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The theme of the Seminar was the examination of the present and future needs of the food industry in West Africa, and the relevance of present teaching programs to the needs of that industry. This report includes the papers presented but not the discussion following the presentation, except in Section III in which it was an integral part of the topic. The papers have been classified into three sections. Section I deals with food industries in Ghana, Ivory Coast, and Nigeria. The second section outlines possible new developments and trends in some important commodity areas of the food industry. In the third section there is a discussion of food science and technology teaching programs, their content, relevance, and role in solving food problems in West Africa. No general recommendations are given.

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SEMINAR ON THE FOOD INDUSTRY IN WEST AFRICA

DEPARTMENT OF NUTRITION AND FOOD SCIENCE
UNIVERSITY OF GHANA, LEGON

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December 1975

University of Ghana
Department of Nutrition and Food Science
Legon

INTRODUCTION

The Department of Nutrition and Food Science at Legon, which hosted this Seminar, has been in existence since 1962, and was the first of its kind in West Africa. Like the rest of the world, West African countries are realising the importance of having well trained graduates and good research facilities as a means of ensuring adequate food supplies to a fast growing population. Already two other Departments of Food Science and Technology have been established, one at the University of Ife, the other at the University of Ibadan, both in Nigeria, and many other universities are interested in establishing similar departments.

This Seminar comes, therefore, at a crossroads in the development of food science and technology education in West Africa. The theme is an examination of the present and future needs of the food industry in West Africa, and the relevance of present teaching programmes to the needs of that food industry. Thus, the first section deals with food industries in Ghana, Ivory Coast and Nigeria. The second section outlines possible new developments and trends in some important commodity areas of the food industry. In the third section, there is a discussion of food science and technology teaching programmes, their content, relevance and role in solving food problems in West Africa.

The original title of the Seminar held on March 28 and 29, 1974, was, "Food Science and Technology Education in West Africa." However, in view of the content of most of the papers, it was decided that the present title would be more appropriate for publication. I hope this publication will be useful not only as a record of the seminar but also in providing readers outside of West Africa with a picture of the problems facing food technologists working in West Africa. It is in no way meant to give a comprehensive study of the food industry in West Africa. As can be seen, only a few of the countries which make up West Africa are represented, but these are the

countries with an established indigenous food industry as well as university facilities for teaching food technology.

One of the main purposes of the seminar was to bring together scientists and technologists involved in teaching the future leaders of the food industry or contemplating the establishment of a teaching department in this field. It therefore provided a forum to exchange ideas and discuss mutual problems. However, for the sake of brevity much of the lively and useful discussion after each paper has not been included, except for Section 3 where it was an integral part of the topic. It is hoped that the Seminar and this publication will act as a starting point and catalyst for future meetings and even joint research projects.

Finally, the organization of the seminar and its publication could not have taken place without the help and cooperation of many people. Therefore, thanks must go to the members of the Department of Nutrition and Food Science, Legon, for their part. Acknowledgements must also go to Professor E. Laing and Dr. D. Y. Dako for opening the Seminar, and Mr. J. E. M. Bartels and Dr. E. O. Idusogie for chairing the sessions on both days. Financial help was received from the United Africa Company (Ghana), and the University of Ghana Research and Conference Committee to run the seminar. Publication costs were carried by the University of Ghana Publications Committee and in particular the United States Agency for International Development (A.I.D.) in Washington. I would also like to thank Dr. Jennifer Woolfe and Mrs. E. Flores for their contribution to the preparation of the manuscript, and Mrs. Jane Ashong for designing the cover.

M. L. WOOLFE

Department of Nutrition and Food Science
Legon

November 28, 1975

S E C T I O N I

THE FOOD INDUSTRY IN GHANA, IVORY COAST AND NIGERIA

FOOD INDUSTRY IN GHANA

by

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INTRODUCTION:

The regions on earth where civilization occurred at an early date were also areas where food production and storage from one harvest to the next were possible. Hence man's civilization has always been linked with his ability to produce, preserve and store his food. It has been said that early man was free to do little else than hunt for food. He was careless of passing of time and neglected to provide for his future needs. The estimate is that in pre-historic times 10,000 acres of land supported life for only one man. As man developed, the land supporting one person reduced to 1,000 and then to 100 acres, and finally to one acre. It has also been predicted that if this trend continues, food production will not be dependent on fertile soil, but man will eventually industrialize food production.

Apace with this development has been man's population increase. One can hardly talk on food production without the mention of population growth. In modern times there has always been the fear that population is outgrowing food production. In addition most countries are forcing industrialization and with it urbanization. As a result people are leaving the food production areas and are moving into regions where industrial opportunities and possibilities of a better life exist. This dislocation of populations means that improved methods of food production, processing, storage and distribution are required to feed not only the already located urban populations, but also those who formerly were producing their own food.

The growth of food industries has always therefore been in response to a public need to provide adequate and better food to the rising populations and to meet the demands of increasing urbanization. It has been reported by Aylward (1970-a) that "in the history of European and other countries there are many records of famine, but in the last century the classical blackspots in nutrition were not in the countryside (among agricultural workers, however poor) but rather in the large metropolitan cities, among workers divorced from the land and forced to purchase all their food."

WHAT IS HAPPENING IN GHANA?

When we come to Ghana, we find that all the factors discussed above have in one way or the other influenced the course of events, especially during the post-independence era. Indeed factors favourable for the development of food industries are numerous. Our population of about 4½ million in 1948 has more than doubled by now and we are very close to 10 million today. In about the same period (30 years), the population of Accra has increased from 70,000 people to a city of over 633,000 people. Tema, a small fishing village, mushroomed overnight into an industrial city. Kumasi, Tamale, Ho, Takoradi, Sekondi, Bolgatanga, Sunyani, Cape Coast, etc., are all expanding rapidly. Meanwhile the young school leavers continue to migrate into the urban centres leaving mainly the aged folk and school children in the village. There is a great need not only to increase the total amount of food available but to provide well-packaged, fresh and processed convenience foods of high quality to suit changes taking place in food habits, in working hours, in earning and housing conditions of the people. It is not, therefore, surprising that food has become a very potent instrument of politics in this country during post independence, and the success or failure of governments hang on how much food they can make

available cheaply for the people. One would therefore have expected the food industry to be booming by now in this country. Contrarily, however, the rate of growth has been rather slow, several factors being responsible for this state of affairs.

Failure of agriculture to generate enough raw material for processing: Until very lately, agriculture has never enjoyed a steady policy of expansion in this country. Except for cash crops for European markets, i.e., cocoa, coffee, lime fruits, practically no organized attention has been given to the production of other agricultural produce, especially those items consumed by Ghanaians. Even during pre-independence, those foods that could be grown locally were imported and exotic ones were also brought in. Cocoa farms were still being established and crops which were grown to provide shade to the young cocoa trees were sources of food.

It was not realized that the country was not producing enough meat, rice, cassava and other necessary foods for development. Meanwhile food habits were developed by certain classes of people that were in no way related to the agricultural pattern of the country. It is not surprising, therefore, that when food processing factories were later established, prominence was given to products such as corned beef, jams, bread, wheat flour, ice cream, etc., while kenkey manufacture, local soups and stews, fufu, gari and other similar things were neglected. Because of the failure of agriculture to generate raw material for food processing, any critical look at the food industry would reveal that only those factories which depend largely on foreign raw materials have enjoyed any substantial growth. Thus the beer brewing industry, distilleries, flour milling, reconstituted milk and milk products, soft drinks like Coca Cola, Pepsi Cola, Fanta, Mirinda and the bakeries are all enjoying a steady and healthy growth. On the other hand,

the Pawhigu and Wenchi fruit and vegetable processing factories and the Zuarungu corned beef factory operate on a limited scale, and even the Nsawam fruit and vegetable cannery cannot even begin to satisfy the home market. Also Nkulenu's factory at Madina has remained essentially a back-yard factory to date. The local food processing industry has not as yet found its feet.

By laying emphasis on failure of agriculture, I do not necessarily subscribe to the "eat what you can and can what you cannot eat" attitude. In the Northern and Upper Regions where there is only one rainy season, even during the harvest period food is used rather sparingly in anticipation of the long, drawn out annual drought. In this environment food must necessarily be preserved whether there is a large surplus or not. But even this does not alter the fact that if agriculture had lived up to the expectation, enough surplus could be generated during the single rainy season.

The picture is not completely gloomy since there are a few cases where development of agriculture has been successful. For example, the tobacco industry owes its success to the careful integration of agricultural planning and methods with production of tobacco products. Also in the space of a few years, Ghana has changed from a total importer of rice to an exporter. Therefore there is a ray of hope for the future.

To illustrate the point about raw material from foreign sources for our industry, one has to look at the following statistics. The Food Research Institute has been compiling a list of food factories in the country. This is summarized in Table 1. (A full list is given in Table 3.) This list covers only registered factories and does not include many rural and traditional processes such as corn milling, fish smoking, etc.

TABLE I

SUMMARY OF THE NUMBER OF FOOD ESTABLISHMENTS IN GHANA ACCORDING TO THEIR INDUSTRIAL TYPE a/

Meat products (fresh meat, processed meat)	7
Dairy products (milk, processed milk, milk products in ice cream)	3
Fruit and vegetables (processed product)	6
Fish products (frozen fish, processed fish)	6
Grain mill products (wheat flour and polished rice)	9
Bakery products (bread, cakes and biscuits)	56
Sugar refining	4
Sugar confectionery (including chocolate)	5
Breweries	4
Non-alcoholic beverages (minerals, tea, coffee, drinking chocolate)	18
Vegetable oil milling	13
Blending of spirits	2
Miscellaneous food preparation b/	28
Total	161

a/ Some factories produce more than one industrial type. In this case the principal type has been noted.

b/ This includes ice blocks, salt, dried staples, local staples such as gari and kenkey, and ground nut paste.

A look at the Greater Accra, Eastern and Western Regions, gives the following information:

TABLE II.

Region	No. of Factories	Those that use local raw material	Foreign Material
Greater Accra	66	19	47
Eastern Region	12	5	7
Western	11	7	4

In the Greater Accra Region, out of the 47 factories that depend on imported raw material, 31 are bakeries and two are breweries. In the Eastern Region, six factories out of the twelve are bakeries, and in the Western Region four out of the eleven are bakeries. It is very significant that the Head of State recently declared that even if we had the foreign exchange to purchase all our food requirements, a time may come when producers will refuse to sell food to us because they would need it for themselves. To eliminate these undesirable imports there is the need to encourage the growth of food industries which utilize indigenous agricultural produce.

Where local raw materials are processed we find that due to absence of large-scale farms near the factories, the processor has to depend upon several sources of supply covering wide areas of production. Naturally material from these different sources is expensive and non-uniform and this is usually reflected in the price and quality of different batches of product. Sometimes even the wrong type of raw material may be processed. Classical examples are the use of prime cuts of beef for corned beef, and canning of horse mackerel instead of Spanish mackerel simply to keep the factories in operation. Furthermore, as agricultural research and food processing have not been coordinated, the breeding of crop varieties suitable for processing is a long way off.

Pre- and post-harvest treatments necessary for the production of good quality raw material are generally unknown among our farming population.

OTHER PROBLEMS:

There are shortcomings within the food industry itself apart from the problem of raw material supplies. Some of these have recently been reviewed by Amu and Dei-Tutu (1974). One is concerned with the extent of proper training and knowledge of food. It was noted that there are two

categories of people involved in the food industry in this country: (a) people who use traditional methods of processing, for example fish smokers, house bakers, small jam manufacturers; and (b) those who use modern scientific methods of processing food, e.g., distillers, brewers, canners, and so on. The traditional food processors started from the kitchen or the backyard where they made small quantities of various items for a small market. They built up experience with time, and as demand for convenience foods increased, they expanded beyond the kitchen and the backyard into small factories. In many cases these small manufacturers lack training in food processing and they are unable to employ trained personnel because of high salary demands. In addition many of the small factories lack the most basic equipment such as scales, thermometers, volume measures, simple pH meters, and refractometers (for detecting changes in fruit quality or measuring end point during boiling of jams). Many factories simply follow recipes and cannot therefore control the processes, detect causes of faults and correct them. Products from such factories are likely to vary from batch to batch.

