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Seminar on the Production and Use of
Composite Flours in Baking Industry

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FROM THE CONCEPT OF COMPOSITE FLOURS TO INDUSTRIAL AND COMMERCIAL APPLICATION AND BEYOND

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Composite flour has been tried in many African and non-African countries with different degrees of success. The key problems to be solved for a successful composite flours programme in Nigeria are: the raw material production at a competitive price, the co-operation of the millers and bakers, the training of the bakers and the wheat price policy.

It should be borne in mind that all the efforts made by breeders, scientists, technologists and equipment manufacturers will be in vain if the politicians do not appreciate issues at stake and do not change their attitude as far as cereal policy, agricultural development and redistribution of incomes are concerned.

INTRODUCTION

1. First and formost, it should be noted that at present Africa is not one of the major wheat producing areas of the world. However, a number of African countries are faced with the rapidly growing problem of satisfying the ever increasing demand for wheat and wheat products, particularly, bread. For example, imports of wheat and wheat flour into Africa have been rising at an average annual growth rate of 11 per cent in physical terms, from 4.5 in 1970 to 16 million metric tonnes in 1982; and at an annual rate of growth of 21.7 per cent by value, from US 319 million in 1970 to US 3364 million in 1982.

2. The magnitude of change for the entire continent is less than that of Nigeria where the wheat imports have been rising at a higher average annual growth rate of 14.6 per cent in physical terms, from 267,000 in 1970 to 1,375,000 metric tonnes in 1982; and at an annual rate of growth of 22.2 per cent by value, from US$22.3 million in 1970 to US$244 million in 1982. Nigeria imported in 1982 41 per cent more wheat per capita (17 kg.) than the per capita import for Africa South of the Sahara (12 kg.) and consequently disbursed US$3 per capita against US$2 for Africa Sub-Sahara for wheat.

3. Against the above level of consumption, Africa produced in 1982 7.6 millions metric tons of wheat 4 per cent of which came from the six North African countries. Countries South of the Sahara produced only 16 per cent, and from as few as the following countries: Ethiopia (8.5 per cent), Zimbabwe (2.4 per cent), Kenya (3.3 per cent) and Tanzania (1 per cent).

4. Nigerian wheat production is insignificant: 20,000 tons in 1970 and 25,000 in 1982 corresponding to 0.3 kg. per capita for a consumption requirement of 17 kg. per capita in 1982.

Table 1: Production and Imports of Wheat

	Q: 10^3 mt V: 10^6 $	Imports				Production			
		1970	1982	Growth rate %	Per caput 1982	1970	1982	Growth rate %	Per caput 1982 (kg)
Nigeria	Q	267	1375	14.6	17 kg	20	25	1.9	0.3
	V	22	244	22.2	3 $				
Africa	Q	4552	15994	11	34 kg	6442	7612	1.4	16
	V	319	3364	21.7	7 $				
Africa South of Sahara	Q	1644	4086	7.9	12 kg	1105	1261	1.1	3.6
	V	134	816	16.2	2 $				
North Africa	Q	2908	11908	12.5	103 kg	5337	6351	1.5	55
	V	185	2548	24.4	22 $				

Source: FAO Yearbooks

5. Bread has become an increasingly important part of the diet of the Nigerian population. The increase in consumption can be attributed partly to the population growth in general and to the growth of population in urban areas where bread has become a staple food for the low income sector as well. This situation has compelled the country to import increasing amounts of wheat, affecting adversely the balance of payments.

I. POLICY OPTIONS AND MEASURES TO REDUCE WHEAT IMPORTS

6. In order to curtail the drain on foreign currency, the Government should explore all feasible alternatives. The question is: How to reduce or stop the wheat imports while providing for the consumers the required quantities and qualities of food products similar to wheat products ?

1.1 Fiscal Measures

7. In simplifying to the extreme, one could wonder if wheat (particularly bread) is absolutely necessary in the national diet. The response is negative for a country where the entire requirement is imported and is a relatively new food item which is enjoyed by only 30 per cent of the population. For example an inquiry carried out in Senegal in 1979-1980 indicates that even in Senegal where bread consumption is the biggest in South Sahara Africa, only 30 per cent of the population consume this item daily (per capita consumption in Senegal is 20 kg worth in 1982). Therefore only a small proportion of the population would suffer if the government were to stop entirely the importation of wheat or to levy a heavy tax on it in order to reduce consumption.

8. In the hypothetical situation where wheat importation is stopped, the likely reaction is that the wheat consumers will forget wheat and substitute traditiional food. But where wheat is indispensable then the alternatives will be either production locally or the innovation of a suitable substitutes.

1.2 Promotion of the use of traditional food

9. The first case leads to the development of food crops and to the improvement of traditional food technology in order to feed the urban and rural growing populations

with good quality quick cooking and ready-made indigenous foods instead of imported products. The first step in this direction is to obtain good quality flours out of local cereals, legumes roots and tubers. A better knowledge of the raw materials will be needed (biochemical composition, histology, functional property of constituents, etc.) and also a better knowledge of the quality factors of the traditional kitchen recipes, in order to help the breeders in obtaining improved plant material adapted to industrial uses. Dr. Subramanian and his team of biochemists are working hard at ICRISAT in this field, in collaboration with other research Institutions.

1.3 Prospects for using local single flours in bakery industry

10. Scientific works on non-wheat flour baking with pentosan were led by Prof. Dr. J.P.J. Casier, from the Department of Food Science and Technology, Katholieke Univerteit Leuven Belgium.

