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Tour Report of INTOSORMII. Team to Zambia

March 14 - April 10

The three member team included Drs. Allen Kirleis, Professor of Agronomy and Food Utilization; and William Morris, Farming Systems Economist, both of Purdue University; and Orrin Webster, Breeder/Agronomist, University of Arizona. Webster arrived in Lusaka March 16 and left April 4; Kirleis arrived March 21 and left April 3; Morris' arrival was delayed until March 28 and he departed April 10.

Since the team arrived at different times and had differing interests, this report will be given in three sections. Needless to say there may be some duplication.

Section (A) Webster

Ernest Gibson, AID Development Office, first introduced me to Mr. Mumba, Director of Research, Department of Agriculture, and Mr. Chibasa, Deputy Director of Agriculture. These officials defined the major objective for the team's visit as providing the Ministry with recommendations as to what future steps might be taken to increase the production of sorghum and the millets. Mr. A. J. Prior, Principal Research Officer, Mt. Makulu Research Station, prepared and revised as necessary an itinerary for the team. Travel arrangements and additional consultations were arranged for by Ms. R.K. Chungu, Chief Research Officer at Mt. Makulu. The team is most grateful for the fine cooperation and efforts of the above persons to make

it possible for us to complete our assignment in a short period.

Mr. Prior arranged for me to have access to the files of the library and to visit the members of the staff at Mt. Makulu from March 18-23.

As background information for the team, I copied out a number of excerpts from publications which follow:

"Zambia is a land-locked country situated in southern central Africa between 8° and 18° South, bordered by Tanzania, Malawi, Mozambique, Zimbabue, Botswana, Namibia, Angola, and Zaire. The country lies on a plateau which rises from 900 to 1500 meters, most land being around 1100 meters. A single wet season lasts from October to May in the north and from November to April in the south of the country. During June and July the weather becomes cool and occasional night frosts occur. The temperature then rises when the mean maximum is over 30°C.'

"The main commercial farming area lies along the railway line from Livingston to the Copperbelt (80 km on each side of the line). Elsewhere the farms tend to be smaller and there are many subsistence farms".[1]

The population of Zambia is about 5.5 million, with a land area of 290,323 sq. mi. Half of the population lives along the rail line.

"Maize is by far Zambia's most important crop with just over a million acres under cultivation. As a food crop, maize is consumed as a daily staple of Zambia families and as a cash crop maize accounts for three-fourths of the total value of market production. It is grown by all categories of farmers in Zambia; about 60% of marketed production and 85% of

[1] Logan, John. Plant Pathology in Zambia. Pans 20:169-176. 1974.

the total production originates from medium-sized and small farms. Marketed maize production rose with some fluctuations, between 1964 and 1967, on an average of about 8 to 10% per year. Poor harvests in subsequent years saw a drop in output and necessitated substantial maize imports in 1979 and 1980. There is also concern by the government that reliance on maize as a single staple should be tempered by attention to other cereal crops. A diversification into alternate staples could provide small farmers with greater security of household food requirements.'

"Other principal food and each crops include the oil seed group: ground nuts, sunflower, and cotton. Oil seeds are valuable for the manufacture of oil for human consumption and meal for protein concentrate stock feeds. Ground nut production has varied widely and current output stands at about two-thirds of the 1964 total. Sunflower and cotton have tended to displace ground nuts and have proven particularily popular among the middle category of farms, whose production is not exclusively oriented to the market or subsistence. Oil seed crops can substitute for commodities presently imported and are generally complementary products which can fill niches in existing farming operations.'

"Other crops include sorghum, millet, and beans, which are favored for subsistence, and tobacco, soybeans, and sugar cane, which are grown almost exclusively for sale. There is little doubt, however, that maize and oil seeds are likely to be central to any strategy for agricultural development in Zambia".[2]

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[2] Reference not noted.

"At present, the main areas of sorghum distribution are found on the Northwestern Plateau and along the banks of the middle course of the Zambezi. Here sorghums account for up to 75% of the production on some holdings. However, it is cultivated by only one-half to three-fourths of the farms.'

"In other areas, both cultivation and frequency and proportion of acreage used are under 50%. At least one-fourth of all farmers grow sorghum in the Luanguwa Valley and on the plateau region between Kapiri Mposhi and Mpika.

"Of all Zambian crops, bullrush millet has the most limited distribution. It is found in two areas only: west on the Barotse Sands and south in the Gwembe Valley, where its cultivation is frequently more than 25% and about 75% at most. The mean acreage under bullrush millet cultivation remains under 50% and often under 25% of arable land."(3)

"The Barotse Sands include an area of 2300 km^2 with 600 villages. 10% of the men are of productive age. The mortality rate of children is high, with malnutrition in 30-50% of children under four. The diet of the people includes casava, maize, cassava leaves and fish. The area is food deficient. Sale of fish is the main money earner. The roads are poor, which limits extension services, marketing, and credit."(4)

Another report mentions millet is also found in the Ndola Rural

(3)Schulte, Surgen. Land Use in Zambia. Ito-Instutat fur Wirtschaftsforschung Muchen Ahteilung Etnwick Lungslander Afrikastudienstalle-Weltforum Verag - Muchen.

(4)Proposals for word-program and budget for 1980.

District of the Copper Belt Province, where rainfall is normally low (500-700 mm/year).

The only hectarage figures found for sorghums was 77,600 hectares in 1967-70 with 51,450 tons of production. No figures were given for bullrush millet, but 130,500 hectares for finger millet with a production of 84,900 tons.

Utilization of sorghum - "A staple food in the villages and in certain parts of the Eastern Province. Polished grain is pounded to remove the pericarp. The polished grain is made into flour. The flour is added slowly to boiling water until a thick consistency is obtained by constant stirring. This thick porridge is called 'nsima'. White grain is generally preferred. Tender grains of certain cultivars is eaten raw. Sweet stalk types are also ubiquitous which are called 'misule', 'zekev' or 'njiho' and are grown on a small scale for domestic consumption. The grain on this is generally astrigent and often unpalatable. Sorghum is used extensively for brew beers".[5]

For brewing, the cultivar Red Framida is preferred. This cultivar was selected at the Mount Makulu Research Station. The colored grain has some resistance to birds and weathering. A small field was visited in the Gwembi Valley. The crop was uniform and will give a good yield. Adjacent to the field was a field of tall local white seeded type, with a lower yield potential. Apparently, the farmer grew the Red variety for sale or for beer

[5] Notes from the Germ Plasm Collecting Mission to Zambia, June 1, 1980, by S. Appa Rao. ICRISAT Program Report-25.

making and used the grain from the local for food. A supply of 130,000 (200 lbs) bags are required annually for brewing. Because of a limited supply of sorghum grain, maize is used.

