program, ZAMARF personnel gave an advanced session on the application and use of statistical software.

The International Program for Agricultural Knowledge Systems (INTERPAKS) conducted a workshop on communications and teaching skills for provincial extension workers and for university faculty. In addition, participants from Zambia and Malawi attended a workshop entitled "Agricultural Research-Extension-Farmer Linkages," which established a broad framework for understanding linkage systems as they apply to agricultural development programs.

Nearly 150 Zambians participated in a series of six workshops on managing agricultural resources and organizations. Taught by faculty members from the University of Maryland-Eastern Shore, workshop topics included administration and management of research stations; techniques and management of experimental plots; management of research farms; tractor maintenance, service, and repair; tractor and field operations; and research-extension interactions.

Field days are an important way to communicate recommended practices and new technology to large numbers of farmers.

With assistance from the International Maize and Wheat Breeding Center (CIMMYT), ZAMARE personnel held a workshop on maize production to upgrade the research skills of diploma-level technicians. Staff from seventeen research sites participated in classroom lectures, discussions, and training exercises in the field.

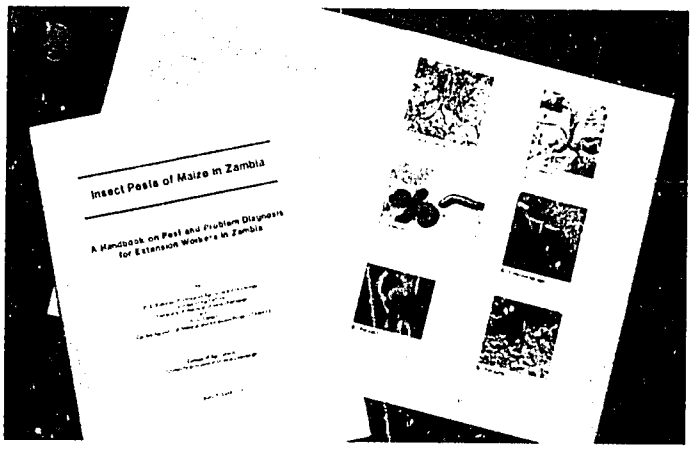


Research and training. Human resource development is perhaps the most essential part of efforts to improve agricultural systems in developing countries. It is, after all, people who shape the institutions and subsequently energize their nation's future. ZAMARE training and research activities reached all levels of MAWD and extended from farmers to professors.

Special studies. The special studies program of ZAMARE provided opportunities for faculty members from the University of Zambia to conduct supplementary research related to ZAMARE objectives. For example, early in the project, faculty members studied the effectiveness of interactions between extension agents and small-scale farmers.

Doctoral research. The research associate special studies program allowed doctoral students from U.S. universities to conduct research work in Zambia on projects of interest to ZAMARE and MAWD and at the same time to gather data for their dissertations. Doctoral students studied soybean diseases, nematodes, breeding for drought resistance, and noneconomic factors influencing decision making by farmers.

Termite damage in maize is a serious constraint to maize production.



Entomology consultants produced a booklet and slide set on identification of pests and appropriate control measures that were widely used for training extension workers and farmers in all provinces of Zambia.

In-country training. MAWD and ZAMARE provided in-service training through workshops, seminars, and lectures for extension workers, extension and research supervisors, research assistants, field interviewers, and data analysts. Experts from INTERPAKS and CIMMYT and other short-term consultants assisted with the training. The National Research and Development College, field research stations, farm institutes, and farmer training centers were used as training sites. An important part of the in-service training occurred on a daily basis as ZAMARE scientists worked closely with their Zambian counterparts

and colleagues in extension and research activities.

Traditional and small-scale farmers formed the largest group of recipients of in-country training. Farmer training consisted primarily of field days held at sites of on-farm agronomic trials and at research stations at Kabwe, Magoye, and Mount Makulu.

Participant training. An important component of the ZAMARE project was providing the Zambian staff of MAWD with the essential scientific, technical, and administrative skills needed to carry out their research and extension work. This training enabled Zambian scientists to move into leadership roles in MAWD.

The long-term training component of ZAMARE assisted 49 Zambian students in obtaining degree training, exceeding the original goal of training 34 students. Twenty-one of the degree participants were selected from the Extension Division of MAWD and 28 from MAWD's research service.