The large-scale manufacturer on the other hand can afford to employ qualified food technologists to take charge of production and quality control functions. However, sometimes inadequately trained personnel are employed. A perusal of local advertisements for top positions in food processing establishments indicates that jobs suitable for food technologists are offered either to engineers, chemists, economists or administrators. This is often because employers do not understand the role that a technologist can play in their factory.

The university faculty which trains food scientists and the Ghana Food Science Association should point out such errors to the appropriate authorties. An engineer may be good indeed but he does not have the specialist knowledge of the food technologist. If this trend is allowed to continue

a time will come when our factories will again consult "foreign experts" rather than local personnel about the solution to simple problems.

Other considerations in connection with the inadequate knowledge of the small processor are concerned with their ability to deal with plant sanitation, screening of workers on health grounds, and safety precautions for workers. Such precautions might include provision of protective clothing or the nature of the premises in which the food is being processed. Dangers from slippery floors, low roofs in hot processing rooms and other details may not be easily appreciated.

Besides these limitations, the food industry in this country has been faced with other problems. As a result of the economic situation certain minor additives which until recently could be ordered without difficulty can no longer be easily obtained. Some of these items, though necessary for quality of the product, are not critical for production and manufacturers have consequently decided to do without them, e.g., pectin, emulsifiers, special essences and purified spices. Packaging material is another "Achilles heel" of the food industry. Once food has been processed it has to be protected from recontamination by agents of spoilage such as insects, micro-organisms, oxygen and light. The product should not react with the container. The range of packaging materials available on the market is so narrow that usually processors are forced to use the wrong type of packaging. The cost of these materials is high so that they constitute a substantial proportion of the cost of the product. The tin can constitutes up to 50 percent of the cost of a canned product. Many potential food manufacturers are not in business simply because they cannot obtain the correct containers to put their products in. It is unfortunate that the glass factory has not yet

produced a standard jar which can be used by most food manufacturers. Instead the factory has concentrated on the production of bottles for beer, other alcoholic and soft drinks.

The present economic situation has brought with it certain trade malpractices such that food processed to have a shelf life of 9 months to one year is held for much longer periods of time. Also, as our markets play a very important role in food distribution, foods that pass through this channel are at times exposed to very testing conditions of temperature, light and humidity, with the result that when finally consumed the product might have lost much of its nutritive value.

WHAT ARE THE FUTURE PROSPECTS?

The present government is seriously tackling the agricultural problem and if the current programme succeeds it will have a most salutary effect on the food industry.

As pointed out by Aylward (1970-b), a sound food industry should benefit the nation in the following ways:

1) Greater availability of food through more efficient utilization of crops by liberation of edible components, reduction in fibre and toxic components;
2) Improvement in food quality;
3) Elimination of seasonal shortages and famine;
4) Establishment of feed and other industries by utilization of by-products generated as a result of processing;

For non-food purposes:

5) Increase in agricultural production through assured markets for farm produce. Losses of produce are reduced since large surpluses of perishables can be transferred into more stable ones;

6) Economic effects such as a) reduction in food imports, b) expansion of exports, c) stimulation of other industries, and d) more job openings;

7) On the social level, reduction of time spent on food preparation. The time saved can usefully be employed on other things.

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TABLE III

FOOD ESTABLISHMENTS IN GHANA - 1974

Compiled by

A. W. DE GRAFT-JOHNSON
and
N. ANANG

FOOD RESEARCH INSTITUTE
(Economics and Marketing Division)

Key:

L=Products distributed locally
N=Products distributed nationally
E=Products exported
P=Privately owned
S=Stated Owned
F=Owned by Non-Ghanaians
J=Jointly owned by State and Private Individuals
M=Ownership by mixture of Ghanaians and non-Ghanaians

REGION: GREATER ACCRA

No.	Name and Address	(See Key)	Production Date	Labor Force	Major Raw Materials	Finished Products
1.	Food Production Corp., P.O. Box 1853, Accra	L, S	1972	28	Cassava	Tapioca, gari
2.	Pioneer Meat Co. Ltd. P.O. Box 2106, Accra	L, P	1971	5	Pork, beef	Bacon, sausage, ham
3.	Ghana Packaging & Tr. Co. P.O. Box 190, Accra	N, P	1972	81	Coffee, sugar, meat	"Bongo" coffee, sugar confectionary (Cascade), "Reynard's" bacon, sausages, hams, delicatessen
4.	Allied Food & Agric. Ind. (W.A.) Ltd. Box 8788, Accra North	L, P			Meat	Meat products
5.	Meat Product Division (GIHOC), Box 5279, Accra	L, S	1968	16	Livestock	Fresh meat, sausages
6.	Meat Processing Plant, Box 3068, Accra	L, P	1972	11	Pork	Fresh meat, sausages
7.	Pioneer Food Cannery Ltd. Box 103, Tema	N, P	1973	79	Fish, oil, cans	Canned fish
8.	Cadbury (Ghana) Ltd. Box 49, Accra	N, P	1969	120	Malt, cocoa, sugar, tea, cans	Packaged tea, drinking chocolate, Bournvita

9.	Beyeeman Freezing Co. Ltd. Box 646, Accra	L, P	1973	6	Ammonia, calcium chloride	Ice blocks
10.	Tuyee Manufacturing Co. Ltd. Box 581, Tema	N, P	1969		Plantain, cassava, yam	Industrial starch, dehydrated foods
11.	Longlife Confectionery Ltd. Box 5215, Accra	N, P	1970	34	Sugar, liquid glucose, essences	Confectionery
12.	Glyco Confectionery P. O. Box 2051, Accra	L, P	1969	18	Flour, baking flour, sugar	Cakes, confectioneries
13.	Go Ahead Indust. Ltd. Box 1071, Accra	N, P	1969	60	Glucose, sugar, essences, citric acid	Sugar confectionery
14.	Mountain View Distilleries Ltd., Box 6670, Accra	N, P, M	1970	50	Alcohol, concentrate bottles, metal caps	Drinkables, spirits
15.	West African Enterprise Ltd., Box 3733	N, P	1958	137	Concentrates, metal closures, bottles, alcohol	Drinkables, spirits
16.	Picadilly Biscuits Ltd. Box 922, Accra	N, P	1970		Flour, sugar, shortening	Biscuits
17.	Overseas Brewery Ltd., Accra	N, P	1931	670	Malt, hops, sugar bottles	Minerals, beer
18.	Tata Brewery Ltd., Private Accra	N, P	1973	500	Malt, hops, sugar, bottles	Beer
19.	Prospect Mineral Factory, Box 1172, Accra	L, P	1957	14	Essence, milk powder, citric acid, sugar	Soft drinks, iced cream
20.	Fan Milk Ltd., Box 6460, Accra-North	N, P, M	1960	62	Milk, sugar, cocoa	"Tetrapak" white milk, chocolate, cottage cheese, yoghurt, iced cream, iced lollies.
21.	X.K.2 Restaurant, Box 5868, Accra-North	L, P	1971	1	Milk, sugar, essence, milk powder	Iced cream

22.	Jade's Mineral Water Enterprise, Box 4492, Accra	L, P	1950	3	Essence, sugar, colour, preservatives	Soft drinks
23.	Sandico Mineral Water Factory, Box 1529, Accra	L, P	1955	4	Sugar, essence, colour	Iced soda, pineapple, ginger ale
24.	Excelsior Soft Drinks, Box 1489, Accra	L, P	1955	4	Essence, sugar, colour	Soft drinks
25.	Yaccas Mineral Water Ltd. Box 273, Accra	L, P	1931	10	Essence, sugar	Lemon, pineapple, ice cream soda, "Pick Me Up"
26.	Pambros Salt Ltd., Box 3394, Accra	N, E, P	1957	173	Sea water	Edible salt
27.	Parosa Salt Ind. Ltd. Box 1565, Accra	L, P	1971		Lagoon salt	Salt
28.	Advanced Food Supplies, c/o Trade Fair Site, Accra	L, P	1973	6	Maize, cassava	Kenkey, gari, kokonte
29.	Food Production Corp. Box 1853, Accra	L, P	1972	17	Maize	Kenkey
30.	Modern Bakery Box 1583, Accra	L, P	1952	20	Flour, essence, yeast	Bread
31.	Coleman's Bakery, Box 127, Madina-Accra	L, P	1972	6	Flour, essence, yeast	Bread
32.	Aliceddo Bakery Ltd. Box 115, Madina-Accra	L, P	1971	4	Flour, essence, yeast	Bread
33.	Paragon Bakery, Box 1578, Accra	L, P			Flour, essence, yeast	Bread
34.	K. E. Bakery Box 1589, Accra	L, P	1973	25	Flour, sugar, yeast, margarine	Bread, biscuits
35.	Nomlasko Bakery, Box 344, Accra	L, P	1974	6	Flour, margarine, sugar	Bread

36.	Akua Akyere Bakery, Box 1310, Accra	L, P	1935	4	Flour, nut milk, margarine, eggs	Bread
37.	A.B.C. Bakery, Box 3052, Accra	L, P	1970	6	Flour, yeast, margarine, sugar	Bread, cakes
38.	Dick's Electric Bakery, Box 6684, Accra	L, P	1971	11	Flour, margarine, salt, yeast	Bread
39.	Ghana New Bakery, Box 3727, Accra	L, P	1971	16	Flour, margarine, butter, yeast	Bread
40.	Ghana New Bakery No. 2, Box 3727, Accra	L, P	1972	14	Flour, margarine, butter, yeast	Bread
41.	Excel Bakeries Ltd., Box 2147, Accra	L, P	1967	40	Flour, sugar	Bread
42.	Wanderland Bakery Box 4008, Accra	L, P	1972	4	Flour, sugar, margarine, nut milk, corn oil	Bread
43.	Love Bakery, H/No.C/131/1 Official Town, Adabraka	L, P	1934	4	Flour, yeast, sugar, margarine	Bread
44.	Fantoakwa Ent. & Bakery, Box 1943, Accra	L, P	1974	11	Flour, sugar, yeast	Bread, biscuits
45.	Jaruby Bakery & Food Ind. Ltd, Box 0282, Accra	L, P	1971	30	Flour, sugar, yeast, margarine	Bread
46.	Vanoly Bakery Ltd. Box 5727, Accra	L, P	1971	23	Flour, yeast, milk, margarine	Bread
47.	Ednat's Bakery Box 745, Accra	L, P	1973	4	Flour, sugar, salt, yeast	Bread
48.	Cak's Bakery Box 750, Accra	L, P	1973	2	Flour, meat, margarine	Meat pies, bread
49.	Ghana New Bakery, Box 3727, Accra	L, P	1972	16	Flour, bakery fat, yeast	Bread
50.	Modern Bakery Ltd. Box 1583, Accra	L, P	1971	10	Flour, yeast, sugar, salt	Bread, cake

51.	Julie's Bakery Box 2452, Accra	L, P			Flour, yeast, sugar, salt	Bread
52.	Cans Bakery Box 596, Accra	L, P	1965	7	Flour, sugar, salt, butter	Bread, cakes
53.	Housing Corp. Ovens-Kaneshie, Behind H/No. A-3, Kaneshie Estate	L, Coop	1973	2	Flour, sugar, salt, butter	Bread, cakes
54.	Doprenos Bakery, Box 5490, Accra	L, P	1973	2	Flour, baking powder, baker's fat, corned beef	Cakes, meat pies
55.	Them's Bakery, H/No. 7, North Labone	L, P		8	Flour, sugar, butter, baker's butter	Bread
56.	B. B. Bakery, Box 3228, Accra	L, P	1971	10	Flour, sugar, yeast	Bread, biscuits
57.	Ghana Electric Bakery Box 1664, Accra	L, P	1971	14	Flour, yeast, sugar, baker's fat	Bread, cakes
58.	Sunwise Bakery, Box 2806, Accra	L, P	1972	14	Flour	Bread
59.	Sparagon Bakery Box 1570, Accra	L, P	1972	4	Flour, baker's yeast	Bread
60.	Crystal Oil Mills Ltd. Box 421, Accra	J, M	1952	36	Copra, groundnuts, soya beans	Coconut oil, copra cake, pressed cake
61.	Crystal Ice Company Box 6312, Accra	L, P	1973	37	Ammonia, cal. chloride	Ice blocks, ice flakes
62.	Irani Brothers & Others Ltd. (G.M.G.), Box 672, (Accra) Tema	N, E, P, M	1968	193	Wheat	Flour, animal feed
63.	Cocoa Products Co. (GCMB) Private Post Bag, Tema	N, E, S	1973	422	Mill powder, sugar, cocoa	Cocoa butter, cocoa liquor, cocoa cake, cocoa powder, chocolate