Collections. An FAO mission (1979/80) collected seed of several crops in the Eastern and Northern provinces. Included were 237 sorghums and 25 of bullrush millet. The rest of the country is to be covered in 1981/82. Dr. K. N. Rao, FAO plant pathologist at the Mount Makulu Research Station, has the first collection planted on the station. We inspected it on March 19. The crop had not headed and we were surprised at the high incidence of downy mildew.

The following is an excerpt from a paper prepared by A. J. Prior, Principal Research Officer, Mt. Makulu, in 1979 which gives pertinent information for the report:

"Bullrush millet - there have been variety trials, but no work is being done at present, although it is grown in inter-cropping trials. Not given a very high priority.'

"Sorghum - a lot of work was done in the 1960's to produce a good variety for brewing. The present program is confined to a variety trial or two and some seed multiplication.'

"A definite policy is required both as a statement of interest by the brewing and animal feed industries, and for the requirements of small scale growers in the valley areas where the crops are grown in the Northwest, Southern and Western Provinces.'

"Initial requirements are to:

(a) survey the areas where the crop is grown and assess problems,

(b) clarify government policy, especially in relation to competing cereals,

(c) establish variety collections from local and international sources

(d) to continue existing work and to assist seed services in organizing a seed supply of malting sorghum and bullrush millet'.

"An initial staff of an agronomist-breeder is required, with a T.A. assistant. After Phase I, occupying two years, the situation should be evaluated and a more substantial project drawn up, if required."

The agriculture of Zambia ranges from ultra-modern to extremely poor subsistence farms. The large commercial farms (about 400 in number) range in size from 100 hectares to several hundred. The operators use all of the latest scientific information available to obtain maximum yields. These include the best adapted hybrids and varieties with the optimum fertilizer recommendations. Such farms often include not only crops, but an extensive livestock program. A second group of farms are described as 'emerging'. They are gradually moving upwards from subsistence to commercial. The extension services concentrate their efforts on helping develop the farming practices of the small farms. A number of international agencies are assisting in the extension effort.

I attended a part of a workshop, March 18, dealing with Crop Husbandry and Extension. The objectives were:

1. To bring to the attention of the IRDP (Integrated Research Development Project) staff and their provincial counterparts any

relevant work in the Research Branch on crops and extension.

2. To bring to the attention of the research staff the problems and views of IRDP staff and their counterparts.

The research staff at Mt. Makulu gave pertinent research data and the extension staff discussed their activities and problems. Much of the discussion was centered around the improvements of the living standards of the small farmer.

The fertilizer for agriculture is subsidized by the government. I was told that 140,000 tons were used in 1980, much of it by the small farmers on maize. Much of the farming on the small holdings is done by women, since a number of men are employed by the mines or in urban areas.

On March 19-20 I was given the opportunity to visit some of the research projects at Mt. Makulu. These visits gave me a better insight on the problems confronting agriculture in Zambia and how research is attempting to find solutions.

Maize Breeding. Mr. Jovanovic, Dr. Rao. A major constraint on the maize breeding program has been the lack of continuity of staff. This applies also to other breeding projects. Mr. Javanovic is on a short term contract. Dr. Rao is on a one-year sabbatical from ICRISAT to work on ear rots of maize.

The improvement program has three components:

(1) Testing materials provided by CIMMYT and from breeders in neighboring countries,

(2) Cleaning up the parent lines used to produce hybrid SR-52. This work has been completed. The single cross hybrid SR-52 is the

leading hybrid grown in East Africa. It is a long season hybrid designed to be planted at the first of the season and mature at the end of the rains. I would fault it in having erect ears at maturity with poorly covered ear tips, which permit water from rain to penetrate the ear, causing ear rots. The local maize we saw in the village was earlier maturing, had well covered ears which dropped over with maturity. We were told that SR-52 is grown for sale and has a low tolerance to stored grain insect pests. On the other hand, the local maize has a more flinty kernel which stores better.

(3) Development of new inbred lines and composites. The farmers would like an earlier maturing hybrid than SR-52, but just as productive.

Hybrid seed production of maize began in 1967 by the government, but is now in commercial hands. The government serves as an inspection and certifying agent.

Wheat Breeding. Dr. Hurd and Mr. Raemaskers.

The wheat improvement work is financed by a Canadian agency. Wheat has been grown successfully for a number of years as an irrigated winter crop. The inputs for irrigated wheat are high, requiring three tons/ha for a break even. With good management, there has been a good profit in this crop. In 1975-76, the crop was tried as a rain fed crop in the north with good success. In 1979/80 the crop failed, due to drought. A thousand hectares is being grown in 1980/81. The nursery at Mt. Makulu had a very good plant growth, but no grain will be harvested, due to disease, primarily

Helminthosporium. In addition to disease, rain fed wheat planted at the warm season of the year tillers very poorly. Some new varieties from Mexico do much better than others which have been tried. Some trials are being conducted using Triticale.

Sorghum. In addition to his work on ear rots of maize, Dr. Rao is spending his "extra" time on sorghums. While in India (ICRISAT) he screened hundreds of lines for resistance to head molds and brought his best material to Zambia (290 lines). If he has in his collection lines with suitable quality for food, but also remaining free of molds, they will be helpful in establishing sorghum as a food crop in Zambia. Most cultivars with a grain quality suitable for human food will weather badly in the tropics if they mature while there is rain or dew.

Dr. Rao has also in test plots 59 of the SEPON-80 (Sorghum Elite Progeny Observation Nursery) lines from ICRISAT. The two nurseries are well headed and the heads have been protected from birds by paper bags. The 237 sorghums collected by FAO in 1979/80 in the Eastern and Northern provinces were growing in observation rows for seed multiplication and classification. All lines appeared to be day-light sensitive and will not head for several days. Some lines were severely attacked by downy mildew. We did not see evidence of the disease in the few fields we inspected in the Southern and Western provinces. Resistance to this disease, as well as others which attacked the leaves, should be present in some local cultivars.

Dr. Rao has a similar nursery at Chipata which he says is very good. Rao plans to expand his sorghum work in 1981/82 and succeeding years if he is in Zambia. His work will be helpful in getting a sorghum improvement

program started until a full-time agronomist-breeder can be trained.

Of interest is a report in the files. "The high position of (hybrid) NK 300 is interesting, in view of the fact that this hybrid came top of six varieties in the Federal Trial (MN 285) not only at Magege, but at all stations in Rhodesia when it was tried (1971-72)." We grew the hybrid in a number of West African trials during the 1960's and it was always top in yield. Unfortunately, it is a brown seeded and high in tanins, which is undesirable for human use. The brown seed provides some protection from birds and resistance to head molds. We do have a white seeded counterpart which will yield as well, but the grain will weather and is preferred by the birds.