ZAMARE also provided short-term training for 85 individuals.

Several ZAMARE officers studying for advanced degrees at U.S. universities returned to Zambia to conduct a portion of their thesis or dissertation research. This participant conducted research on drought tolerance in soybeans. In-country research provides information needed by the project and prepares participants for their duties after completing their degrees.

Pyrenochaeta leaf spot disease on soybeans is a serious problem that was studied in Zambia by two doctoral students from UIUC. This research, which was part of the special studies component of ZAMARE, resulted in the first published information on the epidemiology of the disease.

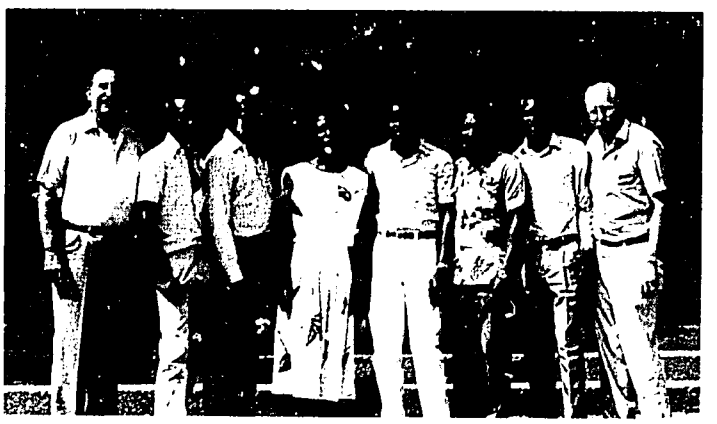
Most short-term training was arranged in the United States, but some training was also conducted at international agricultural research centers and regional centers. Numerous in-country workshops were held for nearly all levels of professional and technical staff.

In-country student research. ZAMARE provided the opportunity for Zambian officers studying for M.S. and Ph.D. degrees at U.S. universities to return to Zambia to conduct a portion of their thesis or dissertation research. In-country student research helps answer local research questions and allows students to learn how to conduct research under the conditions they will encounter after they return from training. Although in-country student research requires careful planning and considerable logistical support, the ZAMARE experience supports its feasibility and validity.

Continuing links. a means of extending project accomplishments, a program was developed to consolidate and augment both the gains of the project and the collaboration between MAWD and ZAMARE universities. Activities planned through 1990 include workshops on computer training, communications, research station management, soybean use, and the sustainability of agricultural systems. Continuity will be enhanced through staff exchanges in research, extension, and communications for former degree participants, their professors, and other staff members.

ZAMARE staff members (above) were integrated into the research and extension service of the Ministry of Agriculture and Water Development. An important part of in-service training occurred on a daily basis as ZAMARE scientists worked with their Zambian counterparts and colleagues.

ZAMARE supported a number of workshops and conferences, including this one (right) on home and village-level use of soybeans.



Some ZAMARE degree participants were able to work with their advisors at their university in the United States and later in the field in Zambia. Interaction of this type forges long-term relationships that continue after the project is completed.

