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SORGHUM IN BRAZIL *

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I. Sorghum production and utilization trends

Sorghum is a relative new crop in Brazil that has developed considerably in recent years. Grain sorghum accounts for about seventy five percent of the acreage planted and forage sorghum accounts for the remainder. Preliminary experimental results and economic analysises demonstrate that sweet sorghum can be grown economically to produce alcohol for mixing with gasoline at current prices, and may soon be planted in large areas near existing sugar mills and distilleries. As sweet sorghum would be harvested when the mills are normally idle little capital investment would be necessary to produce alcohol from sorghum on a large scale.

The data in Table 1 show that grain sorghum acreage increased rapidly during the first half of this decade and since 1975 has decreased slightly. This decrease has been caused principally by lack of adequate handling and storage infrastructure, marketing problems, and inadequate governmental policy for feed grain production and exportation. The current

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estimated 25 to 30 percent reduction in corn production and feed grain deficiency again demonstrates the need for a healthy sorghum industry in Brazil. A emergency campaign was iniciated in the state of São Paulo to plant grain sorghum during the second semester of this agricultural year to reduce the current grain deficit, however, there was an inadequate seed supply of improved hybrid seed to meet the demand. Since 1977 the importation of sorghum seed for commercial planting has been prohibited by the Ministry of Agriculture for phytosanitary reasons. Less than fifty percent of the sorghum seed of the estimated five hundred tons of seed was produced this year and with little "carry over" there will be very inadequate supply of seed to plant the acreage to produce the two to three million tons of feed grain that will be necessary to eliminate the current estimated deficiency that will occur this year.

During the First Brazilian Sorghum Symposium held in 1977 it was shown that by using grain sorghum in the ration industry as only eight percent of the ration, the demand for sorghum by 1980 would be nearly one million tons. This is more than twice the amount of sorghum and about five percent of the corn produced in 1977.

Brazil is not traditionally a wheat producing country. During the last few years the Brazilian government has offered incentives to increase wheat production but production has actually decreased during the last two years. Over the years governmental policy has been to import wheat and consequently eating bread has become a tradition in nearly all of Brazil. Table 2 shows the trend of wheat production, wheat importation and value of wheat imported during the last six years in Brazil. Considering the consumer tolerance for a courser and off-white product, sorghum flour or other flour could be blended with wheat flower in proportions from ten to twenty-five percent without altering the final product. With a blend of, for example fifteen percent, nearly one millions tons less of wheat would need to be imported which would result in a savings of one hundred and ten million dollars at current prices.

The demand for sorghum exists and with adequate policy by the government and/or the ration and milling industry sorghum acreage should increase significantly by 1980.

Table 3 shows that grain sorghum is concentrated in the states of Rio Grande do Sul and São Paulo, however production in the semi-arid Northeast is growing. In this region sorghum is one of the best options for the farmers as sorghum is more drought tolerant than the tradictionally grown corn and the great deficit of feed grains in this region.

In 1977 the national yield averaged nearly two and one-half tons per hectare. In the state of São Paulo which has experienced a recent growth in area planted the average yield was three tons per hectare while

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TABLE 1. Estimates of area harvested for grain sorghum and grain production in Brazil from 1971 to 1979.

Year	Area harvested (1,000 hectares)	Production (1,000 tons)
1971(1)	80	170
1972(1)	120	220
1973(1)	210	400
1974(1)	250	500
1975(1)	230	483
1976(1)	210	553
1977(2)	178	435.
1978 (2)	104	228.
1979(3)	200	450

Source: (1) CFP
(2) ~~SUPLAN — MA~~ IBGE — CEPLAVO
(3) CNPAIS.

TABLE 2. Production, importation and value of imported wheat in Brazil from 1973 to 1978.

Year	Production 1,000 t	Importation 1,000 t	Value of Imported wheat US$ 1,000,000	Total wheat available 1,000 t
1973	2.0	3.0	373	5.0
1974	2.9	2.2	417	5.1
1975	1.8	2.9	558	4.7
1976	3.2	3.8	575	7.0
1977	2.1	3.1	310	5.2
1978	2.0	4.1	451	6.1

Sources: Fundação Instituto Brazileiro de Geografia e Estatística e Fundação Getúlio Vargas – Instituto Brasileiro de Economia.

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TABLE 3. Grain sorghum production in Brazil by State in 1977.