Soil/Crop Advisory. Mr. McPhillips is extremely knowledgeable on the soils of Zambia and what combinations of fertilizers to use on different crops to obtain maximum yields, also economic yields. He not only is held in the highest regard to by commercial and emerging farmers, but has a keen interest in management practices for the small land holder. He has developed the Lima approach for the small farmer which is simple to use and when used will give the proper fertilizer application.

During my visit of an hour, two commercial farmers came to his office for counsel.

I was surprised to learn that sulfur is a limiting element in Zambia. All fertilizers must contain 10% of this element. McPhillips mentioned a trial in which plots with sulfur added gave 25 bags (200 lbs) per hectare, while the check plots yielded 5 bags. The better farmers get yields of maize of 9 tons/ha with an average of 6 to 7 tons.

As we toured Zambia, it was evident that maize without fertilizer will yield little or nothing. On the other hand, sorghum or millet on the same soils without fertilizer will give some production.

Soil Survey. Mr. Commissaries provided me with a soils map of Zambia as well as a publication describing the various soil types. Zambia apparently has had a good soil survey.

Food Storage. Mr. Sakufiwa gave me a tour of the various grain storage bins being used by farmers, as well as models of the bins they are promoting. The newest design is cement plastured over a heavy wire mesh. If a linkage with INTOSORMIL is established, the Grain Storage Lab at Kansas State should be a valuable connection.

One research person commented that dried banana leaves mixed with grain was a good insecticide. I have heard of using wood ashes, but malathion is generally recommended. Farmers generally put their 'best' in storage, which helps prevent insect damage. It is often stated that the percentage of the crop lost to insects is far greater than can be achieved by introducing an improved variety.

Weed Control. Mr. Parker reported that the larger farmers use herbicides and do not cultivate. The availability of equipment and its calibration limits the use of herbicides by the small farmer. If an application is too small, the farmer would get no control of his weeds, and if an excess were used, the farmer could lose his crop. Parker would appreciate a linkage with a weed specialist in the USA for consultation and access to the latest herbicide use and information.

Oil Seeds Development Program. Dr. Ravagnan. Dr. Kirleis arrived in

Lusaka the 22nd of March and we went to Mt. Makulu on the 23rd. The oil seeds project is funded by UNDP-FAO and the major emphasis is on sunflowers. Considerable work has been done on soybeans and a sizeable acreage is being produced by the commercial farmers. From 40 to 50,000 hectares of sunflowers are being grown in 1980/81. There is a surplus of seed in storage waiting to be processed. The capacity of the mills is not great enough to process the crop or to supply the needs for cooking oil. We saw sunflower oil being sold in the public market in less than one-half cup quantities. Some progress is being made in the development of hybrids (CH 241), but most plantings are composites (CCA 73, -75, -77, and CCB 73).

Seed Services Section. We were given a tour of the section by Mr. J. M. Moonga. This section is the seed certification agency for the government which includes the crop, maize, cotton, soybeans, wheat, field beans, and sunflower. The program operates the same as any crop improvement agency in the USA. We were given a list of certified producers of maize. There were over 100 growers, averaging about 50 hectares each.

On the 24th, Dr. Kirleis and I drove to Choma and on the following day toured the Siatwinda/Bulega Malima valley. This is one of the regions where farmers grow sorghum and millet. One stop was at a field of Red Framida sorghum which was nearly mature, while an adjacent field of a local variety was heading. If the local variety had headed with the red seeded one, its white grain would have been weathered and perhaps unfit for use. We saw other fields of local sorghums. There were no foliar diseases of consequence and we saw no downy mildew. The grain formation had not progressed far enough to see if kernel or loose kernel smut may limit

production. These two diseases were estimated to cause loses of as much as 10% in northern Nigeria and if present in Zambia could be controlled by seed treatment. Except for control of seed-borne diseases, seed treatment has little benefit when seed is planted in warm soil.

One sorghum field farmed by a widow had been inter planted with maize. The maize had been badly shaded by the tall-growing sorghum. This woman recognized her mistake and will not repeat it in another season. Most fields of sorghum and millet were planted as sole crops in this valley. A few cowpea plants may be interplanted, which twine up the stalks.

We visited one field of bullrush millet which was as good as any I have seen. Stands were adequate for the poor soil. Ergot, smut and downy mildew were the major diseases in this field, as well as all fields of millet we visited in the Southern and Western provinces. The presence of ergot could create a health problem.

We were taken to see millet near a village about 15 km south and east of Livingston. We were told that there were 500 hectares in the field.

Our trip to the Western province first took us to Kaoma, located in the east district. The Agricultural Officer took us to his experimental plots of bullrush millet, peanuts, and cowpeas. He had been supplied seed of millet from ICRISAT and East Africa. In general, the introduced varieties were not as good as the local. They were earlier in maturing and head development was poorer. We will try to get seed from West African sources for his 1981/82 nursery. We have found from previous trials in West Africa that cultivars from India and Uganda are not adapted. It may be that to improve this crop in Zambia that a breeding program must be carried out

using local material. Local millets are extremely heterogeneous and by inbreeding and selecting for disease resistance and plant type a breeder should be able to isolate desirable lines which could be recombined and released as a synthetic.

The major crop in the Kaoma area is maize and many of the fields had been fertilized. We visited one field of sorghum called 'Syndicate' by the locals which, in my opinion, is Serena, a variety developed at Serere, Uganda. This variety is relatively short (5-6 feet) and has brown seeds with a subcoat making it more tolerant to birds and weathering. The field was more than a hectare in size and should have given a yield of 1500 kg/ha. The grain will be used for brewing.

We also saw a small field of sweet stalked sorghum to be sold in the local market by the stalk for chewing. I inspected one stalk and found it infected with stem borers.

As one travels west towards Mongo, the crop land is planted to casava and bullrush millet. After clearing the land, the farmers plant stems of casava every 5 or 6 feet and inter plant with millet. The casava is harvested the second year. The operation is extended through a second cycle or the field is permitted to go back to 'fallow'. We didn't learn what kind of production is obtained from such a system of cropping and it is difficult to suggest an improvement in the system.

Mongu is located on the Zambezi flood plain, which is a swampy valley over 40 miles across. The escarpment from the upper sandy plain to the valley floor is abrupt, but ranges from almost pure sand at the upper level to peat in the valley. As a consequence, a range of crop is found: maize,

sorghum, millet, fruit trees and horticultural crops. Much of the population in the Western province lives on this rim.

We visited one village north east of Mongu which took us down a 30 km road of sand. The village was located in a small valley with good soil and water near the surface. The sorghum would probably not yield with the maize, but the grain is needed for brewing.

We did not get to Senanga 110 km south of Mongu, where we were told the major crops were sorghum and millet. We are agreed that since a large sector of the population of Zambia is dependent upon these two crops that some attention should be given towards their improvement by breeding as well as management.