11. From the pure flours of several starchy tropical crops and their starches, as well as from blends of several of them, good textured loaves were baked from liquid doughs, using 2-4 per cent waterinsoluble, industrially prepared endosperm pentosan of rye, a powerful "universal baking factor". Additional of protein sources, as defatted soya flour, skimmed milk powder, produces a positive effect on bread quality, i.e. shelf life, crumb coherence and even on the loaf volume. The pentosan action is explained by the hypothesis of a CO_2 gas-retaining network formation in the dough through interaction of pentosan with the surface layer of the swollen starch granules.

12. In October 1979, the first African pentosan baking-trial-project was started in Lomé, Togo in co-operation with the French "Bureau pour le Développement de la Production Agricole BDPA, Paris", using 100 kg of pentosan; Loaves were baked from sorghum, white corn and cassava flours, using 1 per cent pentosan, 0.5 per cent dry yeast,

0.5 per cent margarine and 1 per cent sucrose. 100 kg of industrial pentosane allows production of 16 ton of bread and 600 g flour gives 1 kg loaf. Up to December 1980, baking was continued by the local people only, the loaves being sold 10 per cent cheaper than wheat bread to the population and hotels.

13. Nevertheless, the use of pentosan to bake non-wheat flours is rather new and no industrial/commercial application is recorded so far and the research continue. According to a personal enquiry carried out end July 1981, in Lomé, pentosan bread has not been fully accepted by the consumers. The Togolese authorities are now directing their efforts towards the use of composite flours.

14. Other studies at the Institute for cereals, flour and bread TNO, Wageningen, Holland, have demonstrated that wheat gluten can be entirely replaced by other substances which also serve to bind starch particles together into a cohesive structure. The "binding" substance most used by the TNO workers is commonly called glyceryl monostearate (GMS). In the presence of GMS a starch-water mixture can be mixed to the consistency of a dough which is capable of retaining in fine dispersion the carbon dioxide generated by yeast from sugar. This dough will rise and when baked produce loaves which, though somewhat different in overall appearance, display properties similar to those of conventional bread.

1.4 Growing wheat in tropical conditions

15. The second case, which does not exlude the first, consists of growing wheat under tropical conditions. This is no more a dream since new findings in molecular biology and progress made in the manipulation of gene expression (protoplast fusion) will probably allow the development in the future of new plant varieties, like wheat resistant to high temperature and drought, or sorghum/millet/maize with gluten.

1.5 Production of a synthetic gluten

16. The protein of wheat endosperm is possessed of unique qualities. When it is mixed with water it forms a cohesive rubbery mass commonly called gluten. It is this distinctive property of wheat gluten which makes possible the production of bread dough, the viscoelastic mass which can be stretched, moulded into countless shapes and which will "rise" as its entrapped gases expand. Equally important, when the dough is heated during baking, the protein coagulates and the starch is gelatinized to yield the spongy and variously crusty objects known generally as "bread".

17. The production of a synthetic gluten having all the properties of the natural wheat gluten will solve the problems faced in baking of non-wheat flours. Unfortunately the production of a synthetic gluten would not be possible because of the high cost of the amino acids present in gluten and the lack of knowledge of gluten. The number of "tailoring" agents (monoglycerides; methylcellulose, sucro-glycerides and calcium stearoyl lactylate) is relatively small and all the known functional properties of wheat gluten are not taken care of by one or all of these "tayloring" agents. Special effort should be made to identify and measure the various functional properties of wheat gluten so that replacements for them could be developed. Only after that it will be expected that bakery products could be produced similar to wheat products.

1.6 Extending the utilisation for bread of available wheat - Increasing the extraction rate of wheat flour

18. An important parameter in flour processing is the extraction rate which is the yield of flour as a percentage of the whole grain. Wheat flour extraction rate of 75-80 per cent is conventional in Nigeria, corresponding to the type of bread consumed in the country. A higher extraction rate (for instance 95 per cent) to

produce a likely whole wheat bread will lead to foreign currencies saving of 15-20 per cent. The problem will be to convince the population to consume brown bread instead of the actual white color bread.

II. PROMOTION OF THE USE OF COMPOSITE FLOURS

19. Even though the six approaches are considered feasible for modifying the dependence on wheat imports, the use of composite flours is the best short-term alternative and this seminar will concentrate its work on the ways and means to implement successfully a composite flour programme in Nigeria.

20. The growing popularity of wheat products, particularly bread, in many developing countries continues to increase. Since the major suppliers of wheat are located in hard currency zones, this expanding demand for wheat and bread is tending to create balance of payments difficulties. Many of these wheat producing countries are capable of producing other cereals such as sorghum, millet and maize, or roots such as cassava in substantial quantities. It therefore appears logical in such countries to attempt to replace, at least in part, imported wheat flour by other flours which are locally available.

2.1 Results of research and development

21. Considering the above, the aim of the FAO Research Programme on Composite Flours initiated in 1964, has been to determine through intensive research whether it is possible to produce a wide range of acceptable, high quality, nutritious bakery, confectionery and pastry goods, from flours and starches other than 100 per cent wheat.

22. Since its inception in 1964, the research in this Programme has been conducted by the Institute for Cereals, Flours and Bread TNO, at Wageningen in the Netherlands.

