AGRICULTURAL RESEARCH AND POLICY ORIENTATION TOWARDS THE NEEDS OF CEREAL-BASED AGRO-INDUSTRIES[1]

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A B S T R A C T

The attainment of food self-reliance and security still remain as key problems to agricultural research and development in Africa. Subsistence agriculture, which is practised by most farmers, has not made any headyway in overcoming the food crisis that most African countries have encountered. Past trends in agricultural research and development must be changed and alternative paths taken to improve productivity. Living conditions of the rural population could change, if productivity improves beyond subsistence level and utilization of agricultural produce is diversified.

Cereal-based agro-industries could enhance substantial increase of food grain, since it will open market outlets. Once reliable markets are assured, farmers will substantially increase grain production to meet the requirements for such industries.

Throughout this paper, cereal-based industry is referred to the utilization of sorghum, maize and related cereals in malting and brewing, nutritional weaning foods, development of seed industry, use of cereal flour in building industry (as adhesives for plywoods, or for the manufacture of pulp and paper), production of non-alcholic beverages and the increased use of sorghum, maize, etc, in the bakery industry.

Furthermore, as livestock production is transformed (due to population pressure and shortage of land), from a nomadic to a sedentary system, the utilization of certain types of sorghum as feed would also increase.

The first part of the paper reviews the various industrial uses of cereals, including problems encountered in obtaining quality grain as raw material. The second section discusses future research challenges. Finally, some research and policy orientations essential to enhance the development of cereal-based agro-industries are proposed.

Introduction.

Sorghum and maize have been used as industrial raw materials in the production of beer, nutritional weaning foods, nonalcholic beverages, confectioneries and as composite flours in the bakery industry. Accurate statistics, regarding the volume of cereal production required either for breweries or for other industrial uses is virtually lacking. In a country like Nigeria, where many brands of beer contain substantial amounts of local sorghum and maize, it has been estimated that, at the current level of production and productivity of these cereals, the demand for industrial utilization could not be met, otherwise there will be an acute shortage of these grains for food (A.O. Aribisala, 1990).

In Southern Africa, Kaffir beer is largely a traditional drink. According to Mohale Mahanyele (Taylor, 1993), the National Sorghum Brewery was a state monopoly until 1990, when was made a private enterprise thereafter. As one of the few successful black entrepreneurs in South Africa, he revitalized the Kaffir Brewery industry by raising 21 million dollars and bought the industry by selling shares to over 10,000 members, 90% of whom of the share holders were from the black community. Part of the interview of Mr. M. Mahanyele by Jeune Afrique (Taylor, 1993) is included below:

Restaurer la dignité du sorgho.

" C'était une boisson associée depuis toujours à nos libations de fête, rappelle Mohale Mahanyele. Et voilà qu'elle nous était confisquée. C'était honteux et humiliant. J'ai donc voulu restaurer l'ancestrale dignité du sorgho...

Pour racheter la brasserie et ses 21 usines, il lui fallait réunir 20 millions de dollars sans la moindre ouverture au milieu capitaliste blanc. Aussi a-t-il lancé quelque chose que nul n'avait tenté avant lui : vendre des titres aux Noirs, en misant sur le soutien des traditionnelles tontines locales, appelées stokvels.

Aujourd'hui, son entreprise n'a pas moins de 10.000 actionnaires, dont plus de 90% sont noirs, expérience entièrement inédite dans un pays où peu d'autochtones possèdent ne serait-ce que le toit qui les abrite. Son conseil d'administration, son état-major et son réseau de distribution sont eux aussi en majorité composés de Noirs.

The production of ethyl alcohol is undoubtedly the oldest and most important fermentation product of grain sorghum with a number of milling and saccharification processes used (Wall, J.S. and William, M. Ross, 1970).

Fermentation products from ground sorghum grain has been successfully used to produce citric acid, lactic acid, antibiotics, etc. (Cadmus et al., 1966).

According to Senti (1965), in the USA, over 160,000 tons of sorghum and maize flour were used as adhesives plywood, manufacture of gypsum wall boards, foundry binders, paper and in pulp. Starch from cereal products have been found to perform a number of functions in mining and related industries. For example, of refining aluminum from bauxite ores utilizes large tonnages grain of sorghum flour. Dry-milled sorghum products have been employed in paper making as coating adhesives (Jones et al, 1966). Grain sorghum starch is almost identical with maize starch in properties and therefore has similar uses, such as in the paper products, laminating and corrugating; bakery, confectioneries and other food uses; in textile manufacture and laundries. Dextrose identified from sorghum and maize starch is also known as glucose. It is used primarily as an ingredient in foods.