64.	Food Specialties Ghana Ltd. Box 1739, Tema/Accra. (Nestle)	N, J, S, M	1971	350	Milk powder, butter, oil, cocoa, tin plate beverage	Ideal milk, "Milo" beverage
65.	Lever Brothers (Ghana) Ltd., Box 1648, Tema/Accra	N, J, M	1963	50	Palm oil, coconut oil	Margarine, baking fats
66.	Tema Food Complex Corp. Box 282, Tema	N, S	1970	2,500	Wheat, frozen fish, oil seeds	Canned fish, smoked fish, flour, animal feed, oils
67.	Nkulenu Industries Ltd. Box 36, Madina, Legon	N, E P	1953	45	Oranges, lime, pine-apples, etc.	Lime and orange juices and canned food
68.	GNTC Bottling Dept. Box 2648, Accra	N, S	1962	300	Concentrates, sugar, bottles	Soft drinks
69.	Ghana Bottling Co. Ltd. Box 867, Accra	L, S	1959	250	Concentrates, sugar, bottles	Soft drinks
70.	Distilleries Division (GIHOC) Box 7147, Accra	N, S	1960		Concentrates, sugar, alcohol	Drinkables and spirits
71.	Vegetable Oil Mills, Box 7525, Accra	N, S	1962		Coconuts, groundnuts	Edible oils
72.	Tema Alpha Bakery, Box 184, Tema	L, P	1971	10	Sugar, flour, yeast, salt	Bread
73.	Tema Royal Bakery, Box 8366, Tema	L, P	1973	5	Sugar, yeast, flours, etc.	Bread, Cakes
74.	Vans Quality Bakery, H/No. W. 12, Tema	L, P	1971	4	Sugar, flour, yeast, etc.	Bread, Cakes
75.	Atlantic Cold Store Box B256, Tema	L, P	1972	15	Calcium chloride, ammonia gas, brine	Ice blocks, frozen fish
76.	Attok Fisheries Ltd. Box 325, Tema	L, P	1973	7	Calcium chloride, ammonia gas, brine	Ice blocks, frozen fish

77.	Mankoadze Stores Ltd. Box 103, Tema	L, P	1958	9	Ammonia gas, calcium chloride, brine, fish	Ice blocks, frozen fish
78.	Mankoadze Stores Ltd. Box 103, Tema	L, P	1973	9	Fish, Gas Cookers	Smoked fish, frozen shrimp
79.	Ghana Cold Stores, Fishing Harbor, Tema	L, P, S			Ammonia gas, calcium chloride, brine, fish	Ice blocks, frozen fish
80.	Riviera Salt Enterprises, Box 565, c/o Accra, Tema	L, P	1973	14	Lagoon water	Salt
81.	Yeho Food Products Box 7100, Accra	L, P	1970	5	Groundnuts, eggs, oil, vinegar, maize, legumes	Groundnut paste, mayonaise, "Bamco" flour
82.	Ocean Fisheries, Fishing Harbor, Tema	L, P			Fish	Frozen fish, ice blocks

REGION: EASTERN

No.	Name and Address	(See Key)	Production Date	Labor Force	Major Raw Materials	Finished Products
1.	Piccadilly Mineral Water Supply, Box 81, Nsawam	L, P	1966	25	Essence, sugar, iced cream, soda, citric acid	Minerals
2.	Tetteh Mineral Water Works, Box 38, Nsawam	L, P	1961	4	Essence, sugar, fruit	Vino, iced cream soda, pineapple juice
3.	Roots Processing Co. Ltd. Box 319, Accra	E, P	1971	150	Cassava	Dried cassava chips
4.	Djabanor Farm Products, Ltd. Box 9, Odumasi Krobo	L, P	1972	24	Cassava	Gari, starch
5.	State Farms Corp. (Asesewa)	L, S	1960's		Palm	Palm Oil
6.	State Farms Corp., Box 22, Mamfe, Akwapim	L, S	1970	57	Palm nuts, cassava	Palm Oil, gari
7.	Alfred Ogbodjer Dankwah Bakery, Box 10, Somanya	L, P	1958	4	Flour, yeast	Bread, biscuits
8.	Yamoah's Bakeries, Box 67, Suhum	L, P	1973	5	Flour, yeast	Bread
9.	Bakery's Corner, Box 6, Koforidua	L, P	1949	4	Flour, Yeast	Bread
10.	Froxy's Bakery, Box 243, Koforidua	L, P	1939	4	Flour	Bread
11.	Cannery Division (GIHOC) Box 115, Nsawam	N, E, S	1960	300	Alcohol, essence, fruit, vegetables, cans, sugar	Alcoholic drinks, soft drinks, canned fruits, fruit juices, vegetables
12.	Mary's Bakery P.O. Box 180, Akim Oda	L, P	1947	2	Flour, sugar, baking fats	Bread

13.	Mrs. Gbedashie Adjisah, c/o GNTC No. 2 Store, Asamankese	L, P	1964	5	Flour, sugar, baking fats	Bread
14.	Ghasel Sugar Refinery, Asatsuare	N, S	1964		Sugar cane	Refined sugar, molasses, alcohol, yeast

REGION: WESTERN

No.	Name and Address	(See Key)	Production Date	Labor Force	Major Raw Materials	Finished Products
1.	Vegetable Oil Mills Corp., Box 9, Esiama	N, S	1962		Coconut,Palm nuts	Coconut oil, palm kernel oil
2.	Pan Electric Bakery, Box 97, Takoradi	L, P	1963	10	Flour, yeast, sugar	Bread
3.	Ghana Superfine Electric Bakery, Box 225, Takoradi	L, P	1961	10	Flour, sugar	Bread
4.	A.B.M. Special Bakery, Box 333, Takoradi	L, P	1971	17	Flour, sugar	Bread
5.	Ayebeahwe Electric Bakery, Box 06, Takoradi	L, P		6	Flour, sugar	Bread
6.	Farral Electric Bakery, Box 3441, Takoradi	L, P			Flour, sugar	Bread
7.	Ahanta Electric Services, Box 0256, Takoradi	L, P		2	Water	Ice blocks
8.	State Farms Corp.	L, S			Palm Fruits	Palm Oil
9.	U.T.C. Coffee Factory, box 102, Sekondi	N, P			Coffee beans	Ground roasted coffee
10.	West African Mills Ltd. Box 225, Takoradi	N, E, P, M			Palm nuts, cocoa	Palm oil, cocoa products
11.	Cocoa Products Factory (GCMB) P.O. Box 218, Takoradi	N, E, S	1973	471	Cocoa	Cocoa, cocoa butter
12.	Takoradi Flour Mill, Harbour Area, Takoradi	L, P, M	1974	88	Wheat	Flour

REGION: CENTRAL

No.	Name and Address	(See Key)	Production Date	Labour Force	Major Raw Materials	Finished Products
1.	Rambeluse Ltd., Box 271, Cape Coast	E, P, F	1970		Lime	Lime Peel
2.	L. Rose Co. Ltd., Box 97, Cape Coast	E, P,	1929		Lime	Lime Juice
3.	Cape Coast Citrus Growers	E, S	1974		Lime	Lime juice and lime oil
4.	Abura Okotopon Industries Box 1579, Accra	L, P			Lime	Lime juice, lime concentrate
5.	Akoto-Nzima Co. Ltd., Box 11, Cape Coast	L, P	1938	10	Sugar, essence, preservatives	Soft drinks
6.	State Farms Corp. Box 34, Apam	L, S	1973	30	Cassava	Gari, tapioca, kokonte
7.	Muni Development Co. Ltd., H/No. 6/8-Abasada St., Winneba	L, P	1967	13	Lagoon water	Salt
8.	Asin Salt Industry, Box 42, Apam	L, P	1973	92	Lagoon water	Salt
9.	Coastal Salt Ltd. c/o Box 489, Accra	L, P	1973	10	Lagoon water	Salt
10.	Mr. Dadzie, Pan Electric Bakery, Box 97, Takoradi	L, P	1972	4	Lagoon water	Salt
11.	Nnapa Salt Industry & Trading Co. Ltd., Box 5951, Accra	L, P	1973	10	Lagoon water	Salt
12.	Antorapira Salt Enterprises Ltd, Box 15, Apam	L, P	1972	11	Lagoon water	Salt
13.	Lagoon Salt Company, Box 78	L, P	1970	13	Lagoon water	Salt

14.	Madaka Salt Company Box 79, Elmina	L, P	1972	3	Lagoon Water	Salt
15.	J. K. Asaifuah, Box 77, Elmina	L, P	1972		Lagoon water	Salt
16.	Metsiwoyie, Box 57, Elmina	L, P	1950	4	Lagoon water	Salt
17.	Panbros Salt Industries Ltd., Box 16, Elmina	L, P		50	Lagoon water	Salt
18.	B.P. Salt Industry, H/No. 25/5, Bantama, Elmina	L, P	1962	20	Lagoon water	Salt
19.	Universal Salt Industries, Box 68, Apam	L, P	1964	13	Lagoon water	Salt
20.	Mankoadze Salt Industries, Box 32, Winneba	L, P	1972	26	Lagoon water	Salt
21.	Apam Salt Industries Ltd., Box 22, Apam	L, P	1964	38	Lagoon water	Salt
22.	J. G. Aggrey & Sons, Box 192, Cape Coast	L, P	1973		Lagoon water	Salt
23.	Wankan Salt Company, Box 109, Cape Coast	L, P	1972	15	Lagoon water	Salt
24.	Pomadze Poultry Processing Plant, Box 609, Cape Coast	N, S	1973		Chickens, feed ingredients	Dressed chickens, poultry feed
25.	Economic Industries, Box 98, Winneba	L, P	1967	7	Tomato, pineapple, pepper	Groundnut butter, palm oil, pineapple juice, tomato puree
26.	Ghasel Sugar Refinery, Kommenda	N, S	1964		Sugar cane	Refined sugar

REGION: ASHANTI

No.	Name and Address	(See Key)	Production Date	Labour Force	Major Raw Materials	Finished Products
1.	Pioneer Biscuits Co. Ltd. Box 503, Kumasi	N, P, F	1956		Flour, sugar, coffee	Biscuits, roasted coffee
2.	G. N. Dick Bakery	L, P	1964		Flour, sugar, essence, salt, baking fats	Bread
3.	Bantama Electric Bakery, Box 1925, Kumasi	L, P	1943		Flour, sugar, essence, baking fats	Bread
4.	New City Traders Ltd. Box 1555, Accra	L, P	1948		Sugar, essence, concentrates	Soft drinks
5.	Ashanti Mineral Waters Factory, Box 396, Kumasi	L, P	1962		Sugar, essence, concentrates	Soft drinks
6.	A. G. Irani (WA), Box 1430, Accra	L, P	1963		Sugar, essence, concentrates	Soft drinks
7.	GNTC Bottling Dept., Kumasi	L, S			Sugar, essence, concentrates	Soft drinks
8.	Poultry Projects (Ghana), Ltd., Box 1858, Kumasi	L, P	1969		Fish, meal, cassava, acids	Chick feed
9.	(Agricare) Products Ltd. Box 3934, Kumasi	L, P	1969		Fish, cassava, acids	Animal feed
10.	Kumasi Brewery Ltd., Asakwa, Kumasi	N, J, M	1958	735	Malt, sugar, hops extract, bottles	Beer
11.	Guiness Brewery Ltd., Kumasi	N, J, M		400	Malt, hops extract	Beer

REGION: VOLTA

No.	Name and Address	(See Key)	Production Date	Labour Force	Major Raw Materials	Finished Products
1.	Sika Foods Ltd. P. O. Box 299, Ho	L, P			Flour, yeast	Bread
2.	Panela Sugar Block (Ghana) Ltd., P.O. Box 7753, c/o Accra, Logba Akusame	L, P			Sugarcane	"Panela" sugar blocks
3.	Pechazur (Ghana) Ltd., P.O. Box 190, Keta	L, P			Shrimp	Frozen Shrimp
4.	Denu Oil Mill Corp. (GIHOC) Denu	N, S			Copra, groundnuts	Refind oils
5.	Madam Gertrude Avla, Hohoe	L, P			Flour, yeast, baking fat	Bread