In 1967, new studies were started in the laboratories of the British Arkady Co. Ltd. in Manchester in the U.K. Early in 1970, the Department of Grain Science and Industry of Kansas State University, Manhattan, U.S.A., offered FAO its experience derived from several years work in the utilization of special additives for the production of high protein bread.

23. Further field work was conducted in many other countries including Senegal on millet (1967-1974), Sudan on sorghum (1974-1980) in collaboration with FAO, Andean Pact countries (1967-1978) and Brazil.

24. In addition, the technical problems involved in the making of bakery products with composite flours containing high proportions of non-wheat flours have also been overcome through the development by the food industry of new emulsifiers and other additives that have been found to perform some of the functions of gluten in doughmaking and the baking process.

2.1.1 Milling

25. A composite flour programme will only be possible if the milling industry is able to produce high quality flours from non-wheat materials in sufficient quantities. It is now possible with the recent progress made by the equipment manufacturers and the R & D Institutions. The first important characteristic of the flour is the particle size, which should be almost the same as that of the wheat flour, and should preferably be smaller than 130 micrometres to prevent segregation during blending, transportation and storage.

Cassava flour

26. The most difficult operation is the industrial peeling of the cassava tubers. The problem has been successfully solved by the "Societe Ivoirienne de Technologie Tropicle, 1"

I2T". This Institute, starting its Research & Development Programme from "Bertin" cassava factory, has developped a very reliable advanced technology for the industrial peeling of cassava and its processing into flour. The efficiency of the peeling is higher than that of the hand-peeling process.

27. The peeled tubers are washed, coarse crushed, dryed, milled, sifted and packaged. In the Toumodi plant in Ivory Coast, the production cost in March 1985 is of about FCFA 130/kg of flour, equivalent to US$0.29.

Cassava starch

28. The peeled tubers are chopped into pieces and then rasped into a pulp. To avoid microbial contamination of the material, a solution of sulpur dioxide obtained by burning raw sulphur is added to the rasped mash to make a concentration of 0.05 per cent. The acid is subsequently washed out with clean water during the purification stage. To extract the starch, the pulp is washed over a series of sieves with increasing fineness, using a spray of water. The wet waste-pulp is dewatered, dried and used as fodder.

29. Crude starch milk is passed through a sand cyclone to remove sand and other dirst particles. The material then passes through two successive centrifugal separators in which soluble contaminants are removed from the pure starch. The wet starch is filtered with a vacuum filter. The moisture content of the material is 40-45 per cent. The mash is then dried to a final moisture content of about 10 per cent in a flash-drier at a temperature of 50°C. Dry starch powder is sifted and packaged. Production cost is about US$0.70/kg in 1985.

Sorghum/Millet Flours

30. The commonly understood criteria for sorghum/millet flour are colour and fineness. To achieve these, it was found that a decortication rate of 25-30 per cent will give good flour for breadmaking. A variety of dehullers are available although all of these use the same principle. The grain is brushed by carborandum stones, emery or by metal knives. The bran is separated by 0.50 - 1.00 mm seives as fine powder and dehulled grain is ready for grinding. Dehulling is the key operation in sorghum/millet milling.

31. The decorticated grain is pulverised into the desired granulation according to the end use. Fine flour can be obtained by attrition mills or hammer mills using fine seives. Although conditioning and tempering has deleterious effect on the flour colour, it was noticed that higher moisture content of the grain resulted into finer flour (70-75 per cent extraction).

32. Maize milling into baking flour is well known.

2.1.2 Flours blending techniques

33. Wheat and non-wheat flours can be blended in a suitable vertical cone mixer or in a horizontal drum mixer. SENTENAC (100T/day wheat flour mill in Dakar) evaluated the required investment for mixing wheat and millet flours at CFAF 45 million (US$ 225,000) in 1980.

34. Other alternative for blending flours is the direct milling of wheat plus dehulled sorghum/millet, polished rice or corn grits. The direct milling technique has been designed by Antonio Amoroso for the "Grands Moulins de Dakar" and the system operated successfully during the period of production of "Pamible" in Senegal. This

line was also set up in Colombia for the formula 80 per cent wheat 17 per cent rice and 3 per cent soya. The additional equipment required is the dosifier and the reception bin.

35. Details of machinery manufacturers able to provide turnkey factories for cassava and sorghum/millet processing into baking flour are in Appendix 1.

2.1.3 Bread from composite flours

36. The results achieved are worthy for industrial and commercial applications. On the basis of this, the Fifth Conference of African Ministers of Industry, held in Addis Ababa in October 1979, requested each African countries to establish as soon as possible a National Composite Flours Programme (NCFP).

37. In the simplest method of making bread, flour, salt, water and yeast are mixed together until a dough is formed. The dough is allowed to ferment for several hours, during which the dough rises as carbon dioxide gas is generated by the yeast cells metabolizing fermentable sugars present in the flour. During this "bulk fermentation period" certain sparsely understood changes take place in which the dough becomes more extensible. Bread baked from adequately matured dough displays, generally, larger volume and a finer crumb structure than bread baked from unmatured doughs. After fermentation, the dough is divided and moulded into predetermined sizes and shapes, allowed to rest or "proof" for perhaps one hour, then baked. This basic procedure, which has been deliberately oversimplified in the description, is capable of many variations in ingredients, manipulation and baking.

38. As we all know, the wheat flour used is the most critical ingredient and, in conventional systems, the quality of bread is largely a reflection of the quality of the wheat flour from which it was made. While wheat starch plays an important role, it is the quality and quantity of the gluten-forming protein present which determines whether the loaves will be large or small, coarse or fine grained, firm or fragile.