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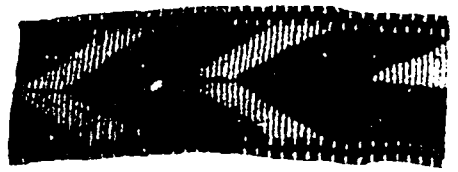
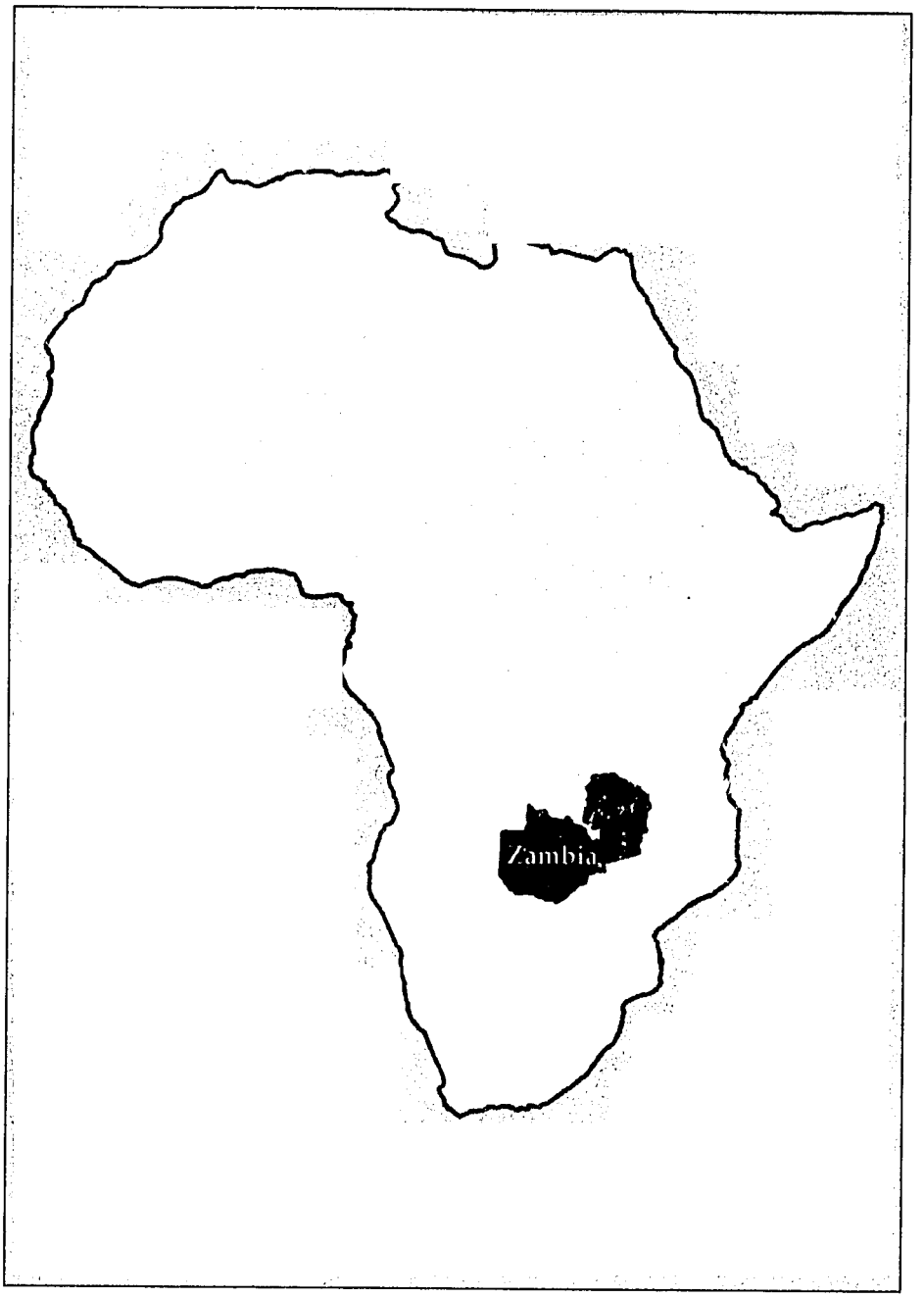
John W. Santas
William N. Thompson
Bessie I. Thornicroft
James A. Tweedy





Zambia Agricultural Research and Extension, ZAMARE, a collaborative project of

University of Illinois at Urbana-Champaign, UIUC

University of Maryland-Eastern Shore, UMES

Southern Illinois University at Carbondale, SIU-C

United States Agency for International Development, USAID

Government of the Republic of Zambia
Ministry of Agriculture and Water Development, MAWD

Zambian woman carrying produce to market. In Africa, women are primarily responsible for marketing the food at the local level. ZAMARE was part of the response of USAID to the critical need for increasing crop production and rural income levels in Zambia.

The Office of International Agriculture (OIA) at the University of Illinois at Urbana-Champaign has a long history of involvement in international activities and programs. A unit of the College of Agriculture, OIA provides a worldwide perspective to the teaching, research, and public service functions of the college. In addition, OIA is the headquarters for several international projects and programs and is involved in institutional development programs overseas. These activities bring direct, demonstrable benefits to Illinois and U.S. agriculture and contribute to the humanitarian and national security efforts of the United States government.

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