REGION: NORTHERN

1.	Advance Bakery, Box 150, Tamale	L, P			Flour, baking powder, butter	Bread
2.	Eagle Bakery, Box 100, Tamale	L, P			Flour, Yeast	Bread
3.	Tamale Veg. Oil Mill (GIHOC) Corp, Box 249, Tamale	N, S	1963	52	Groundnuts, copra, palm kernel	Refined oil
4.	Tamale Rice Mill, Box 14 Tamale	N, S	1970	111	Paddy Rice	Polished rice
5.	Mencilo & Co., Ltd. Box 360, Tamale	L, P		60	Paddy Rice	Polished rice
6.	Yendi Rice Mill, Yendi	L, P			Paddy Rice	Polished

REGION: BRONG AHAFO

No.	Name and Address	(See Key)	Production Date	Labour Force	Major Raw Materials	Finished Products
1.	Vegetable Oil Mill Atebubu, Box 33, Atebubu, Tel. 14	N, S,	1962	44	Coconut, groundnuts and	Crude, deoderised and refined oils and kernel cakes
2.	Wenchi Cannery (GIHOC), Box 85, Wenchi	N, S	1973	85	Mangoes, tomatoes, okro, garden eggs, snails, Bamkarra groundnuts	Canned fruit, vegetables and snails, preserves and juice

REGION: UPPER

	Meat Products Div. (GIHOC) P. O. Box 6, Bolgatanga	N, S			Meat, cans	Corned beef
2.	Rice Mill, Min. of Agric., Bolgatanga	N, S			Paddy rice	Polished rice
3.	Pawligu Cannery (GIHOC) Bolgatanga	N, S	Proposed 1975		Tomatoes, cans	Canned tomato products

THE FOOD INDUSTRY IN THE IVORY COAST

by

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I. INTRODUCTION:

The food industry is one of the main industries of Ivory Coast. In 1972 it employed over 10,000 persons representing one-quarter of all industrial workers. It realised about 31 percent of the total industrial turnover and 40 percent of the exports of the Ivory Coast.

The food industry is divided into five main branches:[1/]

06 - Processed grains and flours

07 - Food preservation and food processing

08 - Beverages and ice

09 - Alimentary fats

10 - Other food industries and tobacco

The main industrial productions of these branches are the following:

06 - Wheat flour, bran, decorticated rice, bread, biscuits, Italian pasta

07 - Canned pineapple, pineapple juice, tuna fish, shrimps, roasted and instant coffee, cocoa butter, cocoa mass, cocoa cake, nuoc-mam (fish autolysate), confectionery

08 - Beer, soft drinks, ice

09 - Crude palm oil, palm kernels, refined oil (palm, groundnut)

10 - Milk products, animal foods

II. BALANCE SHEET OF THE FOOD INDUSTRY:

The latest published statistics are those for 1972 and will be reported here.

Branch 06 - The two main activities are the milling of wheat and decortication of rice followed by the production of biscuits, bread and Italian pasta.

(1) Wheat milling production: 72,000 tons of flour, 21,000 tons of bran. Flour production provides the total of the internal consumption of bakery and pastry flours. The only exports are those of the by-products such as bran pellets to the E.E.C. countries, mainly Ireland.

(2) Rice decortication: A rice programme has been set up in order to replace the imports and satisfy the increase of internal consumption. Production: 8,000 t.

The other products are biscuits (1700 t), bread (74,000 t), Italian pasta (600 t). This branch has a policy of import substitution. Important developments are foreseen with two projects on rice and maize.

Branch 07 - The three main areas are pineapple, fish products, coffee, cocoa.

(1) Pineapple: The production of canned pineapple and pineapple juice is entirely directed towards exports, mainly to France and Germany. Processed fresh pineapple (150,000 t), canned pineapple (slices) (65 000 t), pineapple juice (14,000 t).

(2) Fish products: Canned tuna fish is entirely exported to France (3600 t). One factory has a capacity of production of 50 t per day. The production is irregular depending on available supplies. Shrimps (1,000 t) are entirely exported. Sea shrimps are frozen and exported to France and Japan. Lagoon shrimps are cooked and exported frozen or refrigerated. The capacity of production is much larger than the supplies. Attempts at sea breeding of shrimps were not found to be successful.

(3) Cocoa; crude products: There are several small factories for the sorting and decortication of cocoa and coffee beans which are to be exported as crude products. This activity is planned to be brought on to an industrial scale. Semi-finished products: low-grade beans and a portion of

the high-grade exportable beans are treated locally to produce cocoa mass, cocoa butter, cocoa cake and cocoa powder, which is exported. A chocolate factory is planned. Production: Cocoa butter (11,000 t), cocoa mass (9,000 t), cocoa cake (13,000 t).

(4) Coffee - There are two types of product: roasted coffee and instant coffee. Roasted coffee (600 t) is sold locally and exported to the neighbouring countries. Instant coffee (1900 t) is produced by a subsidiary of Nestlé and exported to other African countries, Greece and the Far East. Local sales represent 14 percent of the total.

(5) Other activities - Confectionery (2600 t) mainly sweets and chewing gum; Nuoc mam 40,000 litres. This supplies the local market. Exports are to neighbouring countries, North Africa, France and Belgium.

Branch 07 is dependent on three main factors:

(1) Supplies of raw materials,

(2) Maintenance of profitable market prices for semi-finished products,

(3) Widening of the local and regional markets for finished products.

Branch 08 -

(1) The production of beer (470,000 hl) covers the national consumption. There are some imports of beers from Europe (20,000 hl).

(2) Soft drinks are essentially sodas, colas and syrups, mainly foreign brands. Production: 400,000 hl.

(3) Ice is produced for industrial and domestic use (100,000 t). Industrial ice is used for cold storage and freezing (brines) of fish.

Branch 08 includes imported wines, spirits and table waters. Low-priced wines are bottled locally.

Branch 09 -

Production: Crude palm oil (90,000 t), palm kernels (18,000 t), refined oils (palm, groundnut) (23,000 t). Exports are to the E.E.C. Refined palm oil is manufactured by a continuous process. Red palm oil

yields a neutralized bleached oil which is used as such or transformed into margarine, glycerol and soap. Priority is given to the local market. Oil cakes are exported to the E.E.C. countries. An increase in production is foreseen with the extension of plantations. An extraction unit for oil seeds (palm kernels, cotton seeds, copra) is planned.

Branch 10 -

(1) Milk products. The milk is reconstituted from imported milk powder. A few small factories produce milk, yoghourt, ice cream, butter and cream. The market is still limited due to difficulties of distribution of fresh products, mainly inland. Its development is dependent on the creation of a cold storage network. Production: 1800 t.

(2) Animal foods are produced by poultry breeders for their own use. Production: 10,000 t.

An important development of this branch is expected with the production of cane sugar from local plantations (1975).

III. AIMS OF PRODUCTION OF THE FOOD INDUSTRY:

The following figures are those of the Ministry of Planning published in 1970.[2/]

Branch 06 (Figures in tons x 10^3)

	1970	1975	1980
Wheat flour	65	81	100
Brans	19	23	29
Biscuits	0.5	1.35	2.70
Pasta	0.68	1.30	2.00
Rice (industrial)	9	85.7	205.4
(artisanal)	54	70.2	60

Branch 07	1970	1975	1980
Canned pineapple	120	175	220
Concentrated juice	-	2	2.5
Tomato paste	-	-	5
Canned fish			
Sardinellas	0.6 (fresh)	1.5	2
Tuna fish	3	10	30
Shrimps	0.5	0.9	1.5
Roasted coffee	0.75	1.0	1.5
Instant coffee	1.7	3.0	6.0
Cocoa butter	30 (beans)	50	70
Instant cocoa	-	0.5	0.64
Anacard	-	3.0	8.0
Branch 08			
Beer (1)	185,000	270,000	380,000
Soft drinks (1)	290,000	430,000	600,000
Ice (2) domestic	90	130	170
Fish storage	30	110	160
Branch 09			
Palm:			
Oil (industrial)	44	166	246
(artisanal)	7.74	6.0	6.0
Kernels (industrial)	11	41.5	61.5
(artisanal)	9.8	8.4	8.4

Branch 09 (Continued)	1970	1975	1980
Seed Oils:			
Palm	3.5	24.95	34.95
Copra	-	8.45	39
Peanut	-	9	13 5
Cotton	-	7.235	10.725
Salad Oils	15	21.7	31.8
Margarine	0.15	0.21	0.30
Branch 10			
Cane Sugar	-	45	60
Chocolate	-	1.3	2.4
Animal foods	10	25	60

IV. FOOD RESEARCH IN THE IVORY COAST:

Food research in the Ivory Coast is carried out mainly at the ITIPAT. This Institute is attached to the Ministry of Scientific Research and is involved in the technology and industrialisation of tropical agricultural products such as fruits, cereals, vegetables and legumes.

Research on fruits is oriented towards the preparation of alcoholic beverages, liqueurs, syrups, juices, fruit salads, wines, vinegars and dried fruits. There is also interest in the preparation of attieke,[a/] foutou,[b/] cocoa milk, biscuits and weaning foods.

References:

1/ Rejectoire Industriel de la Cote d'Ivoire (1973)
2/ Plan quinquennal de developpement 1971-75

Note:

a/ Foutou is the Ivoirian name for fufu, a staple usually made from boiled, pounded plantain, but yam or cassava can be used.

b/ Attieke is a local food prepared by grating, fermenting and steaming cassava, then lightly pounded. The product can be mixed with red palm oil.

THE FOOD INDUSTRY IN NIGERIA

by

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INTRODUCTION:

A. Nigeria

Nigeria, situated in West Africa, extends from the Gulf of Guinea in the south to the border of the Sahara in the north, covering an area of about 357,000 square miles. It is the most densely populated country in Africa, tenth in the whole world, and contains over 58 million people (United Nations Demographic Year Book 1974). The independent Federation of Nigeria came into being in 1960. In 1967 the 12-state administration of the Federal Republic was established under a military rule. The official language is English, but many vernacular languages are spoken.

B. Agriculture, food production and availability

Agriculture is still the mainstay of the Nigerian economy, with about 70 percent of the country's labour force employed in the sector. At independence, the percentage contribution of the sector to the Gross Domestic Product (GDP) was about 70 percent, although by 1968 it had declined to 55 percent (Second National Development Plan of Nigeria 1970-1974).

It is characteristic of developing countries that patterns of food production and consumption overlap, hence statistics on food production and availability in Nigeria are rather limited. However, a Food Balance Sheet for Nigeria, published by the Federal Department of Agriculture, Lagos, in 1972, gives information on production, available supply, waste and net food of various food commodities in Nigeria for the year 1968/69 (Table 1).

Total net supply of the various food commodities in metric tons per year is as follows: cereals - 6,087,850; starchy roots, tubers and fruits - 16,963,507; grain legumes - 723,624; oilseeds and nuts - 159,796; vegetables and fruits - 1,298,056; sugars - 111,511; meat, meat products, eggs, fish and milk - 2,136,818; oils and fats - 595,505; beverages - 1,664.472. It is worth noting that the carbohydrate food sources far exceed those of the protein foods. Percentage of waste in production of these food commodities range from 10 percent for most cereals and grain legumes, 15 percent for starchy roots, tubers and fruits, to 20 percent for eggs and 25 percent for fish. These wastage rates, particularly of protein food, underline the need for much improved storage facilities, better processing and preservation techniques in order to conserve these essential food commodities. The food industry has a major role to play in the realisation of this objective.