39. In the simplest binary classification, wheats are categorized as "strong" or "weak", the terms being literal reflections of the gluten quality. The strongest commercial wheats are grown in North America. These wheats are high in protein which will absorb comparatively large amounts of water to form strong doughs able to retain large quantities of gas and expand to produce loaves high in volume. Outside North America, these strong wheat flours are customarily blended with weaker wheats which may be grown locally or purchased more cheaply from other regions.

40. It therefore seemed possible that one might dilute the strong wheat flours of North America with nongluten forming cereal and root flours/starches. It is demonstrated that highly acceptable bread could be made using up to 15 per cent of any non-wheat flours. Higher protein wheat flour can definitely "carry" more of the nonwheat flour than the medium protein wheat flour.

41. It is also technically possible to increase the non-wheat flour level considerably above 15 per cent without too great a change in bread characteristics, provided certain bread improvers, such as Calcium Stearoyl Lactylate (CSL), Glyceryl Monostearate (GMS) or Diacetyl Tastaric Acid esters are added, or a relatively high percentage of fat and sugar is used.

42. Bread of good quality can be obtained by the use of the formulae in Appendix 2 requiring simple and common breadmaking equipment and procedures.

2.1.4 Other bakery products

(a) Biscuits

43. For the production of biscuits by the moulding or depositing processes, a composite flour consisting of 80 parts of non-wheat cereals or cassava and 20 parts of soft wheat can be used. For the production by the cutting process, a substitution of 20 per cent is recommended. Even 100 per cent local flour can be used in biscuit making.

(b) Flour confectionery products

44. In general, composite flours consisting of 70 parts wheat plus 30 parts non-wheat materials can be used for the production of flour confectionery, such as cake.

(c) Pasta products

45. From composite flour consisting of 70 parts wheat flour, preferably durum wheat flour, and 30 parts of white sorghum or white maize flour, it is possible to produce pasta products with very acceptable colour and cooking characteristics and taste. Higher substitution of wheat flour is not advisable because the product becomes too sticky after cooking. The processing is carried out in the existing pasta factories without modifications of equipment.

2.1.5 Pearl Dura

46. Pearl Dura, a polished sorghum, was developed by the FRC in Sudan. It is normally decorticated to 60 per cent extraction rate; from the remaining part, the fraction between 60-80 per cent is used as flour and the rest as bran. It is an

attractive ready-to-use product, similar to rice. It is cheap to produce, costs about one-third of the price of rice in the Sudan and good in taste. It needs more water in cooking than rice and increases in volume 5-6 times compared with only twice for unpolished grain. Nutritive value is comparable with rice. The acceptability tests carried out in Sweden by a commercial food chain-test kitchen gave a good appreciation. Similar result was obtained from replies over 200 questionnaires in the Sudan.

III. COMPOSITE FLOUR EXPERIENCES

47. The FAO's "Food and Agricultural Industries Service" initiated in 1980 a broad inquiry in "Realisations and Consequences of the Composite Flours Programes (CFP)" in the World. More than 80 R & D organizations in 45 industrialized and developing countries answered the FAO questionnaire regarding their research work and project achievements.

48. To the question: "How many research works or development projects have reached the stage of a permanent commercialization of composite flours products", the analysis of 78 responses showed that:

- in 54 cases, researches were interrupted before the stage of commercialization
- 15 projects were still in course of development
- and 9 projects had been concluded with a temporary or definitive commercialization of end-products like bread, biscuits and pasta.

49. Among the latest, only three research projects undertaken by private firms or under private contracts have reached the stage of a permanent manufacturing of bread and pasta

products containing 30-40 per cent of non-wheat flours (Bolivia, Colombia and Thailand). Furthermore, a small quantity of bread containing 15 per cent of millet and 20 per cent of sorghum is produced daily by the "Food Technology Institute in Dakar and "Food Research Centre" in Khartoum.

50. But it must be said that in many countries (in Latin America and in South-East Asia), the addition of 2-10 per cent diluent like rice, cassava, maize flour ..., is commonly done by millers or bakers when the diluents become available at a favourable price. A good example of this practice is illustrated by the case of Colombia; in 1975, the Government cut off the subsidies on wheat imports, so that wheat flour price rose suddently from 7,000 to 13,300 pesos/m.t. (202 to 384 US$/t). As expected the millers blended wheat flour with various percentages of broken rice flours, whose price was 3,800 pesos/m.t. (US$110/t).

3.1 In Africa

SENEGAL

51. The 'national cereal policy' aims at increasing production and reducing imports and the Institute of Food Technology (ITA) Dakar, assisted by FAO, developed 'millet bread' ("pain de mil") (70 per cent wheat flour + 30 per cent millet flour) and "Pamible" (85 per cent + 15 per cent). ITA then trained the 240 bakers in the country in the technique of baking with composite flour. To ensure consumer acceptability the Government decided to begin with 15 per cent millet flour (Pamible) and increase over time to 30 per cent. It made Pamible production and sale obligatory by decree No. 79-665 of 7 July 1979. The goal of 30 per cent millet flour, at the present time, would mean reducing wheat imports annually by 20 400 MT of flour (or 27 000 MT grain) corresponding to a saving of about CFAF 1 billion in foreign

exchange versus CFAF 500 million for the present Pamible. ITA also developed the techniques of baking products other than bread: cakes (50 per cent wheat flour + 50 per cent millet flour) biscuits (20 per cent + 80 per cent), commercially produced "couscous" (100 per cent millet flour) and soya-enriched flour for weaning.