The potential of forage sorghums for animal feed has not been fully developed in many countries of Africa. In the semi-arid regions, as livestock production is transformed (due to population pressure and shortage of land), from nomadic to sedentary system, the utilization of forage sorghum as feed is expected to increase.

Constraints and Research Challenges

(i) The development of high yielding sorghum and maize cultivars for malting and brewing.

In general, the characteristics of the future cultivars should include: high malt extraction yield, low in fat and polyphenols (tannins); low gelitinization temperature, fast water absorption rate, high amylase activity and medium to soft endosperm.

The development of such miracle cultivars requires multidisciplinary research teams, consisting of plant breeders, brewers-biochemists, agronomists, physiologists, socio-economists, food technologists, etc. Since no single NARS and IARC would be able to generate technology of this nature alone, collaborative effort between several research institutions, universities and industry is of paramount importance.

In the mean time, a new generation of improved sorghum and maize cultivars exist, that could be screened for various industrial uses. In case of sorghum, ICRISAT and NARS have identified some white grain short cycle (90-

100 days), non-photosensitive, cultivars relatively drought resistant and high yielding (2.5 to 3.5 ton/ha). Some of these include: (i) the varieties S-35, CS-95, CS-54, CS63, etc. from Cameroon; (ii) the varieties IS-76, 2Kx17, IS8595, KAT 369, etc. from Kenya; (iii) the varieties KSV-series, SK5912, HQSV, local cultivar Farafara, etc. from Nigeria; (iv) the varieties Gambella 1107 known also as E-35-1, IS9302, Bakosmash 80, Melkamash, Dinkmash, etc. from Ethiopia; and (v) CSM 388, Malisor-84-7, CSM63, etc from Mali (SAFGRAD Phase II Report, Menyonga et al., 1987, Ndambuki, F.M. 1992). Rooney, L.W. (1991) observed that variety Dorado produced the best malting regarding B-amylase activity; followed by Sureno and Malisor 84-7.

Several improved maize varieties and hybrids are also available in main countries. For example, the variety TZB in Nigeria, the variety Okomasa in Ghana and SR-22 in Burkina that could be of interest for various industrial uses.

(ii) Cultivars with high extration rate of quality flour and production of grits and also suitable for bakery industry.

In addition to the development of suitable cereal cultivars for infant weaning foods and for the bakery industry, the improvement of the milling techniques could increase the rate of quality flour extration from sorghum and maize.

(iii) Seed Production.

An efficient seed production system is crucial for enhancing any agricultural development. Lessons learned in the past three decades, have been that, several countries did face difficulties for developing a viable seed industry. The problems encountered were both institutional and technical. Donors have also contributed to failures of national seed production systems, not only by building cumbersome and unsustainable seed processing infrastructures, but also through the direct transfer of technology without due consideration of local environment, socio-economic conditions, seed production scheme, distribution, etc. As a result, several parastatal seed companies had to phase out as soon as donor contribution was withdrawn. Accurate statistics of seed production in various countries is virtualy lacking. Annexes 1 and 2 indicate seed production of sorghum in Kenya and Mali, respectively.

Cereal-based agro-industries should also be supported by a quality seed source and production. Collaboration between the national research system and industry could stimulate the multiplication of adequate breeder or parent seed. Farmers could then be contracted to grow quality seed, which could be used for larger scale production. This system of seed production will ensure that enough raw material of the right varieties and quantity is produced, for example, for breweries and food industries.

(iv) Constant supply of raw material.

In the West and Central African semi-arid region, food grains constitute about 70% of the staple food. In Eastern Africa, nearly 4 million tons of sorghum grain is produced annually on about 6 million hectares. Finger millet is the dominant millet type grown in Eastern Africa, particularly in the dry areas that are usually unsuitable for sorghum production. There is also limited production of pearl millet in this region. The total area devoted to the production of millets approximates 2 million hectares, with a total annual grain yield of just over a million tons.