States	Area Harvested (ha)		Production (t)	Average yield (kg/ha)
Ceará	2,000	8	1,600	800
Rio Grande de Norte	4,615	5	3,733	809
Pernambuco•	106	11	152	1,434
Minas Gerais	2,290	7	2,740	1,200
Espírito Santo	205	10	615	3,000
São Paulo	56,540	2	169,620	3,000
Roraima	855	6	3,470	4,058
Santa Catarina	450	9	1,320	2,933
Rio Grande do Sul	91,000	1	214,000	2,352
Mato Grosso	4,583	4	8,258	1,802
Goiás	15,000	3	29,625	1,975
Brasil	177,644		435,446	2,444

Source: SUPLAN – MA

in the semi-arid Northeast the average were much less. National yield trials of both commercial and experimental hibrids and varieties frequently produce more than double the state average.

Nearly all the grain sorghum acreage is planted with hybrids except in the Northeast where some varieties are used. Until this year this seed was imported or produced by a few commercial companies. Next year, however, the majority of the seed available will be from two companies with two or three other companies supplying a small percentage. Because of the uncertainty at planting time, of regulatory action by the federal government related to the disease "downy mildew", the supply of grain sorghum seed will be inadequate this year. Some companies are producing extra seed in the Northeast this winter but they will not be able to meet the total demand.

The only forage sorghum seed being commercially produced in Brazil this year is the variety Sart. Seed of some hybrids that have traditionally been imported and planted in the past will be unavailable this year.

The National Corn and Sorghum Center released two grain sorghum hybrids and two forage sorghum hybrids in 1977 as well as five sweet sorghum varieties and will probably release additional hybrids in 1978. The foundation

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seed will be produced and sold by the Foundation Seed Production Service of EMBRAPA. In addition a white seeded hybrid is in the final stages of development and testing for use in blending with wheat flour.

II. Research Activities at the National Research Center

Sorghum research at the CNPMS has developed around specific problem areas and the research program contains several multidisciplinary projects to resolve specific problems, or develop production systems for specific conditions. The research projects currently include the following:

1. Ecological zoning.
2. Development and testing of new production systems.
3. Survey of insects and diseases.
4. Disease control.
5. Insect control.
6. Development of technology to produce sorghum in acid soils with toxic levels of exchangeable aluminium.
7. Development of technology to produce sorghum in droughty areas.
8. Improvement of productivity and quality.
9. Improvement in the efficiency of the use of plant nutrients.
10. Mechanization for sorghum.
11. Development of technology for handling and storage of grain sorghum.
12. Analysis of systems of marketing and use of sorghum.
13. Germoplasm bank activities.

These research projects are summarized in the bulletin "Atividades e Programa do Centro Nacional de Pesquisa de Milho e Sorgo - 1978" and will not be discussed here in detail. Instead I would like to concentrate on some recent advances in priority areas that have been made at the National Corn and Sorghum Research Center.

In tropical and subtropical regions, the soils frequently are characterized by low levels of calcium, magnesium and phosphorus, high acidity and toxic levels of aluminum and/or manganese and low water holding capacity In Central Brazil where sorghum and corn acreage is expanding, this is a problem that is not resolved completely or economically by the application of lime and fertilizer. Our objective at the National Corn and Sorghum Research Center is to adapt the plant to this environment instead of only modifying the environment with the addition of lime and fertilizer. After screening several hundred lines in soils with aluminum saturation above sixty percent five lines have been identified as tolerant. These are SC 112-14 (IS 12612), SC 418 (IS 13356 C), SC 048 (IS 12564 C), SC 283 (IS 7173 C) and

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SC 175-14 (IS 12666 C). In addition two breeding-lines (CMSXS 101 and CMSXS 903) have been identified as being highly susceptible. Preliminary inheritance studies indicate that a single dominate gene is responsible for tolerance to this soil acidity complex. Many progenies of crosses of these lines with other elite materials are currently being evaluated.

Sorghum midge (Contarinia sorghicola) continues to be one of the most serious pest of sorghum and is being studied in great depth at CNPMS. The most animating aspect of this program is the confirmation that the tropical line, AF-28, the most resistent genotype to this pest tested to date, and a short early selection (In cooperation with researchers at Texas A and M University) of Tx 2536 x AF-28 appears to have maintained this resistence. Panicles of this selection infested with ten adults per day maintained a high degree of seed production. These data are currently being tabulated and analyzed. Several crosses have been made between this selection and elite materials and the F_2 generation is currently being produced in our winter nursery. Techniques are being studied to rear the midge for controlled infestations. Providing that this resistance holds up and is reasonably simply inherited, CNPMS should have resistant varieties and hybrids in the near future.