52. At the millers' level a price 'balance' is achieved by subsidising millet flour and selling at less than cost - and taxing the imported wheat. The wheat tax balances the millet subsidy.

53. Unfortunately, millet production in 1980 was insufficient and the flour-mills could not be supplied. It was the end of the commercial operation.

BURKINA FASO

54. In order to reduce wheat imports the Grands Moulins Voltaiques (GMV) launched the "Blegho" operation (30 per cent sorghum flour + 70 per cent wheat flour) in 1974, including the bakers' training. "Blegho" was readily accepted by the consumers though its volume was a little less than the 100 per cent wheat bread loaves (at the same weight).

55. The Blegho operation stopped in 1975 because of lack of sorghum at a lower price than wheat. Nevertheless, Blegho remains an important experience for the future.

IVORY COAST

56. The Ivory Coast has some experience in the composite flour field. In conjunction with the pilot cassava processing plant at Toumodi the new "Societé Ivoirienne de Technologie Tropicale" (I 2 T) carried out composite bread trials - 15 per cent of cassava flour with wheat flour - successfully. In addition the first trials carried out by the

former "Institut de Technologie et d'Industrialisation des Produits Agricoles Tropicaux" (ITIPAT) together with Buhler (Switzerland) showed that it was possible to incorporate without reducing bread quality - 15 per cent maize flour specially milled for that purpose.

GHANA

57. There is increasing interest in composite flours, but activity is at the research level in the Food Research Centre (FRC) and the Department of Nutrition, Food Science and Technology (University of Ghana, Lagon) - both of which have produced scientific papers on various aspects of composite flours development. Bakers are very keen to use composite flours as far as the local flour is available at an acceptable price. They even use gari as diluent of the wheat flour.

BENIN

58. Two types of infant/weaning food based on composite flours have been developed with FAO assistance and are commercialized throughout the country. The market price is FCFA 100/250 g.

First formula: Maize 57 per cent, Rice 29 per cent sorghum and sugar 14 per cent.

Second formula: Maize 27 per cent, sorghum 27 per cent, Beans 20 per cent, Groundnuts 13 per cent, Sugar 13 per cent.

Nine tons of this infant food have been produced in 1981 to cover part of the urban needs. Government envisages to set up production unit in each province.

TOGO

59. A project document on composite flour development is submitted to the Government end 1984 for consideration and decision. Trials on pentosgan breadmaking has already been mentioned.

CAMEROON

60. Sorghum, millet and maize flours, when cheaper than wheat during harvest period of the year, are currently used (illegally) by bakeries to dilute wheat flour. Official discussion on a Cameroon National Composite Flour Programme started in 1982 and the creation of a National Commission on Composite Flours is envisaged to co-ordinate all the related activities.

CONGO

61. During the Regional Workshop on Composite Flours held in Dakar from 6 to 11 December 1982, the representative of Congo reported that his Government has put in the new Economic Development Plan a feasibility study on Composite Flours development in the country.

ZAIRE

62. Six tons of composite flour bread (maize 25 per cent, wheat 75 per cent) are produced per year since 1982 in the Agro-Food Research Centre of Lubumbashi in the Shaba province. The bread is sold to the staff of the Centre.

KENYA

63. Although successful research has been achieved by Kenya Industrial Research and Development Institute, official discussions did not lead to the concrete establishment of a National Composite Flour Programme.

TANZANIA

64. There are three separate composite flour research activities in the country:

- the Food Science and Technology Department of the University of Dar-es-Salaam at Morogoro is handling a project - "Promotion of Home and Commercial Utilization of Sorghum" (supported by the International Development Research Centre);

- the Tanzania Food and Nutrition Centre (TFNC) continues to work with wheat/sorghum and wheat/cassava composite flours for breadmaking;

- the National Milling Corporation (NMC) has installed a large new sorghum mill at Dodoma to market the flour alone and also the composite flour with wheat for breadmaking (supported by FAO).

BOTSWANA

65. Since 1979 at Gabane, "Pelegano Village Industries" is making bread with up to 30 per cent sorghum added to wheat in a manually-operated bakery and sells the product locally.

SUDAN

66. From 1975 to 1980, the Food Research Centre, through its R & D:

- has adopted and mastered the dehulling technology and the industrial milling of sorghum. Kisra and baking flours are obtained at extraction rates of 75-80 per cent and 70-75 per cent respectively.

- has brought new products: bread, biscuits, chips, cookies, starting from different formulae of composite wheat/sorghum flours. The tests on pasta have also been effected in co-operation with the Institute of Tropical Agricultural Research (IRAT) of Montpellier, France.

- has succeeded in producing "Pearl Dura" as a rice substitute. Sorghum, dehulled and cleansed, losses 40 per cent of its original weight.

67. The sum-total of theoretical knowledge and the practice acquired makes available to FRC a valuable technique and experience which can easily be extended to the industries to commercialise the results of the research for mass production. Composite flour (wheat + sorghum) for breadmaking and pure flour for Kisra are of immediate industrial application.

68. Activities for the establishment of a national programme for composite flour started in 1982. The use of sorghum for products initially made of 100 per cent wheat poses a problem of competition in terms of price between the two raw materials. Until the beginning of March 1982 grain was subsidised by the Government and sold at about 33 per cent less than its cost price. The Government decided to cut this subsidy as it has just done for medicine, sugar and petrol so that sorghum would become competitive with wheat.