TABLE I FOOD PRODUCTION AVAILABILITY AND WASTE IN NIGERIA - 1968/69

Commodities	Production (Thousand long tons)	Available Supply	Waste	Food (Net)	Food (Net in thousand metric tons per year)
Maize	1,039,000	1,039,000	90,781	817,028	831,883
Millet	2,152,000	2,152,000	208,350	1,875,120	1,909,213
Sorghum	3,424,810	3,424,810	325,760	2,931,800	2,985,106
Rice	347,000[a]	348,640[b]	17,260	328,000	333,964
Wheat (Flour)	16,070[a]	27,910[b]	560	27,190	27,684
Cassava	8,691,000	8,691.000	1,303.650	7,387.350	7,521.607
Potato (Sweet)	168.150	168.150	21,930	133.710	136.141
Potato (Irish)	15.000[a]	17.000[b]	0.850	13.690	13.939
Yams	12,197,000	12,197.000	1,254.663	7,109.758	7,239.028
Cocoyams	1,287.000	1,287.000	139.032	787.848	802.173
Plantain	-	1,228.227[c]	-	1,228.227	1,250.559
Groundnuts (Shelled)	1,624.330[a]	988.330[b]	261.140	258.440	263.139
Cowpeas	640.000	640.000	105.754	423.018	430.709
Other legumes	+	32.493[c]	3.249	29.244	29.776
Melon seeds	70.000	70.000	2.714	51.572	52.510
Other oilseeds	-	-	-	-	-
Kolanuts	117.080[a]	105.370[b]	-	105.370	107.286
Vegetables	+	1,270.311[c]	127.031	1,143.280	1,164.087
Fruits	+	148.222[c]	14.626	131.596	133.989
Sugar (refined)	25.000[a]	94.900[b]	-	94.900	96.625
Sugar cane stem	+	14.620[c]	-	14.620	14.886
Beef	173.016[a]	206.498[b]	-	206.498	210.253
Goats	113.807	113.807	-	113.807	115.876
Sheep	26.121	26.121	-	26.121	26.596
Poultry	51.902	51.902	-	51.902	52.846
Pigs	29.827	29.827	-	29.827	30.369
Bush meat	292.430	292.430[c]	73.110	319.320	223.307
Offala	399.222	399.222	-	399.222	406.481
Eggs	+	51.898[c]	-	51.898	52.842
Fish	733.708[a]	1,012.017[bc]	184.426	827.591	842.638

TABLE I (Continued) FOOD PRODUCTION AVAILABILITY/WASTE

Commodities	Production (Thou. long tons)	Available Supply	Waste	Food (Net)	Food (Net in thou. metric tons/yr.)
Milk	402.262 a/	432.518 b/	21.626	170.869	173.976
Cheese	1.605	1.605	-	1.605	1.634
Palm oil	+	526.383 c/	-	526.383	535.954
Groundnut oil	+	29.244 c/	-	29.244	29.774
Butter and shea butter	+	220.470 c/	-	20.470	20.842
Other oils and fats	+	8.773 c/	-	8.773	8.933
Beer (European)	85.919 a/	86.832 b/	-	86.832	88.411
Beer (Local)	+	204.704 c/	-	204.704	208.426
Palm wine	+	1,608.393 c/	-	1,608.393	1,367.635

Source: A Quantitative Analysis of Food Requirements, Supplies and Demands in Nigeria, 1968-1985 by Olayide, et al, published by the Federal Department of Agriculture, Lagos, Nigeria, p. 20.

a/ and b/ Difference due to export and import available supply computed from consumption data.

\+ Positive values but cannot be quantified.

CLASSIFICATION OF FOOD INDUSTRY:

The food industry in Nigeria may be classified under the following headings using the International Standard Industrial Classification (I.S.I.C.) Code (Ref.).

ISIC Code	Industry
201	Meat products
202	Dairy products
203	Fruits and vegetables
204	Fish products
205	Grain mill products
206	Bakery products
207	Sugar factory refinery
208	Sugar confectionery
209	Miscellaneous food preparations
211	Blending of spirits
212	Wine industries
213	Breweries
214	Soft drinks
312	Vegetable oil milling

201 - Meat Products

Industrial activities connected with meat products include the following: (i) meat slaughtering as carried out in abattoirs, (ii) slaughtering, preparation and preservation of poultry, (iii) slaughtering, preparation and distribution of pork products, (iv) slaughtering, refrigeration and distribution of meat, (v) packing of meat products.

202 - Dairy Products

Activities include the production and distribution of fresh milk,

manufacture of butter and ice cream and reconstitution of milk and ice cream.

203 - Fruits and Vegetables

This involves the canning and preservation of fruits and vegetables including the manufacture of fruit squashes and juices, and canning of fresh fruits and vegetables.

204 - Fish Products

Activities include deep sea fishing and trawling, distribution of frozen fish and fish canning.

205 - Grain Mill Products

Essentially flour milling from cereal grains, rice milling, manufacture of livestock feeds and groundnut flour.

206 - Bakery Products

These include the baking of bread, cake and assorted biscuits and the manufacture of doughnuts.

207 - Sugar factory and refinery

Manufacture of sugar from sugar cane, refining, sugar cubing and granulated sugar production.

208 - Sugar confectionery

Manufacture of cocoa and chocolate drinks, sugar confectionery including various sweets, toffee, peppermint and fondant.

209 - Miscellaneous Food Preparations

Manufacture of baby foods, edible crisps from yam, potato and other vegetables, traditional local foods, margarine and cooking fats and packing of tea and coffee.

211 - Blending of Spirits

These include distilling, rectifying and blending of spirits.

212 - Wine Industries

Bottling and preservation of palm wine.

213 - Breweries

Brewing of European-type beers including stout and manufacture of malt.

214 - Soft Drinks

Bottling of various brands of soft drinks and carbonated water including Coca-Cola, Fanta, Sprite, Krola, Targo, Sundowner Schwepps, Seven-Up, Howdy, Mission brand drinks, Sword-brand drinks, Pepsi-Cola, Mirinda and flavoured mineral water.

312 - Vegetable Oil Milling

Manufacture of vegetable oils and fats from groundnuts and oil palm. These include manufacture of groundnut oil and cake, palm oil and kernels, palm kernel crushing for palm kernel oil and cake.

TABLE II

FOOD INDUSTRIES IN THE FORMER FEDERAL

TERRITORY OF LAGOS - 1965 and 1967

ISIC CODE	Total No. of Industries		Size of Establishments or Number of Employees	
	1965	1967	1965	1967
201 Meat	4	6	C(2)D(1)F(1)	C(2)D(2)F(2)
202 Dairy	3	2	D(3)	D(2)
203 Fruits and Vegetables	1	1	D(1)	D(1)
204 Fish	18	16	B(3)C(2)	B(1)C(3)D(3)I(9)
205 Grain mill products	1	1	F(1)	F(1)
206 Bakery	13	19	B(4)C(3)	B(7)C(2)D(1)
207 Sugar factory	-	-	-	-
208 Confectionery	5	-	B(1)D(1) E(1)I(2)	
209 Misc. foods	5	6	D(1)E(2)	
211 Spirits	1	1	H(1)	E(1)
212 Wine	-	-	-	-
213 Breweries	1	1	H(1)	G(1)
214 Soft drinks	7	4	B(1)D(4)	D(1)E(3)
312 Vegetable oil	-	1	-	(1)

Key A - 10 employees
B - 10-24 employees
C - 25-49 employees
D - 50-99 employees
E - 100-199 employees
F - 200-499 employees
G - 500-999 employees
H - 1000 and above employees
I - Unknown

Source: Industrial Directory 3rd Edition 1965, published for Federal Ministry of Industries by Federal Ministry of Information, Lagos

(ii) Directory of Business Establishments in Nigeria, 1st Edition 1967, Published by Federal Ministry of Labour, Lagos.

TABLE III

FOOD INDUSTRIES IN THE FORMER WESTERN

REGION OF NIGERIA - 1965 and 1967

ISIC CODE	Total No. of Industries		Size of Establishments or Number of Employees	
	1965	1967	1965	1967
201 Meat	1	1	D(1)	B(1)
202 Dairy	3	2	B(1)D(1)	C(1)D(1)
203 Fruits & Vegetables	6	3	B(4)C(1) E(1)	C(1)D(1)E(1)
204 Fish	-	-	-	-
205 Grain mill products	1	3	D(1)	B(1)I(2)
206 Bakery	9	28	B(2)C(5) D(1)E(1)	A(1)B(2)C(2)D(1) E(1)F(1)I(2)
207 Sugar factory	-	-	-	-
208 Confectionery	2	3	D(1)G(1)	A(1)B(1)D(1)
209 Misc. foods	2	3	E(2)	C(3)
211 Spirits	-	-	-	-
212 Wine	-	-	-	-
213 Breweries	2	2	F(2)	E(1)G(1)
214 Soft drinks	3	8	B(1)C(1) D(1)	B(4)C(1)D(2)I(1)
312 Vegetable oil	4	1	D(3)E(1)	F(1)

Key A - 10 employees
B - 10-24 employees
C - 25-49 employees
D - 50-99 employees
E - 100-199 employees
F - 200-499 employees
G - 500-999 employees
H - 1000 and above employees
I - Unknown

Source: Industrial Directory 3rd Edition 1965, published for Federal Ministry of Industries by Federal Ministry of Information, Lagos

(ii) Directory of Business Establishments in Nigeria, 1st Edition, 1967, Published by Federal Ministry of Labour, Lagos.

TABLE IV

FOOD INDUSTRIES IN THE FORMER NORTHERN

REGION OF NIGERIA - 1965 and 1967

ISIC CODE	Total No. of Industries		Size of Establishments or Number of Employees	
	1965	1967	1965	1967
201 Meat	7	-	B(3)C(3)D(1)	-
202 Dairy	1	1	G(1)	C(1)
203 Fruits and Vegetables	1	-	B(1)	-
204 Fish	-	-	-	-
205 Grain mill products	3	-	B(1)C(1)I(1)	
206 Bakery	8	6	B(5)C(2)E(1)	A(1)B(1)I(4)
207 Sugar Factory	2	2	C(1)H(1)	D(1)H(1)
208 Confectionery	3	-	F(2)G(1)	-
211 Spirits	-	-	-	-
212 Wine	-	-	-	-
213 Breweries	2	-	F(2)	-
214 Soft drinks	4	2	B(2)E(2)	I(2)
312 Vegetable oil	11	8	D(3)E(5)F(2) G(1)	C(1)D(4)E(1) F(1)I(4)

Key A - 10 employees
B - 10-24 employees
C - 25-49 employees
D - 50-99 employees
E - 100-199 employees
F - 200-499 employees
G - 500-999 employees
H - 1000 and above employees
I - unknown

Source: Industrial Directory 3rd Edition, 1965, published for Federal Ministry of Industries by Federal Ministry of Information, Lagos.

(ii) Directory of Business Establishments in Nigeria, 1st Edition, 1967, published by Federal Ministry of Labour, Lagos.

TABLE V

FOOD INDUSTRIES IN THE FORMER EASTERN

REGION OF NIGERIA - 1965 and 1967

ISIC CODE	Total No. of Industries		Size of Establishments or Number of Employees	
	1965	1967	1965	1967
201 Meat	3	1	B(2)D(1)	B(1)
202 Dairy	1	-	E(1)	-
203 Fruits and Vegetables	2	-	B(1)I(1)	-
204 Fish	3	-	I(3)	-
205 Grain mill products	3	2	B(2)C(1)	B(1)C(1)
206 Bakery	23	19	B(6)C(11)D(4)	B(9)C(4)D(3)E(1)
207 Sugar factory	-	-	-	-
208 Confectionery	-	-	-	-
209 Misc. foods	1	3	B(1)	A(1)B(1)C(1)
211 Spirits	-	-	-	-
212 Wine	1	-	B(1)	-
213 Breweries	2	2	F(2)	D(1)E(1)
214 Soft drinks	3	3	B(11)E(1)F(1)	C(2)I(1)
312 Vegetable oil	24	76	B(2)C(6)D(6) E(7)G(2)H(1)	B(42)C(12)D(1)E(1) F(1)G(13)H(1)I(15)

Key A - 10 employees
B - 10-24 employees
C - 25-49 employees
D - 50-99 employees
E - 100-199 employees
F - 200-499 employees
G - 500-999 employees
H - 1000 and above employees
I - Unknown

Source: Industrial Directory 3rd Edition, 1965, published for Federal Ministry of Industries by Federal Ministry of Information, Lagos.

(ii) Directory of Business Establishments in Nigeria, 1st Edition, 1967, published by Federal Ministry of Labour, Lagos.