I have briefly mentioned the procedure which can be used to improve bullrush millet by breeding. The breeding of improved cultivars of sorghum for the tropics is not as easy as in the temperate zones, particularly if the grain is to be used for human consumption. Breeding types for brewing would be much easier. For human use, the crop must be planted at the start of the rains and head out when the rains are 'finished' in order to have bright, non-weathered grain. For long season types, the cultivars must be photo period sensitive, which permits a month or more latitude in the date of planting and still have the crop head at the end of the season when the rain usually stops. Delayed plantings in most of the tropics are attacked by the shoot fly. I haven't seen any reference to the pest being present in Zambia. Breeding of shorter plants is a possibility if the long stalks are not needed for fencing or building purposes. Shorter plants could be planted in heavier stands with fertilizer and give increased yields, providing

the season is normal in length. If the rains stop early, thick plantings could suffer from drought before the grain matures.

In most areas of the world where sorghums are grown, midge can be a problem if genotypes of differing heading dates are grown in the same area. Midge multiply on the heads of early lines and then infest the florets of later lines.

We noted Striga (witch weed) in one field of millet in the Southern province. It has reddish-orange flowers which may identify it as asiatica. The crops did not seem to be affected. Over much of Africa this is the worst pest we have to contend with. A few lines have been found to be tolerant to Striga in some areas.

It was suggested the the finger millet be a responsibility of the team. We have not as a team been able to address this crop, but because of its importance in the East any project on the improvement of the production of sorghum and bullrush millet must include finger millet. A. A. U. Sarmezey, working in the period of 1960-1977, prepared an excellent report of his work which will be very useful to the person or persons assigned to this crop.

We were given, by the Agricultural Officer at Choma, typed copies of all trials with sorghum and millets which he has in his files. All such data should be studied if a new improvement scheme is launched. It is essential that as information is accumulated which could benefit farm production that a number of on-farm demonstrations be conducted. The researcher must always keep the farmer in mind in planning his experiments.

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CONTRACT NO. AID/DSAN/XII-G-0149

INTSORMIL
MISSION
TO
ZAMBIA

March - April, 1981

Allen W. Kirleis

William H. Morris

Orrin J. Webster

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Zambia Report

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Appendix

A. Annual Report of the Research Branch 1969

B. Directory of Personnel Contacted

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INTSORMIL Mission to Zambia

March - April, 1981

Allen W. Kirleis

1. AGROCLIMATIC REMARKS

Zambia, a republic in Central Africa, lies between 08°15' and 18°S latitude and 22°15' and 34°15'E longitude. It is entirely land-locked and is surrounded in the north by Zaire and Tanzania on the east by Malawi and Mozambique, south by Zimbabwe and west by Angola.

1.1 Climate: Zambia lies wholly within the tropics. There are three seasons: the cool, dry winter months of May to July; the hot, dry months of August to October; and the warm months of summer rain from November to April. Temperatures are closely related to altitude and less closely to latitude. Details of latitude, longitude and elevation of some important places in Zambia are given in table 1.

The agroclimatic information is from World Bank Report No. 841a - ZA, Agricultural and Rurual Sector Survey col-III, October, 1975.

Table 1: Latitude, longitude and elevation of some important places in Zambia[1]

Station	Latitude		Longitude		Elevation (m)
Chipata	13	33	32	35	1032
Choma	16	50	27	04	1278
Kabompo	13	36	24	12	1075
Kabwe	14	27	28	28	1207
Kafironda	12	36	28	07	1243
Kafue Polder	15	46	27	55	978
Kaoma	14	48	24	48	1213
Kasama	10	13	31	08	1384
Kasempa	13	32	25	51	1234
Kawambwa	09	48	29	05	1324
Livingstone	17	49	25	49	986
Lundazi	12	17	33	12	1143
Lusaka I/A	15	19	28	27	1154
Mansa	11	06	28	51	1259
Mbala	08	51	31	20	1673
Mongu	15	15	23	09	1053
Mount Makulu	15	33	28	15	1213
Mpika	11	54	31	26	1402
Mwinilunga	11	45	24	26	1363
Ndola	13	00	28	39	1270
Petauke	14	15	31	17	1036
Samfya	11	21	29	32	1172
Serenje	13	14	30	13	1384
Sesheke	17	28	24	18	951
Solwezi	12	10	26	22	1386
Zambezi	13	32	23	07	1078

1 Zambian Climatological Summary, surface and upper air data September, 1976.

On the Zambian Plateau, Lusaka, at an altitude of 1277 m has a lower winter temperature than Abercorn (1668 m) in the eastern highlands. Temperatures over the country vary from 16° to 27°C in the cool season and from 27° to 38°C in the hot season. Although the pattern of rainfall over the whole of Zambia is fairly uniform, there is considerable variation in the amount. The northern parts of the plateau have annual amounts of generally between 1000 and 1400 mm, decreasing southward to about 760 mm at Lusaka. Below Lusaka rainfall is between 500 and 750 mm except for occasional showers in August, rainfall is mainly confined to the November-April wet season.

1.2 Physiographic regions: Five more or less distinct physiographic regional types may be recognized: 1) the highlands of more than 1200 m altitude including the Lunda upland merging eastward into the Muchinga watershed (between the Zambezi and Luangwa drainages) and the Bemba upland, 2) the midland, lying between 700-1400 m covering most of the western and central part of central province, 3) the Rift Valley represented by the Luangwa - Luano through, 4) the Kalahari sand surface in Zambia the Barotseling sand surface, and 5) the drainage basin, in which erosive, depositional and tectonic features may occur, including part of Luapula Basin and the Mweru - Wantipa fault zone lying between lakes Mweru and Tanganyika.

1.3 Soils: In the plateau region, the soils are predominantly leached sandy loams and loamy sands of low fertility. In the Muchinga and Luangwa Escarpment, shallow stony soils are found. In the Luangwa and Lunsemfwa Rift Valley the soils are mainly of alluvial and colluvial origin, are varied in texture and fertility. The Kafue flats have almost impermeable black clay soils and a fringe with lighter soils developed on old alluvium and colluvium.

1.4 Crops grown: About three quarters of Zambia's population derives a living from agriculture. Though maize (Zea mays L.) is the staple food crop almost throughout the country, supplementary crops are finger millet [Eleusine coracana (L.) Gaertn.], sorghum [Sorghum bicolor (L.) Moench], cassava (Manihot esculenta Crantz) and beans (phaseolus vulgaris L.). Rice (Oryza sativa L.) is grown in swamp areas around the river basins, Luangwa, Chembeshi, and Zambezi. The commercial crops are groundnut (Arachis hypogaea L.), sunflower (Helianthus annuus L.) and tobacco (Micotiana tobacum L.). The most common fruit crops are banana (Musa spp.), papaya (Carica papaya), citrus (Citrus spp.) and mango (Mangifera indica L.), Phaseolus beans and cowpeas [Vigna unguiculata (L.) Walp.] are commonly grown mixed with maize. Sweet potato [Ipomoea batatas (L.) Lam.], pigeonpea [Cajanus cajan (L.) Millsp.] and pearl millet [Pennisetum americanum (L.) Leeke) are mostly grown in the backyards. Among the

supplementary crops, finger millet and sorghum are important in different provinces as shown in table 2.