Maize is the most important crop in Eastern and Southern Africa, where it constitutes the major staple food crop. There has been an increase in maize production in West and Central Africa during the last two decades: this has been accomplished mainly by the expansion of production areas rather than by improvement of average yield due to the use of better technology and improved agronomic practices. West and Central Africa account for only 15% of total production of maize on the continent. In this region, over 50% of the maize is produced in the northern Guinea savanna. Because of the availability of suitable technologies, maize cultivation has gradually moved into the Sudan savanna which at present produces about 20% of the total output (SAFGRAD Phase II Report 1991).

Prior to the establishment of a brewery or food industry, there is need to assess the supply and demand of these cereals within the market. Any successful industrial operation of this sort requires an adequate and constant seed supply of clean, high quality grain. A well defined grain acquisition programme and an adequate cleaning system are essential. Provided credit is made available for some level of inputs, and a reliable market is assured, farmers will substantially increase production of sorghum and maize.

Furthermore, contract growers could produce quality sorghum and maize as raw material for industrial utilization.

Research Policy Orientation to Enhance the Development of Cereal-Based Agro-Industries.

(1) A demand-driven approach for allocation of research resources.

Under the conventional research system, identification of research priorities and allocation of resources, for example, in crops improvement and production research has been based on the importance of the commodity as staple food, or of its economic importance as export crop. Thus, research has often been geared to alleviating, major constraints that impede production and productivity of crops and livestock commodities, but not to diversify their utilization. First of all, there is little evidence that research attention was given to solve problems of cereal-based agro-industries.

The demand-driven approach places emphasis on the economic and market demand for the commodity or its by-products by establishing close linkage between production and income generation, which is essential for food security and economic growth. Focusing our discussion on the objectives of this symposium, some important research criteria for allocation of resources to enhance cereal-based industries are outlined below:

(i) Is there any demand for the commodity or for its by-products, for example in brewerying, nutritious infant weaning foods, etc in the domestic and export markets? This can be established through rapid appraisal market surveys or detailed feasibility studies.

(ii) Has the commodity or its by-products the potential to generate jobs and revenue?

(iii) As a consequence of the diversified use of the product, could national food security be attained? It is expected that production of the commodity such as sorghum, maize, millets, etc. and their by-products would increase because of the market demand created.

(iv) Is there potential growth of a multifaceted agri-bussiness as a result of the development of the commodity. For example, in the case of brewery: distribution and sales of beer, purchase of inputs to enhance production of cereals for food and industry.

In the case of seed production (i.e. sales and distribution of hybrid and improved seeds of various cereals; distribution and sale of fertilizer, etc.).

The research agenda in the 1990s, thus, should not be limited in scope just to increasing agricultural production, but also to generation of technologies to enhance diversified utilization of commodities.

(2) Conducive policy environment for research.

The policy making body and management of NARS vary considerably. In some countries, the national agricultural research systems under the supervision of a "Council" comprised of various development, planning and finance ministries as in Burkina Faso. Other NARS operate under a "Board of Governors" or Directors, as in Ethiopia and Kenya. Few of the NARS are managed by a "Supervisory Committee" comprised of technical ministries and research agencies including universities, or technical committees comprised of senior researchers and policy makers, as in Cameroon, Ghana and Mali (Sanders, J.H. et al., 1993).

The above are examples of the variations governing NARS policy guidance, and management, most NARS, however, have highly centralized administration. In recent years, agriculture research funding have become even more dependent on donor funding, which is not sustainable. What is encouraging, however is that several countries already have taken radical reforms to improve their capabilities in the identification of research priorities, development of short and long-term plans, etc. In general, modernization of the research environment needs to include:

- Establishment of conducive research policies, including research statutes with adequate allocation of funds and competitive salary-scale benefits to attract scientists so that they can make research their long-term careers.

- Recognition of innovative and highly productive researchers at national level through periodic evaluation of research output and technology diffusion. Special prizes, merit awards, promotion, and salary increases could be provided to more deserving scientists.

- Encouragement of technical publications in professional and national journals, technical bulletins, and leaflets for extension and farmers' use. Such scientific tradition, i.e., building the knowledge base through publications should be encouraged.

Introduction of the system of competitive research grants which could motivate NARS researchers not only to increase research output but also to be creative, with major concern to transfer results to end users (farmers, private agencies, industry, etc).

(3) Funding.