TABLE VI

FOOD INDUSTRIES IN THE FORMER MID-WESTERN

REGION OF NIGERIA - 1965 and 1967

ISIC CODE	Total No. of Industries		Size of Establishments or Number of Employees	
	1965	1967	1965	1967
201 Meat	-	-	-	-
202 Dairy	-	-	-	-
203 Fruits & Vegetables	-	-	-	-
204 Fish	-	-	-	-
205 Grain mill products	-	-	-	-
206 Bakery	3	5	C(2)D(1)	B(2)I(3)
207 Sugar factory	-	-	-	-
208 Confectionery	-	-	-	-
209 Misc. foods	1	-	G(1)	-
211 Spirits	-	-	-	-
212 Wine	-	-	-	-
213 Breweries	-	-	-	-
214 Soft drinks	1	-	F(1)	-
312 Vegetable oil	4	14	B(2)C(1) G(1)	A(1)B(2)C(4)D(1) E(1)F(3)I(2)

Key A - 10 employees
B - 10-24 employees
C - 25-49 employees
D - 50-99 employees
E - 100-199 employees
F - 200-499 employees
G - 500-999 employees
H - 1000 and above employees
I - Unknown

Source: Industrial Directory 3rd Edition, 1965, published for Federal Ministry of Industries by Federal Ministry of Information, Lagos.

(ii) Directory of Business Establishments in Nigeria, 1st Edition, 1967, published by Federal Ministry of Labour, Lagos.

TABLE VII

FOOD INDUSTRIES IN NIGERIA - 1965 and 1967

ISIC CODE	Federal Territory of Lagos		Former Western Region		Former Northern Region		Former Eastern Region		Former Mid-West Region		Total	
	65	67	65	67	65	67	65	67	65	67	65	67
201 Meat	4	6	1	1	7	-	3	1	-	-	15	8
202 Dairy	3	2	3	2	1	1	1	-	-	-	8	5
203 Fruits and Vegetables	1	1	6	3	1	-	2	-	-	-	10	4
204 Fish	18	16	-	-	-	-	3	-	-	-	21	16
205 Grain mill	1	1	1	3	3	-	3	2	-	-	8	6
206 Bakery	13	19	9	28	8	6	23	19	3	5	56	77
207 Sugar factory	-	-	-	-	2	2	-	-	-	-	2	2
208 Confectionery	5	-	2	3	3	-	-	-	-	-	10	3
209 Misc. foods	5	6	2	3	3	-	1	3	1	-	12	12
211 Spirits	1	1	-	-	-	-	-	-	-	-	1	1
212 Wine	-	-	-	-	-	-	1	-	-	-	1	-
213 Breweries	1	1	2	2	2	-	2	2	-	-	7	5
214 Soft drinks	7	4	3	8	4	2	13	3	1	-	28	17
312 Veg. Oil	-	1	4	1	11	8	24	76	4	14	43	100

Sources: Industrial Directory 3rd Edition, 1965, published for Federal Ministry of Industries by Federal Ministry of Information, Lagos.

(ii) Directory of Business Establishments in Nigeria, 1st Edition, 1967, published by Federal Ministry of Labour, Lagos

FOOD INDUSTRIES IN THE FORMER REGIONS OF NIGERIA ACCORDING TO ISIC CODING:

Information on the food industries in Nigeria is rather sketchy and up-to-date statistics are rather limited. A current assessment of food industries in the country will involve several field trips to various locations to obtain the required data. With the time available to the author for preparation of this report and its presentation, this has not been possible. The data now being presented were obtained in surveys carried out by the Federal Ministries of Industries and Labour in 1965 and 1967 but published in 1966 and 1972. Although now out of date, they serve as indicators of activities in the food industry in Nigeria. Plans for a detailed food industry survey are under way and data obtained from this survey will be available in the near future.

The total number of food industries and the size of the establishment assessed in terms of number of employees for the former regions and Federal Territory of Lagos are given in Tables II-VII. As would be expected, the civil war disrupted industrial activities in the country and this is reflected in the number of food industries surveyed in 1967 compared with 1965 (Table VII).

In the former Federal Territory of Lagos, food industries engaged in fish and bakery products topped the list (Table II), although breweries and spirit distilleries had greater number of employees (over 1000 each).

There were more vegetable oil processing industries in the former Northern Region although the breweries as noted elsewhere had more employees (Table IV).

In both the former Western and Eastern Regions, there were more bakeries than any other food industries (Tables III and V). The breweries again had more employees. There were 76 vegetable oil milling establishments in the former Eastern Region according to the 1967 survey. These were principally

engaged in the oil palm processing and most of these establishments had less than 25 employees each, an apparent reflection of the scale of operation.

Food industry activities in 1965 and 1967 in the former Mid-Western Region were limited to bakery products and vegetable oil milling (Table IV). It would be interesting to find out what changes have been taking place as regards food industry activities since the 1967 survey was carried out.

Table VII summarises the distribution of the various food processing establishments in Nigeria in 1965 and 1967. The two big groups were bakeries and vegetable oil mills with 56 and 43 in 1965 establishments respectively, and 77 and 100 in 1967. The vast majority of food processing industries (Tables II-VI) are small employers having less than 50 employees each.

The processing and manufacturing techniques adopted in most of these food industries are similar to those carried out in the developed countries. However it would be fascinating to find out what modifications have been introduced and how these have affected the quality of the finished products.

This report, although sketchy, gives a review of the food industry activities in Nigeria. I believe other speakers will give more details in their respective reports.

Finally, I would like to take this opportunity to express publicly, on behalf of the entire Institute of Applied Science and Technology, University of Ibadan, Nigeria and myself, our profound pleasure for the invitation to this historic seminar and for being asked to present a report on "The Food Industry in Nigeria." We would like to congraculate the Department of Nutrition and Food Science, University of Ghana, particularly my professional colleague and fellow Procterite of Leeds University, Dr. Mark Woolfe, for the trouble they have taken in arranging this successful meeting.

S E C T I O N II

SOME AREAS OF DEVELOPMENT IN THE FOOD INDUSTRY IN WEST AFRICA

DEVELOPMENTS IN BREAD TECHNOLOGY

by

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INTRODUCTION:

Historically one can trace the development of man in revolutionary terms. Some 8,000 to 10,000 years ago began the Neolithic Revolution when man changed from the vital but precarious pursuit of hunting for his food to growing crops and living in settlements. The fact that storage of cereals and grains is not too difficult made a significant contribution to the change in the way of life. Three early major civilisations were founded on the growing of cereal crops, the first being Near and Middle East based on the growing of wheat, the next being the Southern and Eastern Asian based on the growing of rice, and the other being the Central American based on the growing of maize. At the turn of the nineteenth century, the Industrial Revolution occurred when man harnessed steam power, later electrical power, and developed the internal combustion engine. Thus machines could be constructed and powered to enable large scale processing of foodstuffs and their transportation. With this great change in the way of living, the patterns of food consumption have also changed and are still changing considerably.

Cereals of many kinds provide the staple food of a major proportion of mankind, and make up more than half of all goods in overseas trade. Although the nutritional value of most cereals as such is not extraordinarily high, as in fact no single product except perhaps milk and eggs can claim, the role of cereals in good nutrition is clear. (For example, a diet of beans and cereals in the right quantities can cater for the essential

amino acid supply.) The ways cereals are being processed into foods vary all over the world, ranging from simple preparation like roasting to the preparation of starch derivates from maize or the preparation of fortified breakfast cereals. Certainly one of the most important ways of processing is the baking of bread. Bread can take many forms which all have the advantage of being a product that can be eaten at all times of the day, be prepared in advance and kept for a few days if stored and packed under the right conditions, and can be easily transported. It is these facts about bread and similar baking products that makes them particularly fit for more modern consumption patterns in which the traditionally prepared foods, like pounded yam or gari, are often too labourious and time consuming to prepare. Bread consumption in developing countries is therefore steadily increasing. In a country like Nigeria the bread industry is one of the major industries and it is clear that in the future this industry will continue to play an important role in the food supply of the country. The internationally best known types of bread are the European types of wheat bread, and these types have been introduced in many countries outside of Europe during the last decades. They also have been introduced in countries which cannot grow wheat themselves and therefore many of these countries import large quantities of wheat, thereby influencing their balance of payments. At the same time these countries are often able to produce many other types of cereals. This situation has given rise to a worldwide interest in the use of "composite flour" in breadmaking. The use of these mixtures of wheat flour and other starch and protein sources in the baking of bread gives the opportunity to reduce wheat imports and at the same time improve the nutritional value of the bread products.

In this paper we will give some attention to the possibilities and difficulties of the application of composite flour techniques in bread-making in Nigeria and more widely in West Africa. First, the properties of wheat flour as well as the types of bread made will be examined.

Wheat:

Broadly, wheat can be divided into three groups:

1. The hard spring wheats are grown in large land masses such as Canada and the United States where the continental-type climate ensures heavy winter snows which melt in the early spring and give moisture for the rapid germination of the spring sown wheat. The hot dry summer weather gives quick-growing, ripening and harvesting conditions. Such wheats produce strong flours of excellent bread making qualities. Flour strength may be defined as the ability to give bread of good volume and crumb structure. It is called hard because physically it is hard; it does not crush easily. Many such flours have a protein content in the 14 percent to 15 percent range.

2. The soft winter wheats are grown in temperate climates such as Britain and France, or in the coastal regions of large land masses. The grains are plump, easily crushed, hence called soft, and yield flours with a low protein content, many as low as 9 percent. The sowing takes place in autumn and the grains lie in the ground over the winter. These flours give doughs with plastic rather than elastic properties, and are the choice flours for the making of short sweet biscuits (American cookies).

3. Durum wheats are grown in Italy and other Mediterranean countries. The warmer weather suits this type of wheat. Italian pastas such as macaroni and spaghetti are made usually from durum wheat semolinas (endosperm grits).

Wheat yields (1970)

The world average yield is	1.38 ton/ha
Prewar British yield	2.26 ton/ha
Present British yield	4.14 ton/ha
Red River Valley, USA	6.90 ton/ha
Yield in some developing countries	0.74 ton ha

In recent years, when crops have failed in one part of the world, wheat available from Canadian and U.S. reserve stocks has been purchased by countries able to afford to do so, or has been distributed through International Relief Organisations. The depletion of stocks has lead to the sharp rise in world market prices.

Wheat Bread

Bread has been simply defined as "a mixture of flour, salt and water made porous by yeast." [1/] The unique ability of wheat flour to produce large-volumed bread with good crumb stability is due to the properties of the insoluble proteins, gluten, a visco-elastic substance with good gas retention properties.

Jongh [2/] explains the function of gluten as:

1. An effective (the best known) binding agent between starch granules;
2. The coherence between the starch granules must be sufficient to prevent dough from becoming leaky during final proof and first stage of baking;
3. The coherence must nevertheless leave sufficient mobility to the dough constituents to enable the dough to rise; and

4. The binding agent must help the bread crumb to gain elasticity and softness desired for bread to be palatable.

Countries tend to develop baked products designed to utilise the flours milled from native wheats; this is particularly the case where countries are self sufficient in wheat. The French Stick loaf is an example. This loaf is made using a flour much too weak for American and British breads. In the making of British breads using conventional fermentation processing, the wheat blend (known as the Millers' Grist) used was about two-thirds very strong Manitoban wheats and one-third weak English wheats. A recent technological advance has been the making of bread using high energy mixing known as mechanically developed doughs -- the doughs are processed immediately as they are cleared from the mixing machines, (Chorleywood Bread Process). Using this technique it is possible to make acceptable bread using one-third only of expensive Manitoban wheats with the remainder being wheats grown at home.

Bread is the least expensive staple food of most people. The importance of bread as a food has lead governments over some centuries to invoke legislation covering price and weight controls. After the end of the 1945 war, probably the first legislation to be passed in both the U.S. and Britain in connection with food was to fix "standards of identity" legally defining the composition of various types of bread.

Around the world bread is a principal food and provides more nutrients than any other single food.[3/]

In 53 percent of the countries, bread supplies more than 50 percent of total calorie intake; in 87 percent of the countries bread supplies more than 30 percent of total calorie intake. In most Western European countries bread provides:

1. approximately 50 percent carbohydrate supply;
2. approximately 30 percent protein supply;
3. more than 50 percent of Vitamin B supply; and
4. more than 75 percent of Vitamin E supply.