Table 2: Area and distribution of Sorghum and Finger Millet in Zambia (1969 - 70)

Province	Finger Millet		Sorghum	
	Area (1000 ha)	Production (tons)	Area (1000 ha)	Production (tons)
Central	7.4	4,100	13.1	6,500
Copper belt	0.8	300	8.8	13,900
Eastern	11.9	6,000	5.4	1,000
Luapula	9.6	7,600	0.3	50
Northern	43.6	38,700	4.0	4,500
N. Western	9.4	6,500	11.7	6,000
Southern	7.1	2,200	15.0	8,400
Western	40.7	19,500	19.3	11,100
	130.5	84,900	77.6	51,450

Source: World Bank Report No. 841a - ZA, Agricultural and Rural Sector Survey col-III, October, 1975.

1.5 Utilization of crops

Sorghum: a staple food in the valleys and in certain parts of the eastern province. Soaked grain is pounded to remove the pericarp. Polished grain is made into flour. The flour is added slowly to boiling water until a thick consistency is obtained by constant stirring. This thick porridge is called "nsima". White grain types were generally preferred. Tender grain of certain cultivars is eaten raw. Sweet stalk types are almost ubiquitous which are called "misale", "zekiv" or "njiho" and are grown on a small scale for

domestic consumption. The grain is usually astringent and often unpalatable. Sorghum is extensively used to brew beer.

Pearl millet: used mostly to brew beer.

Pigeonpea: mature whole grain is consumed after boiling. However it is used more extensively by the Asian population who use the split grain "dhal".

Groundnut: an important commercial crop, is exported for confectionary use. Pounded kernels are used for seasoning vegetables.

Finger millet: used like sorghum as a staple food to prepare a thick porridge called "nsima". It is also extensively used to brew beer. Reportedly finger millet produces an excellent beer.

1.6 Variability observed

The traditional cultivars are gradually being replaced by early maturing cultivars, introduced by the Ministry of Agriculture. Table 3 lists the important characters of Sorghum cultivars found in the various areas of Zambia by the ICRISAT germplasm collection mission in 1980.

Table 3: Sorghum types and their important characters in different areas of Zambia

Local Name	Distribution	Panicle	Glume	Seed	Use	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Chibakweni	Chipata, Luangwa Valley	loose drooping	black open	white	-	Guinea
Chibowa	Chadiza	loose large	long	white	nsima	Guinea
Chimbwa kayllo	Petauke	large, loose	white	white	nsima	Bicolor
Kabango	Chadiza	large, loose	black	red	beer	-
Kadyaligone	Chadiza	small, compact	white	white	raw tender grain	grain sweet
Kamchawere matuwa	Chama	semi-compact	white	white	nsima	-
Kachawere senga	Chama	v. compact conical	red	brown	nsima	90 days maturity
Kamphumphu	Chadiza	small, compact	red	yellow	nsima, beer	early
Kamutuhali	Chama	loose	red	brown	chewing	sweet stalk
Kampyanga	Chipata	-	black	yellow	beer	Shatter cane
Kamya	Mbala	compact, cylindrical	white	white	nsima	-
Kandondo	Luangwa Valley	compact	partly cover	white	nsima	Durra
Mamphenga	Petauke, Isoka	small, compact	red	red	nsima, beer	Bicolor
Masaka	Chama	small, compact	white	white	nsima	-
Masaka	Kasama	large, loose cylindrical	white	white	nsima	Guinea
Misale	Chipata, Kasama	small, compact	red	brown	chewing	sweet stalk
Mphange	Chipata	long, loose	black	brown	beer	Bicolor
Mulelembe	Petauke	large, loose drooping	open	twisted	nsima	Guinea
Mukumba	Isoka	drooping	white	white	nsima	half-broom corn
Musindo	Chadiza	-	-	red	beer	-
Mwadankope	Chadiza	-	-	yellow	-	-

Local Name	Distribution	Panicle	Glume	Seed	Use	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Nachizyanda	Luangwa Valley	semi-compact	red	red	chewing	sweet stalk
Njiho	Lundazi, Chama	large and loose	black	brown	chewing	sweet stalk
Nkona	Mbala	compact, conical	open	white	nsima	Caudatum
Nkuma	Isoka	small compact, conical	white	white	nsima	-
Nyasarande	Chama	loose, drooping	black completely cover	brown	beer	Bicolor
Sambe	Luangwa Valley	long, loose drooping	red and open	white	-	Caudatum
Sonkwe	Kasama	compact	white	white	-	Durra
Sonke	Mbala	large, loose	white	white	-	Guinea
Zekiv	Petauke	semi-compact	red	red	chewing	sweet stalk

Pearl millet: bristled types with small corneous grain are grown in the backyards. Cylindrical compact heads with short bristles are also found.

Finger millet: classified into two broad categories based on head characters. The open type is called "katubatuba" around Lundazi and "mamwoli" around Isoka. The closed or fistular type is called "kafumbata" around Lundazi and "maufula" around Isoka. In Katangarilla area another type called "chawankwela" with long, incurved fingers is commonly grown. The grain color varies from almost white to black with intermediate colors.

Storage: Unthreshed heads of sorghum and finger millet are stored after drying in locally made bins. The frame is made up of bamboo, napier grass, maize or sorghum stalks. Mud is plastered on the outer surface for protection against rain, rats and insects. A small hole is kept near the bottom to draw samples periodically. The entire structure is built on a raised wooden platform.

2. TRAVEL NOTES

Left Lafayette, Indiana on 20 March, London, England on 21 March and reached Lusaka on 22 March.

22 March

Arrived in Lusaka at 7:00 am, however, no one was at the airport to meet me. I took a taxi to the Inter-Continental Hotel and located Orrin Webster at the Hotel.

There were no scheduled activities for this day, although, Webster up dated me on his activities (he had been in Zambia for about one week prior to my arrival) and provided me with some background material on sorghum and millet production in Zambia.

Met with Mr. Ernest F. Gibson, Agricultural Development Officer, A.I.D. mission Zambia, at the Hotel. He briefed us on the schedule for the up-coming week.

23 March

Webster and Kirieis were briefed on the FAO sunflower breeding and seed services programs at the Mount Makulu Research Station.