Symbiotic-biological nitrogen fixation (Azospirillum lipoferum) has been observed in sorghum, millet and corn at CNPMS. Preliminary experiments have shown genetic variability between the sorghum genotypes tested and between these three species. Measurements have indicated that sorghum was fixing nearly 800 g of nitrogen per hectare per day at anthesis. Indirect evidence indicates that pearl millet has much greater nitrogen fixing capacity than sorghum. Sorghum lines selected in 1977 showing greater fixation capacity are currently being reevaluated as well as several pearl millet cultivars.

The most important diseases for sorghum in Central Brazil are anthracnose and rust. Downy mildew is a potential disease as it has been observed in many areas of the states of Rio Grande do Sul and São Paulo. Several elite lines have been identified as tolerant to anthranose and rust and other foliar diseases and have been used in our breeding program. One line showing much potential is SC 326-6 (IS 3758 C). Several hundred progenies between this line and several other elite lines are currently beeing evaluated as varieties and in hybrid combinations. Several selections with yellow endosperm, open panicles, large seed and good disease resistance are currently being evaluated in hybrid combinations. CNPMS in cooperation with the Secretary of Agriculture of the state of Rio Grande do Sul and the University of São Paulo in Jaboticabal has set up a downy mildew testing service for both commercial and public institutions. In Jaboticabal the infestations this year were much higher in corn than in sorghum. The incidence of the disease in corn varied from zero to one hundred percent while in sorghum

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the incidence only varied from zero to about twenty percent.

The sorghum breeding program has as its objective to incorporate the various traits mentioned earlier into high yielding productive varieties and hybrids of good quality. In our program special attention is being given to forage quality and nearly half our program will be devoted to the improvement of forage and sweet sorghum types.

Governmental policy to mix alcohol with gasoline has generated a search for new renewable sources of raw materials for fermentation. Sweet sorghum appears to have much potential in this aspect as it can be milled and fermentated when the sugar mills are normally idle and is a crop that can easily be mechanized from planting to harvest with existing equipment. As a result of this, CNPMS has initiated a sweet sorghum breeding and testing program to identify sweet sorghum cultivars adapted to the various regions having potential. The factor most limiting in varieties from the US is the sensibility to short days. In terms of liters of alcohol per hectare per days, sweet sorghum is even competitive with sugar cane.

The National Corn and Sorghum Research Center in cooperation with the National Center for Genetic Resources maintaines a Germplasm Bank for corn, sorghum and millet. Introduced genetic materials as well as improve material will be maintained in the germplasm bank. Currently there are over three thousand sorghum lines and several random mating populations from our breeding program that are being catologued into the germplasm bank.

One other function of CNPMS is to coordinate sorghum research in all of Brazil. CNPMS evaluates all sorghum projects of other institutions (financed by EMBRAPA) and offers technical assistence when necessary.

A network of national grain sorghum, forage sorghum and sweet sorghum trials as well as experimental trials are organized in all of Brazil. In 1977 more than 165 trials were prepared and distributed to cooperators. The breeding program also prepares genetic materials to support the other sorghum breeding programs in Brazil principally those in Pelotas, Rio Grande do Sul (UEPAE-Pelotas/EMBRAPA) and Recife, Pernambuco (IPA-Secretary of Agriculture of Pernambuco). Several lines and varieties as well as 16 bulks were released in 1977. Additional material will be released in 1978.

In summary these are a few of the highlights of sorghum production in Brazil and some research advancements that we at the National Center consider important. Thank you for the opportunity to present this report.

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This paper deals with production trends of sorghum in Brazil beginning in 1970 when grain sorghum began to expand in Southern Brazil to the present. Grain sorghum is the principal theme of this discussion but forage sorghum and sweet sorghum for alcohol production are also discussed.

The infrastructure for sorghum research in Brazil is discussed including the sorghum research projects of the National Center for Corn and Sorghum Research. The principal research findings are summarized. The most important of these being the incorporation of midge resistance from a tall tropical photoperiod sensitive line (AF-28) to a short insensitive line, the development of sorghum lines tolerant to highly acid soils with high levels of exchangeable aluminum, the development of sorghum lines resistant to anthracnose of Brazil (reaction different from that obserd in the USA) and resistence to foliar diseases and the development of production systems for various levels of tecnology. The progress in symbiotic nitrogen fixation (Azospirillum lipoferum) for sorghum is also discussed.

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