In addition, British Bread and Flour Regulations require flour millers to add both calcium and iron to flour in the interests of national health.

In Europe, bread consumption per capita provides an index of the standard of living in the different countries. It is highest in the southern and southeastern countries such as Italy, Greece, Rumania, Bulgaria, Hungary, USSR and Yugoslavia. It is lowest in the Netherlands and Sweden. In the Near East bread comprises 75 percent of the total food intake. In the Western European countries there has been a steady decline in bread consumption, and it is only the increasing size of populations that maintains a near static total demand.

BREAD IN NIGERIA:

Bread is a universally popular food. Of the temperate foodstuffs which are exotic to the tropics, bread has made the greatest inroad into the market for indigenous staples in developing countries.

Flour imports[4/] into Nigeria (used almost exclusively for bread-making) in 1946 was about 2,540 tons. By 1960 this had risen to 60,960 tons. During this period bread consumption increased nineteen-fold, and rose per capita intake from 0.142 kg. to 2.268 kg. annually.

Wheat and Flour Import into Nigeria (thousand tons)

Year	Imported Wheat	Wheat as Flour 70% extr.	Imported Flour	Total Flour
1966	176.8	123.8	3.7	127.5
1970	258.7	181.0	6.0	187.0

Thus in the decade 1960 to 1970 flour imports had trebled. The approximate value of 1970 wheat and flour imports was £8 million. The wheat came from two countries only and the flour from six countries. In both cases the U.S. was the largest supplier.

About 90 percent of all bread produced is eaten in Southern Nigeria, mainly in urban areas. A limited survey conducted exposed the following pattern:

For the high income group, bread consumption averaged 16.3 kg./year;

For the low income group, bread consumption averaged 5.4 kg./year.

The relative perishability of bread, together with difficulties of distribution, has led to the establishment of a new bread industry different from the usual in that it is mainly a village industry for local supply. The bread made is smooth textured, is moderately sweet, and sold in 4-ounce, 8-ounce and 16-ounce units. The technique used in manufacture was imported from the Caribbean area and was introduced commercially by a Mr. Shackleford who established his bakery in the early 1920's.[5/] This technique of production has spread to cover Nigeria, and I believe is used in Ghana.

Ninety percent of the bread made is "sugar bread" and is eaten by itself or with drink; 10 percent of the bread made is "butter bread" and is eaten with a meal. A lot of bread made is sold near transport pick-up stations and eaten when travelling.

Since 1960 when the Golden Penny Flour Mill was established, the importation of flour has been phased out. Today this mill is capable of milling 1,500 tons of wheat daily and claims to be the largest mill in the world built on one site. Within this last year, two other flour mills have come into production, one at Sapele milling "Life" flour and the other at Port Harcourt milling "Crown" flour. Bread production

in the future should increase as a result of increased demand due to overall economic growth. The build-up of the flour milling industry indicates that national planning is prepared for a considerable increase.

Breadmaking in Nigeria

In the large towns there are a few bakeries with mechanised production run by personnel trained abroad. The remaining bakeries are confined to the production of the sandwich or box tin loaf, made using the Shackleford technique. The premises occupied by the typical Nigerian bakery are on the ground floor of a house. Entrance is by the central passage and the rooms on either side of the passage form the flour store, the dough mixing, dough sheeting, dough moulding and tinning rooms and the bread store. The ovens are built in the backyard; the yard is covered with corrugated iron roofing supported on timber framing.

A unique feature of the Nigerian bakeries is the use of a power-driven dough sheeting machine. The machine is locally made, and except for the turned rolls, is angle and sheet steel. The electric motor is coupled to a motor car gear box and as the gear is not changed, this serves as a speed-reduction device. As this is the only mechanically-operated machine in most bakeries, it is obviously important to guard against electric power failure, some having emergency standby petrol engine drives.

The doughs are mixed manually and the ovens are wood fired.

A typical recipe for bread is, based on flour weight, 100 parts flour, 0.25 parts yeast, 1.25 parts salt, 50 parts cold tap water and 10 parts sugar. The dough is left to ferment for eight hours before taking to the sheeting machine for repeated rolling and folding. This

physical treatment degasses the dough (clears the dough of pockets of carbon dioxide gas evolved by yeast), brings some free water to the surface, and has the effect of developing the dough structurally.

After this treatment the dough is divided into loaf-sized pieces which are moulded to fit the tin, and the tin cover is placed in position. The filled tins are multi-tier stacked (on the floor) and left to proof rise for about two hours before baking. After primary cooling, the warm bread is closely stacked on the bread store shelving. The reason given for the close stacking is to prevent the bread from drying out. Unfortunately, in addition it lengthens the time required to cool the bread and encourages sporulation by bacterium B. subtilis. Microbial breakdown of starch leads eventually to a sticky, smelly mass known to British bakers as "ropey bread." In Nigeria "rope development" rather than staling is the main cause of spoilage.

The bread tins play an important part in aiding production, helping to prevent dough surface dry skinning during final proof; in baking they trap some generated steam under the cover, allowing greater expansion by delaying crust formation. Should the oven radiate heat too strongly, the cover acts as a reflector. If the final proof is quicker than normal, the tins can be double-tier stacked in the oven to enlarge oven baking capacity. The tins are locally made from used kerosene cans, etc., and fabricated in sets of four by direct fold-clipping together and riveting a light strapping to the tin ends. The covers are made with a flanged edge.

The Shackleford technique over many years has proved to be workable without undue difficulty. This technique requires a very strong flour to withstand the long fermentation at warm temperatures and the considerable physical treatment given by sheeting and folding a number

of times; the flour strength confers time tolerance in processing. The high level of sugar ensures that an adequate supply of sugar is available for fermentation. Some sugar is not utilized by yeast and this residual sugar gives the sweet tasting crumb of "sugar bread."

To effect any change in the character of the bread and to produce different bread varieties would require:

1. Training in the production of different varieties of bread;

2. Investment in dough mixing machines necessary to make other varieties. Nigerian bread as made at present depends on a long fermentation and on sheeting treatment of the poorly mixed doughs to give a clear developed dough for processing into bread.

3. Investment in ovens with flexible control of temperature and design features related to variety interests. The ovens would be oil fired but such ovens require a dependable electric power supply to drive the circulating fans, otherwise considerable disruption of production would occur unless one also invested in standby emergency generating equipment.

Composite flour bread

Bread made from composite flour, for example, a blend of wheat flour and cassava flour or starch with some bean flour added to restore the protein level to that of wheat flour, offers the opportunity to:

1. Improve the quanity and quality of the protein intake of the people eating large quantities of starchy root foods. The nutritional characteristics of some baked products made from composite flours (from a publication of T.N.O. Graan Meel en Broad, Wageningen, The Netherlands) is shown in Table I.

Table I

Bread Composition	Proportions	Protein content 1/	P.E.R. 2/
Wheat flour	100	12%	0.96
Wheat/cassava/soya flour	70/25/5	12%	1.58
Wheat/maize flour	70/30	11%	0.61
Cassava starch/soya flour	80/20	11%	2.13
Cassava starch/groundnut flour	80/20	11%	1.26

1/ Protein content of the baking product

2/ Protein efficiency ratio = weight gain in grams of the experimental animal per gram protein consumed.

2. Increase the output levels of bread production without incurring additional scarce foreign exchange expenditure on more wheat, a cereal likely to increase in price due to increasing demand.

3. Lower the price of bread if locally-produced ingredients can be purchased at a lower price than imported wheat flour.

These advantages have caught the attention of institutions all over the world. No less than 22 institutions are or were involved in Composite Flour studies and had produced a massive number of publications by 1971.[6/] Among these are Institute de Technologie Alimentaire, Dakar, Senegal, and the Federal Institute of Industrial Research, Oshodi, Lagos, Nigeria. Research showed that it is possible to produce bread very similar to wheat bread using a variety of non-wheat constituents like starchy root crops, other cereals, beans, etc. Generally it also appeared possible to make products acceptable to the consumer, although consumer acceptance will vary according to local tastes and traditions and therefore will have to be tested again in every new field of introduction. The production of

composite flour breads, especially if a high degree of wheat replacement is wanted, requires a technology which differs from the usual wheat flour bakery technology. Two main lines of research may be distinguished:

1. Techniques which are based on the use of high speed mixing or mechanical dough development (Chorleywood Bread Process). In this case high levels of energy input are used in the mixing stages to build the needed structure of the bread; mixtures of high gluten content wheats (hard wheats) and non gluten-protein constitutents are required. The Tropical Products Institute in London has worked on this approach.

2. The use of chemical baking quality improvers like fats and emulsifiers to improve the baking quality of mixtures which may even be non wheat. The Institute of Cereals, Flour and Bread in Wageningen has worked on this line. Of course combinations of these two approaches can be used.

Although extensive knowledge has been gathered, application of this knowledge is not yet developed. There may be a number of reasons why this is the case. This research has been performed with the use of the modern bakery equipment and techniques. However, as may be gathered from the preceding paragraphs, the breadmaking techniques used in Nigeria are not applicable in such circumstances without additional investments in mixing machines, ovens, temperature-regulated provers, etc. These necessary investments may cause the whole concept of composite flour bread to be commercially unattainable by the local baker. Looking at the existing methods in Nigeria perhaps the chemical approach would have a better chance than the mechanical dough development approach. Another important consideration is the availability of the locally-produced constituents, both in terms of standard quality and quantity. Although large production levels are recorded of

suitable crops, the well-developed and centralized market structure found with wheat and wheat flour does not exist. Before the baking industry can successfully adopt the composite flour technology it will be necessary to ensure a reasonable supply of raw materials. This demands large units to produce and market a standard type of non-wheat flour, in the same way as the wheat flour mills do, or for the introduction of standard processing procedures in the existing local milling industry to produce such a standard product. It will be clear that governments and developing agencies will have to provide the incentives to take the described proposals into the commercial sector, by either legislating on the setting up of big units, or by providing credit facilities to the local baker and/or miller to enable him to invest in the new methods.

CONCLUSION:

The food scientist and the food technologist have a vitale role to play in raising food production both quantitatively and qualitatively, and in improving preservation of this food.

The heraldic inscription of the London Borough of Southwark reads, "The health of the people is the highest law." There exists an essential relationship between food and health. The increasing bread consumption is a progressive nutritional advance, but to the low income group, bread may be a semi-luxury, and to the very poor, completely out of reach. It is interesting to note that the British Government has recently announced a policy of "bread subsidy" to stabilize its price. Breadmaking gives the opportunity to mix starchy roots such as cassava with cereal protein in the form of composite flours. Nutritionally, a composite of cassava, wheat flour and legumes gives bread of similar protein level to wheat

bread, but better "balanced" in terms of essential amino acids. Researchers have shown the possibility of producing such bread, but to make it acceptable not only to the consumer but also to the producer requires a lot more work. A choice will have to be made between investigation and a recipe developed which is adaptable to the local circumstances without too high investments. Therefore, it is essential to have a knowledge of the existing methods in the local industries. In West Africa, methods using the chemical baking improvers will probably be the most suitable. The product will also have to be acceptable to the consumer. The "sugar bread" which is produced in Nigeria may give opportunities to camouflage the non-wheat tastes in composite flour bread. Last but not least, it will be necessary to give a description of the desired non-wheat flours, and perhaps develop guidelines for production to enable the local industry to produce and market these. After such work is done, the existing baking and milling industry in West Africa might successfully influence improvement of health and the development of society in general.

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Note: The Department of Food Science and Technology of the University of Ife is currently running a research project on these lines.

DEVELOPMENTS IN THE EDIBLE OILS AND FATS INDUSTRY IN WEST AFRICA

by

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INTRODUCTION:

This paper considers how far the existing fat technology is being applied to the production and storage of commercially important oils and fats in West Africa. It also examines how existing technology is being applied to improve the quality of these oils and fats in order to improve their desirable qualities for local consumption and to ensure that as export crops they command the same price in the world markets as similar oils and fats produced in other countries.