Dr. Ravagnan, Sunflower Co-ordinator and Chief Technical Advisor, NODP, provided information about oil seed production and processing in Zambia. He also discussed the FAO sunflower breeding program which has been in place since 1972. In short, oil seed production would have to be doubled in order to meet the cooking oil

needs of the country.

Seed production and certification programs were outlined by Mr. J.M. Moonga of Seed Services. Sorghum and millet are not included in the seed certification program. The seed certification program includes maize, cotton, sunflower, soybean, wheat and some beans.

Before leaving Mount Makulu we had a brief visit with Ms. Chungu, Chief of Agricultural Research Officer. She was interested in knowing what recommendations the INTSORMIL team may have concerning future research efforts, at a national level, on sorghum and millet. Presently there are no active national research programs on the crops in Zambia.

Along with E. Gibson we meet Mr. Frank Wisner, U.S. Ambassador to Zambia at the U.S. Embassy. We had a useful discussion on Agricultural development in Zambia with the Ambassador.

Late in the day we were briefed by E. Gibson, at A.I.D. Mission Headquarters, on our trip to the Southern Province scheduled for 24 to 27 March.

24 March

Webster and Kirieis accompanied by Mr. Watson Mwale traveled from Lusaka to Choma by land rover. All along the route maize was the major crop grown.

In Choma we met with Mr. Joel Chivwema, Southern Province Agricultural Officer. A summary of the important points from our discussion with Mr. Chivwema are listed below.

1. The Gwembe District is the only District in the Southern Province where sorghum and millet are more important than maize.
2. The agricultural research and extension efforts are presently concentrating on maize, not on sorghum and millet.
3. Sorghum and millet are grown, to any degree, only in the low rainfall areas where maize will not do well.
4. Sorghum yields in the Southern Province average about 900 kg/ha.
5. The official market price of sorghum and maize are K9 and K13.50 (K = kwachas), respectively, per 90 kg bag.

Traveled from Choma to the Mochipapa Regional Research Station (near Choma). At the Station we met Mr. S.C. Mufaya, Officer in Charge; Mr. C.W. Lubasi, Crop Husbandry Officer; and Mr. A.K. Gudta, Agronomist. We worked out a tentative itinerary for our trip to the Guembe District. In addition we were given some sorghum and millet yield trial data conducted in the area between 1969 and 1975 (Appendix A).

25 March

Webster, Kirieis, Mwale, Mufaya, and Gudta traveled from Choma to the Gwembe District. Our first stop was at Sinazeze to visit the Gwembe South Development Project. This project is a German irrigation project being handled by a seven man team from the Gossner Service. We met Mr. Klaus J. Jaehn and Mr. G. W. Nakasamn (national on project) who briefed us on the project. The irrigation project

was not involved with sorghum or millet research. Thus, they were unable to provide much information about sorghum or millet production and uses in the area. However, they did indicate that farmers are generally not interested in growing sorghum and millet as there is no market for these crops outside the Gwembe area.

We next visited with Mr. Petrol Miyanda, Assistant Gwembe District Agricultural Officer. Mr. Miyanda gave us the following information about the types of cereal crops grown by farmers in the Gwembe District.

Number of Farmers	Area Farmed (ha)	Crop
1,500	2,350	sorghum
75	50	pearl millet
20	15	red sorghum
350	480	maize
	2,895	

Accompanied by Mr. Miyanda we visited three of the local farmers in the Sinazeze area.

Farmer #1 - This farmer planted more maize than sorghum. His 1 ha field of sorghum was planted with a cultivar (Red Framida) used for brewing beer. According to the farmer the "Red Framida" out yields the local traditional cultivars. The sorghum field was prepared for planting with an ox-plow and no fertilizer was used. The field was weeded once using an ox-plow, after planting. The sorghum field had a poor stand with an excess of weeds.

Farmer #2 - This farmer had inter-planted maize and sorghum. The sorghum was a local traditional cultivar (about 5.5 m tall) not yet headed. The field was prepared for planting with an ox-plow and had been weeded two times. This sorghum field had a good stand and had few weeds.

Farmer #3 - This farmer had inter-planted sorghum (2 types) and millet. According to Mr. Miyanda the sorghums and millet were local traditional cultivars. In the field we saw some striga and other diseases on both the sorghum and millet heads (see Webster's notes for disease identification).

Returned to Choma for the night.

26 March

We drove from Choma to Kalomo. At Kalomo we discussed sorghum and millet production and utilization with Mr. A.S.B. Kapasa, Kalomo District Agricultural Officer and Mr. S. Muzamballka. According to Mr. Kapasa only about 10 ha of sorghum is grown in the Kalomo District compared to thousands of ha of maize. The farmers growing sorghum have no formal [National Agricultural Marketing Board (NAMBOARD)] marketing channel for selling their crop. We were told that three large farms in the Kalomo District were involved in poultry operations. Sorghum may be considered as a potential feed for these poultry operations if it were available.

We left Kalomo and traveled to the Zimba. In Zimba we picked-up

Mr. Albert Mudenda, Zimba Agricultural Extension Officer, and visited two farmers growing sorghum in the area.

Farmer #1 - This farmer had one field of sorghum (approximately 0.7 ha) planted with a local traditional white seeded variety. The farmer indicated that his expected grain yield from this field would be about 540 kg. About one-half of the grain would be used for food and the other half would be brewed into beer (by the farmer) and sold at the local market. By making beer and selling it at the local market the farmer can make a much greater profit as compared to selling the grain directly.

Farmer #2 - This farmer was a widow who had inter-planted a small field (approximately 0.5 ha) surrounding her compound with sorghum, maize, and cow peas. The maize was doing very poorly as the much taller sorghum (about 4.3 m tall) had shaded the shorter maize. When questioned about her reasons for growing sorghum, the farmer indicated that she preferred sorghum over maize as a food. Additional questions brough out the following points: 1) only enough sorghum is removed from the farmers storage to supply the family food needs each day; 2) the grain from the sorghum heads is threshed and ground into a product called "mealie meal" (approximately the coarseness of corn meal); 3) the mealie meal is commonly used to make a thick porridge food called "nsima" (the same name is used for a thick porridge made from corn).

We left Zimba and drove to Livingston. At Livingston we were

Introduced to Mr. H.M. Millapo, Livingston District Agricultural Officer who briefed us on the agriculture in the district. Our discussion with Mr. Millapo provided the following information about the Livingston District.

1. Most soils in the district are sandy soils which are better suited for sorghum or millet than maize.

2. Generally, local traditional cultivars of sorghum and millet are grown without the use of fertilizer.

3. The most serious problems limiting sorghum and millet production in the district are drough, diseases, and birds.

4. Sorghum and millet (bullrush) are grown as subsistance crops rather than cash crops. The large farmers in the district do not grow these crops.

5. Sorghum and millet have a hidden market in the district - that is these grains are used for brewing beer which is sold at local markets.