69. On Thursday, March 4, 1982 an interministerial meeting (Commerce, Industry, Finance, Economic Development, Agriculture, Energy and Food Research Centre) took the following decisions on for extending the utilization of available wheat:

(a) Government policy had set an 80 per cent ceiling for the extraction rate of wheat flour. This rate will be increased to 86 per cent.

(b) Thought has been given to incorporate finely ground bran to wheat flour reserved for bread making so as to bring the extraction rate up to 96 per cent; by so doing the wheat bread could even become less expensive than that made of composite flour in the ratio of 10 per cent sorghum and 90 per cent wheat flour, extracted at the rate of 80 per cent.

(c) Cutting down subsidy would not necessarily place wheat and sorghum on an equal footing in terms of competition. It was recommended that all wheat (imported at the current price or received as gift) be sufficiently taxed to make composite flour bread 20-30 per cent cheaper than the 100 per cent wheat bread.

(d) FRC recommends organising a preliminary information campaign to prepare the people for the new provisions which will be taken.

70. At least six industrial projects are underway since 1980 to install sorghum mills - alone or in tandem with wheat flour mills - to produce baking quality composite flour. "Arab Mills" project in Khartoum and that of "Sudanese Development Corporation" in Wad Medhani are completed and operating since 1982.

71. FRC's bakery produces 500 loaves of 20 per cent sorghum and 1500 to 2000 buns of 15 per cent sorghum daily and is involved in training industry's bakers. FRC bread is known as the best in the country.

72. It has been learned early this year that FRC will launch soon the National Composite Flour Programme for a mass commercializing composite bread production in the private sector with USAID assistance.

3.2 In Developed Countries

73. Most of the industrialized countries - mainly Canada, U.S.A., Australia and the E.E.C. countries know about composite flours and are fabricating bread and other bakery products with wheat flour diluted with other cereal or non-cereal flours. Maize bread is traditionally made in the North of Portugal and in Yugoslavia. Elsewhere, rye bread is widespread. Composite flours products can be easily found in the supermarkets in London, Brussels, Geneva, Paris and Frankfurt. U;S.A., Holland, Canada and Australia currently provide assistance to Colombia, Mexico, India, Brazil and Korea in the composite flour development.

3.3 Central America

74. In Costa Rica, the commercialisation of biscuits incorporating 10-15 per cent of cassava was interrupted by the high cost of the cassava. In Jamaïca, 160 tons of cassava flour are produced daily for the production of baking composite flour. The operation stopped with the bankruptcy of the Jamaïca Flour Mills consecutive to the high price of the cassava flour. In Panama, a law of 1976 makes obligatory the dilution of 10 per cent cassava flour in the wheat flour. Commercialisation of such bread has been interrupted for inadequate supply and the high cost of the cassava.

3.4 South America

75. Composite flours have been explored from the technological aspect in the five Andean countries (Bolivia, Colombia, Equador, Peru and Venezuela) since 1967. The concept was accepted by different agents involved in the system but a problem arose concerning the availability and price of the substituting raw materials. However,

in 1978, the Andean Projects for Technological Development in the Field of Foods were approved by the Commission for the Andean Pact and one of the projects to be implemented by institutions in the five Andean countries concerned composite flours. Among the experiences, that of Colombia is very successful and led to a definitive and permanent commercialisation of a bread containing 20-30 per cent of maize flour. Composite pasta is also commercialized on a permanent basis.

76. In South America, all countries have food laws for bakery products including composite flour products. In Colombia and Bolivia, addition of maize in pasta is an old practice. Brazil issued a law in October 1973 making obligatory dilution with 2 per cent cassava flour in the bread making formula, and 10 per cent various non-wheat flours in biscuits making. In Chile, composite flour production with quinoa started only few years ago with "ESCUADRON" mill. In Equador, training of industrial bakers, a pre-requisite for the mass production/commercialization, has been completed.

3.5 Asia and Middle East

77. In India, Sri-Lanka and Pakistan, composite flours made of millet, sorghum, rice and chick-peas are well known. In India wheat/maize bread is ruled by law. Comparable law is under study in Thailand where composite flour buns and baby food are already commercialized. In the Philippines, the Republic Act No. 657 constrains the bakeries in the use of composite flour (cassava). The Government of South Korea is studying the dilution of the baking wheat flour with 5-20 per cent of barley while in Sri-Lanka the "State Flour Milling Corporation" and "Prima (cey.)Ltd." envisage to blend wheat (80 per cent), rice (20 per cent) and soya (2-5 per cent) flours in the bread formula.

78. Consumption of brown bread containing sorghum or barley is a food habit in Yemen. In Egypt, Iran and Turkey, the bread contains maize, rye, barley and even potato (Turkey).

IV. STRATEGY FOR A SUCCESSFUL COMPOSITE FLOUR PROGRAMME IN NIGERIA

79. The study on composite flours reveals the various reasons why so many programmes failed to reach the commercial scale and on a national basis. They are the following:

- Economical factors : Wheat price (subsidised or aid) lower than local flours; Overestimation of local exchange rates.
- Political factors : Necessity of providing low cost food to urban populations; lack of interest of the governments for composite flours and agricultural development of staple foods; lack of appropriate cereal policy.
- Agricultural factors : Lack of surplus production due to low agricultural prices. Broad variability of available quantity and quality of agricultural products.
- Structural factors : Lack of storage facilities and processing facilities on industrial level (milling, cassava processing), transport difficulties and lack of efficient trading facilities.