Governments allocations have been the major source of funding for public research institutions. In the past twenty years, there was a two-to threefold increase in the number of researchers and tripling of the number of technicians, particularly in relatively more developed NARS. However, funding increases has not been commensurate with the expansion of programmes and personnel increases. Hence, expenditure per scientists have continuously declined. Conducive research policy by governments could diversify sources of research financing as follows:

(a) Establish a national and donor-funded competitive research grants system to stimulate creativity and enhance output.

(b) Encourage the private sector and parastatals to finance research of commodities of their own interest, by providing incentives such as tax breaks.

(c) Facilitate contractual research arrangements between the private sector and public research institutions. Export crops such as cotton, coffee, rubber, etc. are more attractive to receive research support from revenues generated. In most francophone Africa, cotton research direcly, or indirectly is financed by the industry. For example in Côte d'Ivoire, (Eponou 1993); The "Compagnie Ivoirienne de Développement Textile (CIDT), the Ivorian cotton development agency, has signed a financial agreement with the industrial crops department of the Institut des Savanes (IDESSA), the regional research institute. Through that agreement, IDESSA provides CIDT with technical research backup.

Funds for cotton research and technology development were provided by CIDT from revenue generated from cotton sales. As a result of such a research contractual agreement, relevant technologies were delivered to small producers. This tripled cotton yield over the last 30 years in the savannah zones of Côte d'Ivoire".

(4) Accountability.

Accountability attaches specific responsibility to ensure that resources provided to research have brought benefits. It calls for transparent accounting and financial management systems, enhances competitive research grants and contracting that make researchers and programme leaders more directly responsible and, inturn, accountable for the support they received.

CONCLUSION.

(a) The challenges of cereal improvement in the 1990s and beyond should not only be based on enhancing food self-reliance and security, but also on generation of technologies that could lead to diversified industrial utilization.

(b) New generations of improved sorghum and maize cultivars do exist. These should be screened for various agro-industrial uses.

(c) Collaboration between industry and public research institutions is crucial in order to reorient research efforts towards solving problems of cereal-based agro-industries.

(d) Allocation of research resources should be demand-driven, which places more emphasis on the economic and market demands of the commodity or technology, including the potential to generate jobs and revenue.

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Annex 1. Sorghum Seed Production Trends in Kenya.

YEAR	Production			Seed Production of Improved Varieties in MT.*	
	In 1000ha	In 1000MT	Yield kg/ha	Brown Seeded Varieties	White Seeded Varieties
1982	-	-		74,645	21,211
1983	114.8	100.74	877.5	33,475	11,223
1984	168.0	111.0	660.7	58,926	58,926
1985	168.0	111.0	660.7	36,350	12,649
1986	168.0	160.0	984.0	161,795	7,805
1987	138.44	105.18	762.2	182,811	3,044
1988	143.90	115.12	800.0	224,520	NA
1989	156.04	139.43	893.8	46,208	94,445
1990	116.30	101.59	875.8	220,085	52,389
1991	110.09	97.55	878.8	NA	NA

* Up to 40 tons of seed produced is sold locally, the remaing amount from 50 to 280 tons of seed has been exported.
Source (1) Kenya Seed Company Limited.
Source (2) B.M. Kanyenji (1992) Status of Sorghum and Millets as a Food Crop in Kenya pp. 27.
Up to 40 tons of the sorghum seed produced is sold locally. Surplus improved seed has been exported to neighboring countries.

NA. = Not Available.

Annex 2. Seed Production of Improved Varieties of Sorghum in Some Villages of Mali 1991/1992.

Zone	Village	Variety	Seed Multiplied in Tons	Total in Tons
MOPTI	Madiana	CE-151 CSM63	5.370 7.111	12,481
ODIPAC	Yarangabougou	CSM63	36.274	
	Forogoubougou	CSM388	10.629	
	Baleani	CSM388	8.154	
	Danabougou	CSM388	36.500	91,557
SEGOU	Tonzougou	CSM63	11.462	
	Kelle	CSM63	12.653	
	Badibougou	CSM63	2.280	26,395
OHV	Sougoula	CSM388	11,462	
	Kolié	CSM388	12,653	
	Sikou	CSM388	22,940	
	Tomba	CSM63	15,800	
	Foncebougou	CSM63	21,200	114,345

Source : OAU/STRC-SAFGRAD Networks Impact Assessment Study Unpublished data (1992)

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