6. Type of Cereal Crops Grown by Farmers in Livingston District

Number of Farmers	Area Farmed (ha)	Crop
453	471	millet (bullrush)
890	1,007	sorghum
1,458	4,654	maize

7. Livingston District Cereal Crop Yields

Crop	Yields (kg/ha)
sorghum	750
millet (bullrush)	900
maize	
emergant farmer	1350
traditional farmer	1800-2250
commercial farmer	4500

Mr. Millapo arranged a visit with a village Chief in a millet (bullrush) growing area, located about 6.2 kilometers from Livingston. We were told that farmers from this village had planted a total of about 500 ha of millet in the area. The field (sandy soil) we were shown had a good stand and was generally free of disease. The village Chief informed us that most of the crop would be used for brewing a local beer.

The night was spent in Livingston.

27 March

We drove from Livingston to National Irrigation Research Station near Mazabuka where we visited with Mr. G.C.H. Hill, Officer in Charge. The most important points from our discussion with Mr. Hill were:

1. Some years ago, under rain fed conditions, intercropping trials with millet (bullrush) and pigeonpeas were conducted on the Station. From these trials they found that the bird losses on the millet crop were very high.

2. An introduced sorghum cultivar from Uganda "Dobbs" was not accepted by the local farmers. The farmers did not grow Dobbs as they claimed the traditional local cultivars made better local beer.

3.Most sorghum grown in the Mazabuka area is used for brewing local beer.

4. The Zambian agricultural extension service is relatively ineffective in getting information to the small farmers. In part, this results from a lack of transportation for the extension agents. Thus, much of the important research findings needed by the small farmers never reaches them.

The remainder of the day was spent traveling from Mazabuka to Lusaka.

28 March

Webster and Kirlels had an early morning meeting with E. Gibson at the Inter-Continental Hotel to brief him on the trip to the Southern Province.

INTSORMIL team members William H. Morris arrived in Lusaka and was briefed on our mission.

29 March

The team (Webster, Kirleis, and Morris) visited with Mr. Richard Vernon, Weed Control and Tillage Unit, Mount Makulu, about his work on sorghum and millet in the Western Province of Zambia during the early 1970's. See Webster or Morris trip reports for details of this discussion as they made the trip to the Western Province on 30 March to 1 April to observe the agricultural systems in this region.

30 March

Kirleis accompanied by Mr. Alex J. Prior, Principal Agricultural Research Officer, Mount Makulu met with: the Executive Secretary and staff of the National Food and Nutrition Commission; the Dean and faculty of the School of Agriculture, University of Zambia; and the Secretary General and staff of the Food Technology Research Unit of the National Council of Scientific Research.

Notes from the meeting with the National Food and Nutriton Commission (NFNC) group. NFNC personnel attending the meeting included: Mr. Alex P. Vamoer, Executive Secretary, Mr. Chapa Chikamba, Assistant Executive Secretary, Ms. Charity Dirorimwe, and Ms. Dorothy Muntemba.

The main function of the NFNC is to act in an advisory capacity to the government Ministries on food and nutritional problems in Zambia. The NFNC has twelve professional staff who work in five Units. These five Units are:

1. Traditional Education
2. Food Science and Technology
3. Public Health and Nutrition
4. Mass Communication
5. Research Planning

The NFNC identified the principle reasons why maize is slowly replacing sorghum and millet (bullrush and finger) on the Zambian agricultural scene as: 1) the NAMBOARD policies do not encourage farmers to grow sorghum and millet as a cash crop; and 2) the agricultural extension services do not promote growing sorghum and millet. However, despite the governments policies in some areas of Zambia, sorghum and millet are preferred to maize for food uses.

In some respects the NFNC group was not well informed concerning the nutritional aspects of sorghum. In fact, they were unaware of the anti-nutritional effects of consuming high tannin sorghums.

Notes from the meeting with the Dean and faculty of the School of Agriculture, University of Zambia. University personnel at the meeting were Dr. P.J. Mathai, Dean of Agriculture, Professor G.B. Chibilite, Head/Crop Science, Professor J.C. Patel, Lecturer/Crop Science, and Professor N.S. Sisodia, CIDA Team Member/Crop Science.

The discussion with the University group was very lively and provided a useful exchange of ideas about Zambian agriculture. The reason for the dominance of maize over the more traditional food crops (sorghum, millet and cassava) was linked directly to the

Zambian agricultural policies by this group. Specific examples were given as: 1) the NAMBOARD'S crop pricing policies do not encourage farmers to grow sorghum and millet; 2) there are few national or donor agricultural research and extension programs in Zambia that are working with sorghum and millet; and 3) the National Milling Company Limited (not associated with the government) mills only grind maize into "mealie meal" which is used for preparing nsima. As a result of these negative governmental policies, small farmers growing sorghum and millet are often considered backward. The group felt that only a change in the governments marketing policies could change the poor image of sorghum and millet in Zambia.

The School of Agriculture was doing their part to promote sorghum to the Zambian farmers by having a large field growing near the University. The grain from the crop was being used to feed some of the University livestock.

Notes from the meeting with the Secretary General of the National Council of Scientific Research (NCSR) and staff. Discussions were held with the following NCSR personnel: Dr. S.M. Silangwa, Secretary General, NSRC; Mr. E.J. Zimba, Technical Service Administration Officer, NCSR; Mr. M. Elahi, Head/Food Technology Research Unit, NSRC; and Mr. M.T. Kaputo, Food Technology Unit, NSRC.

Mr. Zimba outlined the structure and mandate of the NCSR. There are seven research and development units in the NCSR.

1. Pest and Livestock Research Unit (largest unit)

2. Tree Improvement Research Unit
3. Water Resources Research Unit
4. Radio Isotope Research Unit
5. Building Research Unit
6. Ceramics Research Unit
7. Food Technology Research Unit (FTRU

   Sections in the FTRS

   a) Food Microbiology
   b) Food Engineering
   c) Fruits and Vegetables
   d) Food Chemistry
   e) Cereal Technology

The type of research and development work done at NCSR is determined to a large extent by the need to solve problems that have been identified by the Zambian Government (i.e. other government Ministries).

Dr. Silangwa restated many of the same reasons that were given by the NFNC and University groups for the decline of sorghum and millet in Zambia. That is, NAMBOARD's policies, and lack of research and extension inputs for the farmer growing sorghum or millet. Dr. Silangwa would like to see the government develop policies to encourage farmers to grow more sorghum and millet in Zambia. Accordingly, he indicated there are areas in Zambia where maize is now grown that are actually better suited for sorghum or millet.