- Human factors : Consumer's acceptability for composite flour products is low; millers and bakers are generally opposed to invest capital or to change their habits for composite flour programmes.

All these factors are more or less interdependent, and many of them may jointly contribute to the failure of a project. A successful composite flour programme should solve a number of problems out of which the production of raw material, the training of bakers and the wheat price policy are crucial.

4.1 Production of Raw Materials

80. At the moment, it exists in Nigeria 9 wheat mills and some others are planned. They are dispersed in the country (Apapa, Kano, Port Harcourt, Sapele, Calabar, Tin Can Island, Kaduna, Ibadan and Maiduguri). More or less, each mill is located in the natural production area of a given tuber or cereal (cassava, maize, sorghum and millet) which can be used as diluents of wheat.

81. Studies should be carried out to indicate clearly how each wheat Mill can produce its own cassava, maize, sorghum or millet in order to secure the production of the composite flour. For instance, the Maiduguri Flour Mills with a capacity of 80,000 tons of flour per year, will be requested to farm directly 35,000 tons of sorghum or 48,000 tons of millet 1/ per year to produce the necessary diluent for a

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1/ Raw material required per ton of flour is 1.33 ton for wheat, 4 tons for cassava, 1.33 for maize, 1.43 for surghum and 2.00 for millet.

good quality baking composite flour containing 30 per cent local flour and 70 per cent wheat flour. The suggestion is feasible, since the Texaco Agro-Industrial Company produces its own cassava on a large plantation to secure a regular supply of raw material to its gari factory. It is proposed that the studies be completed by the end of 1986 and that implementation start in 1987.

4.2 Production of the Composite Flours

82. Feasibility studies will be carried out in 1986 to determine the methods of milling, separately (cassava, maize, sorghum, millet) or directly with the wheat in the wheat mill (decorticated sorghum/millet). Procurement of the milling equipment and installation will be executed in 1987 or 1988 according to the progress made in the production of the raw materials. Specifications of the composite flours will be elaborated by FIIRO.

4.3 Training of the Bakers

83. Staff of all country bakeries will be trained on composite flours baking technologies with the collaboration of the Association of Master Bakers in Nigeria. The recipes will be elaborated by FIIRO for each mill area; for instance, recipe wheat/sorghum will be for Maiduguri area and all bakers in that area will be trained accordingly. The training will take place in 1987.

4.4 Information Campaign

84. While FIIRO will be training the bakers during the year 1987, Government should launch a big campaign to inform the people about the heavy foreign expenses borne by the country because of wheat imports; the population will be advised to find themselves local substitutes for bread or to accept composite bread.

4.5 Wheat price policy

85. Considering the market price of raw material per ton of flour, wheat is by far the cheapest (₦ 266); and then cassava (₦ 480), maize (₦ 798), sorghum (₦ 858), millet (₦ 1200)1/. Can the Flour Mills produce the local materials at cheaper price than wheat ? That is the main problem the composite flour programme should solve at the early stage of its activities or to find acceptable alternative solution knowing that the composite bread, in any case, will be more expensive than the pure wheat bread.

86. The best way to foster the use of composite flour in the bakeries is to make wheat much more expensive than the local cereal and tuber flours. The simplest way to reach that result is to levy a heavy tax on the wheat imports. The new income generated for the Government -may be utilized to assist millers in financing their new activities of raw material production.

87. Government may desire utilizing its new income to subsidize the local flours in order to make them cheaper than wheat. The percentage of tax will be determined accordingly.

88. Other alternative is that the Government can purposely tolerate in the market, the pure wheat bread whose flour will be heavily taxed to subsidize the composite flour. In that case, an equilibrium of sale of pure wheat flour versus composite flour should be determined for a zero difference. For instance, if composite flour constitutes 80 per cent of the all baking flour in Nigeria, tax on 20 per cent of baking flour will be determined to subsidize the composite flour in order to reach a certain target price for both composite flour bread and 100 per cent wheat bread.

1/ Report of the Composite Flour Mission to Nigeria, November, December 1982, March 1983, FAO.

ANNEX 1

DETAILS OF MACHINERY MANUFACTURERS ABLE TO PROVIDE TURNKEY FACTORIES FOR CASSAVA PROCESSING

Name and Address of Company	Comments
1. Societe Ivoirienne de Technologie Tropicale (I2T) 04 B.P. 1137 Abidjan 04 Rep. de Cote D'Ivoire	Complete flour plant
2. ALFALAVAL POSTFACH S14700 TUMBA, SWEDEN	Complete starch plants from cassava using centrifugal process. Fresh roots to starch only.
3. HOVEX ENGINEERING LIMITED AE - KADE 35a P.O. BOX 105 VEENDAM, HOLLAND	Complete engineering design and installation of starch factories.
4. NIVOBA POSTBUS 40 9640 VEENDAM, HOLLAND	Compact containerised starch plants. Considerable experience of cassava processing especially from dried chips. Also glucose and dextrin plants.
5. SALZGITTER INDUSTRIEBAU GmbH POSTFACH 411169 3320 SALZGITTER 41 F.R. GERMANY	Complete starch glucose and dextrin plants from fresh cassava.
6. STARCOSA GmbH postfach 5105 AM ALLENBALMHOF 5 D 3300 BRAUNSCHWEIG F.R. GERMANY	Cassava flour plants and complete starch plants.
7. UBERSEE-TECHNIK RODINGSMARKT 29 2000 HAMBURG 11 F.R. GERMANY	Planning and erection of industrial plant, specialising in equipment for the production of starch, and starch derivatives.