Mr. Elahi briefly outlined the cereal work being done by the FTRU. At the present time this unit is not working with sorghum or millet. Presently, the two major ceral projects in the unit are: 1) developing the technology for using a maize-wheat composite flour to bake bread; and 2) developing a high protein weanling food from soybeans-maize mixtures. The unit had a long list of equipment on order - included on this list was an IDRC disc mill for decorticating sorghum. Thus, some future FTRU projects may include sorghum utilization work.

31 March

Kirleis accompanied by Mr. S. Kean, Agricultural Economist, Ministry of Agriculture and Water Development visited the Chibuku Brewery at Kafue. At the brewery we met with Mr. Simukanga, Manager of the Kafue operation.

Chibuku Brewery. The Chibuku Brewery is one of twelve operations owned by National Breweries (headquarters in Kitwe). The Chibuku operation produces about 2,000,000 liters of beer per month. The Brewery serves the Mazabuka, Lusaka, and Mumbwa areas of Zambia. The beer was brewed with sorghum until 1971. At that time the switch was made to maize as a sufficient supply of sorghum was no longer available. The brewery now uses about 360,000 kg of maize per month.

A brief description of the beer brewing process follows:

1. Corn is cooked in a large steam cooker.

2. The cooked corn is ground, slurried with water and amylase enzymes are added to breakdown the starch to simple sugars.

3. Yeast is added to the mixture and it is allowed to ferment for about four hours. The alcohol content of the beer after fermentation is between 1 and 2%.

4. After fermentation the beer is pasturized and delivered to the distribution points by tank trucks.

Animal Production Research Unit of NCSR. Kirleis met with Dr. Justin E. Opio, Animal Production Research Section of the Pest and Livestock Research Unit, NCSR, Chilanga. The group has conducted studies feeding maize offals (bran or hulls) to cattle and poultry. However, they have not used sorghum or millet in any of their animal nutrition work.

Food Conservation & Storage Unit. Kirleis briefly met with Mr. Sakufiwa, Food Conservation and Storage Unit, Mount Makulu. Mr. Sakufiwa discussed the improved traditonal grain storage huts developed by the unit. These huts range in cost from almost nothing up to about K80.

National Milling Company. Accompanied by Ms. Chungu, Kirleis visited with personnel from the National Milling Company Limited in Lusaka. National Milling Company personnel at the meeting were Mr. F.J. Mkwanazi, Mill Director; Mr.R.D. Mathur, Technical Manager; and Mr.J.P. Kajhawga, Acting Chief Chemist. This company operates six maize mills and three wheat flour mills in Zambia. The Lusaka corn

mill grinds about 600 metric tons of corn per day. The mill produces two grades of corn mealie meal. About 35% of the meall meal produced is called "breakfast" - a 65% extraction product (ground to pass through a 32 W screen) with a protein content of about 6%. The other 65% of the mills production is a mealie meal called "roller mill" - a 92% extraction product (ground to pass through a 24 W screen) with a protein content of about 7%. In general the people at the National Milling Company showed little interest in the idea of producing a sorghum or millet flour.

1 April

Kirlels met with Mr. Hartwell and Mr. Savage of the Food Strategy Study project. This group has not given serious consideration to the potential uses of sorghum and millet in their planning as most of the sorghum and millet production in Zambia comes from small traditional farmers. In addition as mentioned before the NAMBOARD's policies tends to limit the future expansion of sorghum and millet.

The urban centers of Zambia require about 7 million (90kg/bag) bags of maize per year. In addition the stock feed industry presently uses about 120,000 metric tons of maize and wheat offals per year. This figure is projected to increase to 200,000 metric tons in five years. A large portion of the maize and wheat offals are used by the poultry industry. The largest of these poultry

operations are located in Copperbelt, Lusaka and Livingston.

2 April

The team (Webster, Morris and Kirleis) worked at the Inter-Continental Hotel drafting a set of preliminary recommendations for Morris to present to Mr. Chibasa, Deputy Director of Agriculture (Research) Ministry of Agriculture and Water Development, after his trip to the Copperbelt.

The team had dinner at the Gibson's with Mr. Chungu and Mr. Chibasa.

3 April

Traveled from Lusaka to Copenhagen via London.

4 & 5 April

Free days in Copenhagen

6 April

Consulted with Dr. Lars Munck at the Carlsberg Research Center on their United Milling System sorghum mill unit.

7 April

Traveled from Copenhagen to Lafayette.

3. FUTURE UTILIZATION OF SORGHUM AND MILLET

Maize is by far Zambia's most important crop with just over one million acres under cultivation. As a food crop, maize is consumed

as the daily staple of most Zambian families, and as a cash crop, accounts for three-fourths of the total value of marketed crop production. It is grown by all categories of farmers in Zambia. Approximately 60% of marketed production and 85% of total production originates from medium-sized and small farms. Marketed maize production rose, between 1964 and 1976 on the average of about 8 to 10 percent per year. Poor harvests in subsequent years saw a drop in output and necessitated substantial maize imports in 1979 and 1980. There is a concern as voiced by Mr. Vamoer, NFNC, Dr. Mathai, University of Zambia, Dr. Silangwa, NCSR, and Ms. Chungu, Director of Research, Mount Makulu, that reliance on maize as a single staple should be tempered by attention to other cereal crops such as sorghum and millet. A diversification into sorghum and millet as alternate staples could provide small farmers with greater security for their household food requirements.

If the production of sorghum and millet are encouraged in Zambia, through governmental research and extension, and marketing policy changes, a number of options exist for utilizing the grain. The first and most important use option, of course, would be as a human food. The grain from sorghum and millet could be ground into a "meali meal" (comparable to maize) and used to make the traditional food "nsima." A high quality sorghum or millet flour could also be composited with wheat flour and used to produce bread for the industrial and urban centers of the country.

In order to make a sorghum or millet mealie meal or flour of acceptable quality, the traditional wheat or corn roller milling technique now used at the National Milling Company would be unacceptable. It has long been recognized that when sorghum is subjected to roller milling the bran or offals are very difficult to separate from the flour, as compared to wheat or corn. Thus, roller milled sorghum flour usually has a dark color and has a high ash content. However, a high quality sorghum flour (white color and low ash content) can be made by first decorticating the grain to remove the bran, followed by impact grinding. A commercial system for decortication and impact grinding sorghum are available from the United Milling System, Copenhagen, Denmark. Accordingly the offals obtained from a sorghum milling operation could be sold as an animal feed ration.

The technology for producing an acceptable bread with a sorghum/wheat composite flour (30:70) is now available at the Food Research Centre, Khartoum North, Sudan. In fact, FAO has established a training program at the Food Research Centre for transfer of the composite flour technology to other Nations in Africa.

A third option of course would be to use the sorghum and millet for brewing commercial beer. As both sorghum and millet are presently used for brewing local beers, there should be no difficulty if sorghum or millet are substituted for maize in a commercial beer operation such as the Chibuku Brewery.

4. ACKNOWLEDGEMENTS

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