ANNEX 1 (Cont'd)

EQUIPMENT MANUFACTURERS FOR SORGHUM AND MILLET

Name and Address of Company	Comments
(a) United Milling Systems, GAMLE carlsberg Vej 8 DK 2500 - Valby Copenhagen, Denmark	Supplies a vertical decorticator, together with an impact mill to reduce particle size.
(b) F.H. Schule GmbH, Hammer Deich 70 D 2000 Hambourg 26 Federal Republic of Germany	Supplies a vertical cylindrical decorticator in combination with an attrition mill.
(c) Bühler, 9240 Uzwil Switzerland	Manufactures a vertical cylindrical decorticator, milling of the endosperm is carried out on roller mills.

ANNEX 2

COMPOSITE FLOUR BREAD FORMULAE AND PROCEDURES

Recipe 1 - Cassava starch

	Parts (per cent flour weight)	
	Strong Wheat Flour (1)	Weak Wheat Flour
Yeast ferment		
Dry yeast	1.3	1.3
Water at 38 °C (100 °F)	7.5	7.5
Sucrose	0.4	0.4
Dough		
Wheat flour	50	70
Cassava starch	50	30
Salt	2	2
Sugar	1	1
Diastatic Malt Flour (2)	0.4	0.4
Hardened fat (3)	0.7	0.7
Emulsifier (GMS)	0.2	0.2
Ascorbic acid	0.015	0.015
Water	60	55

(1) Protein content of 14-15 per cent (N x 5.7) on 14 per cent moisture basis.

(2) Molt flour is added in the appropriate amount needed to adjust the falling number to 200-250 level in the flour mixture.

ANNEX 2 (Cont'd)

Procedure

(a) The yeast is activated during half-an-hour in water to which sucrose is added.

(b) All of the ingredients are mixed until a uniform dough is found.

(c) The dough is fermented for approximately 35 minutes.

(d) The dough is punched, knocked back or remixed.

(e) The dough is divided and rounded

(f) A further bulk fermentation of 15 minutes.

(g) The pieces received intermediate proof for 20 minutes.

(h) The pieces are finally moulded.

(i) Final proof of approximately one hour.

(j) The loaves are baked.

Baking temperature: 240 - 250 °C
Baking time: 15 to 35 minutes, depending on the weight and size of the bread.

1. With the mechanical dough development, all the ingredients are mixed in a high speed mixer (Tweedy type) and mixed in about 2.5 minutes to an energy input level of approximately 11 watt-hours per kilogram of dough. Then:

(a) Scaling in pieces and rounding
(b) Intermediate proof - 10 min.
(c) Moulding and panning

ANNEX 2 (Cont'd)

(d) Final proof - 60 min.

(e) Baking - 15 to 35 min.; 35 min. for loaves of 450 g.

Baking temperature - 240 - 250 °C

2. When cassava flour is used, the substitution level of wheat flour is reduced to 30 per cent with strong wheat flour and to 20 per cent with weak wheat flour and the procedure remains the same.

3. Defatted soya flour or peanut flour can be added to the recipe in the proportion of 3.5 per cent on flour basis. The nutritive value of these breads has been shown to be superior to conventional bread made only with wheat flour.

4. Technologically, cassava behaves best of all as wheat substituent.

Recipe 2 - Wheat/Sorghum or Wheat/Millet

	Parts (per cent flour weight)	
	Strong Wheat Flour	Weak Wheat Flour
Wheat flour	70	80
Sorghum or Millet flour	30	20
Yeast, dry	3	3
Sugar	2	2
Fat	1	1
Salt	2	2
Ascorbic acid (p.m.m.)	50	50
Water	65	60

ANNEX 2 (Cont'd)

Procedure

Mixing time	:	15 - 20 min. with a conventional mixer (use of high speed mixer is not advisable)
Dough temperature	:	about 28 °C (82.5 °F)
Bulk fermentation time	:	30 min.
Dividing	:	after a rest in bulk of 5 min.
Intermediate proof (fermentation)	:	20 to 30 min.
Moulding into desired shape	:	
Final proof	:	30 to 50 min.
Baking temperature	:	about 260 °C (500 °F)

5. A wheat flour of good quality mixed with 30 per cent sorghum or millet flour can give a larger bread volume than a bread from 100 per cent wheat flour of poor quality. No visible difference between the bread with and without sorghum/millet could be detected.

ANNEX 2 (Cont'd)

Recipe 3 - Wheat/Maize

	Parts (% flour weight)
Wheat flour (1)	75
Maize flour	25
Yeast (instant)	1
Salt	1.5
Sugar	3
Fat (or margarine)	2
Emulsifier	0.2
Water	58

(1) Minimum protein content (N x 5.7) 11% on 14% moisture basis; ash value maximum 0.6 per cent.

Procedure

Mixing time	-	10 min.
Bulk fermentation with knock back	-	50 min.
Dividing	-	-
Intermediate proof	-	30 min.
Moulding and panning; final proof	-	60 min.
Baking time	-	35 min.
Baking temperature	-	about 260 °C