Two further things should be said at this point. The first concerns the use of the word "quality" in relation to oils and fats. In the world of food, especially in industrial circles and in food advertising, the world "quality" is presently used in an imprecise way. People speak of "high quality" or "poor quality" foods and while sometimes it is clear what is meant by these words, at other times it is difficult to know. Two definitions which can be applied to foods insofar as "quality" is concerned can be given. The first is Duran's definition, "quality is fitness for use."[1/] The second is by Howat,[2/] "quality is that attribute or group of attributes in a food which makes it acceptable to, or desired by, the consumer." This point is made now because as we will see later high quality palm oil as desired by Nigerians for use in food preparation contains about 10 percent free fatty acids (f.f.a.). For most purposes this would be classed as a very low grade oil. Indeed in Nigeria the marketing board demands for export

a f.f.a. of 3.5 percent because users of palm oil in food preparations in many countries demand a low figure. This point should be carefully noted.

The second point is that examples and data will be drawn from Nigerian sources since these were more readily available. This does not mean that Ghana data is less trustworthy. It simply means that it is much easier for me to get Nigerian figures than Ghanaian ones.

The four main edible oils and fat crops in West Africa are cocoa, groundnuts, palm oil and palm kernel oil. Two of them, groundnuts and palm oil, are important sources of food in their own right in West Africa, but they are also exported in quantity. The other two, palm kernel oil and cocoa butter, are essentially export crops although in processed and compounded form they are used by many West Africans in imported foodstuffs.

Table I shows figures for the quantities of each handled by the Marketing Board in recent years and also the total value to the crop producers.

Table I

Export Commodities Handled by Nigerian Producer Marketing Board
(Purchases in 1,000 tons)

	1968/69	1969/70	1970/71	1971/72
Cocoa	189	224	302	254
(Value in million ₦)	(35.7)	(64.6)	(89.8)	(71.3)
Groundnuts	776	648	307	307
(Value)	(38.9)	(38.2)	(19.2)	(24.3)
Palm Oil	3	28	31	19 a/
(Value)	(0.3)	(2.3)	(2.8)	(1.7)
Palm Kernel Oil	192	299	307	235 a/
(Value)	(11.0)	(17.1)	(18.1)	(13.9)

a/ January-October only

In the case of cocoa and palm kernel, the export crops, the figures represent also the total production. In the case of groundnuts and palm oil they represent only the quantity which will be exported. For groundnuts this will be 75-80 percent of the total crop. In the case of palm oil it represents only a small part of the total production. It is doubtful whether reliable figures for the production of palm oil in Nigeria exist. There are only estimates which vary widely.

Some estimates can be made. In the Southern States of Nigeria, the total population is, in round figures, 25 million. Most of these, say 4 our of 5, eat palm oil in some form nearly every day, say 5 days per week. If the amount consumed, taking children into account, is even as little as one-quarter ounce (7 g.) per day, then the total consumed per annum is 580,060 tons. This makes it a very large crop.

What kind of technology is being used in the production and storage of these oils and what more might be done?

Let us begin with cocoa. Partly because it is the main export crop in Ghana, our host country, and partly because it is the easiest to deal with.

Cocoa Products:

Cocoa beans are being processed into the two main cocoa products, cocoa butter and cocoa liquor, used industrially in two large factories in Ghana. These products are exported to Western Europe, U.S.A. and Japan. These factories are well equipped and utilise modern methods to give products which are fully acceptable in the world markets. The Cocoa Industries plant in Ikeja, Nigeria is also a factory where up-to-date equipment, well-maintained and managed, gives acceptable cocoa butter and cocoa liquor in many of the world's markets.

Most of us are familiar with the treatment given to cocoa beans to produce cocoa liquor and cocoa butter. For those who are not so familiar, the method is that the beans, after cleaning and sorting, are roasted and then allowed to cool. The cool beans are then broken in a machine called a kibbler which gives small pieces of the kernel called "nib" and at the same time removes the shell from the cotyledons.

In the next stage the shell is separated from the cotyledon in winnowing machines. The pieces of cotyledon or nib are then ground in a series of refiners each of which grinds the pieces of kernel more finely. During this process the fat, which amounts to about 54 percent of the cotyledons, is expressed from the cells in which it has been stored and the finely-ground end product appears as a dark brown liquid, "cocoa liquor." This is isued as an important ingredient in chocolate manufacture. When this material is submitted to high pressure in hydraulic or other presses, some of the fat is expressed. This fat, after solidification on cooling, is the white or yellowish "cocoa butter" well known in commerce. This is another essential ingredient in the chocolate industry. It has also wide uses in the pharmaceutical and cosmetic industries.[3/]

It is only necessary to say here that up-to-date technology is being used to produce high quality products. All that might be added is that the total amount of cocoa beans processed is quite small. (See Table II.) There is no reason why the amount currently used should not be considerably extended.

Table II

Exports of Cocoa Products
(in cwts.)

Year			
Cocoa Beans (Value in million ₦)	3,492,100 (64.72)	5,349,000 (143.12)	4,478,800 (101.14)
Cocoa Butter (Value in million ₦)	- -	163,700 (8.16)	202,500 (10.10)

Palm Kernel Oil:

As has already been noted, palm kernel oil is essentially an export crop. Indeed it is only in the last 10 years or so that any palm kernel oil was exported. Prior to that time it was only kernels which were exported. Now both kernel and the expressed oil are exported. There is, as far as I am aware, only one or two plants in Nigeria which express palm kernel oil. One is a modern plant situated near Lagos with up-to-date equipment, and it produces a large tonnage of palm kernel oil for export each year. The most recent export figures are:

Table III

Exports of Palm Kernel Oil (in tons)

Year	1960	1961	1962	1963	1971	1972
Amount	1.0	-	850	3,153	25,942	33,051
Value in thousand ₦	-	-	(11.68)	(385)	(6,210)	(5,521)

The spectacular growth of this edible oil export is apparent.

It should be noted at the same time that the total quantity of palm kernels has fallen. This is evident from Table IV. Nevertheless the total quantit is considerable, both in tonnage and in value.

Table IV

Exports of Palm Kernels (in tons)

Year	1963	1971	1972
Amount	398,307	208,862	237,858
Value in thousand ₦	(41,637)	(15,669)	(25,917)

It is evident that there is considerable scope for further pressing of palm kernels in Nigeria.

The quality of the oil exported is not good in terms of the attributes by which quality is judged in the user countries, mainly colour and free fatty acid content. There is little doubt however that this poor quality is due to the quality of the kernels supplied and not to the manner or conditions of processing. Having visited one plant, I believe that what is needed is a more consistent quality of the kernels, and for them to be stored under better conditions at the plant prior to use.

It is worthwhile taking a closer look at what happens to palm nuts in Nigeria before they become palm kernels.

The palm nuts, with the kernels still inside the hard shells, are obtained as by-products in the production of palm oil, and we will be looking at that operation later in the paper. The shells are removed either by hand or by machines. The former method is done by women and children in the villages and is slow and irksome. The latter method is followed in the commercial oil mills and involves power driven centrifugal mills. It is fast but unfortunately it produces a high and variable proportion of bruised and damaged kernels. This defect has a serious effect on the quality of the oil obtained. In contrast, the village method rarely gives damaged kernels and a good quality oil can be obtained from them.

In the context of this paper, quality of the oil refers to the amount of free fatty acid present. The freshly-cracked nuts give oil immediately after cracking of 1.0 to 1.5 percent f.f.a.[4/] This is an acceptable figure but during storage this rises rapidly and will reach between 2 percent and 10 percent according to conditions of storage and how much the kernels are damaged.

The reason for this is as follows. The equilibrium moisture content of cracked kernels is between 7 percent and 8 percent. But about half the weight of the kernel is fat in which there is no moisture. So the effective

moisture content in the fat-free portion of the kernel is 14 percent to 16 percent. Biological material of this moisture content is very suitable for growth of molds and other micro-organisms. This is especially true of damaged nuts where the mold hyphae can easily penetrate through ruptured cell walls. The lipase present in the kernels and in the invading molds can therefore easily attack the glycerides and produce a high level of free fatty acids, thus affecting oil quality.

Lipase, like other enzymes, can be destroyed by heat, usually by exposure to temperatures just under 100°C for several minutes. In consequence, some mill managers steam the stored kernels periodically, a process called "sterilization", in an attempt to control mold growth and thereby to limit the increase of the f.f.a. content of the oil inside the kernel. This is probably better than nothing but it is an expensive control treatment and it has to be followed by drying the kernels with hot air or in the sun.

In addition to flavour deterioration caused by the free fatty acids there is also an economic loss. The f.f.a. represents lost glyceride content. This shows up on refining and at high levels of f.f.a. the economic loss is considerable. The f.f.a. content after neutralisation with alkali has, in the form of soap, some economic value provided a use can be found for it locally, but it is much less than that of the lost glycerides.

From what has just been said it is evident that good quality oil can be produced only if two requirements are met. First, that the number of damaged kernels is kept low, and second, that the kernels are kept really dry before delivery to the factory and while they are awaiting processing. One further factor of importance is that storage time after breaking should be as short as possible. It must be borne in mind that storage temperatures are normally high and will encourage lipolysis. In farm stores the temperature will rarely fall below 30° C and in large stacks of bags containing

kernels the temperature can reach 50° C due mainly to different forms of biological activity.

The production of a high quality palm kernel oil in West African conditions is therefore not easy. Apart from ad hoc investigations by industrial companies, very little ordered study of the problem seems to have been attempted. The ingenuity of some of our food technologists should be turned to this in the near future.

It is not easy to suggest ways to improve the present situation within the framework of existing conditions. One possibility would be to limit the trade in kernels to those hand-cracked or, preferably, still in the nut so that damaged kernels with a rapidly rising f.f.a. would not be circulating in trade. If cracking the nut to get the kernel then became the first stage in the process for expressing the oil, a low f.f.a. oil would be produced.

Technologically this would be satisfactory. However, any move to make trade in cracked kernels illegal would be to deprive many women and children of a useful source of income. Also, economists would point out that there is a disadvantage in transporting kernels-in-shell, while the agriculturalists would add that a wide difference exists in different species in the ratio of kernel to total nut, and buyers would have difficulty in establishing a satisfactory payment basis.

But once a good supply of high quality palm kernel oil is available an oil refining industry can be set up in Nigeria. That in turn leads the way to hardening and production of the tailor-made fats so widely used in modern food processing.

Palm Oil Production:

Palm oil production has been carried on in West Africa for centuries. For much of the last century and the early part of this century, vast quantities were exported annually to Britain and Western Europe mainly

from Nigeria. This was in addition to the oil used in cooking. It was not for nothing that the Niger Delta was known as the Oil River. Although some was of edible grade almost all this oil was exported for use in the manufacture of soap and other non-edible products.

Today palm oil is still the most widely used vegetable oil in Nigeria for cooking. As such its production has been the subject of much study. But it must be admitted that West African palm oil is generally classed as being low standard in world trade. Palm oil from Zaire and the Far East countries is generally reckoned to be of much better quality. Indeed I must confess to surprise that there has been so little official pressure to change this and to avoid the poor image which Nigerian oil has among users.

It is hardly necessary to remind participants at this seminar that the quality of palm oil in world trade is measured by three attributes:

1. Free fatty acid content;
2. The presence or absence of water and other impurities;
3. Bleachability.

Most of the palm oil produced in Nigeria is produced under conditions in which quality as so defined is bound to be poor. That is the f.f.a. is high, water and vegetable impurities are present, and the oil has a poor bleachability.

I believe that there is available in Nigeria the necessary information and the required skills to change this picture in a relatively few years. However, absence of capital on the part of the peasant producers coupled with a ready market for what he does produce will not make the change an easy one to achieve. One must bear in mind that edible palm oil as desired by consumers, and therefore classed as a good quality for cooking food in Nigeria, has an f.f.a. of around 10 percent.

Three factors are known to be involved in the production of palm oil of high f.f.a. These are; first, the degree of ripeness of the bunches harvested; second, the period of time which elapses between harvesting and processing; and third, the care with which bunches are handled between harvesting and processing. The importance of these has been dealt with in papers at a symposium held in London in 1965, especially by C.W.S. Hartley.[5/] All that needs to be added here is that over-ripe bunches give an oil with a high f.f.a. And so also do bunches which have been roughly handled in transport with consequent bruising of the fruit.

None of the requirements listed above seems difficult to meet in normal farming practice. But those who know oil palm producers in Nigeria realize that often they are not met. Sometimes for good reasons; sometimes for what seem to be reasons not readily understood to others. Economic and sociological factors are both involved. Peasant producers are usually self employed and they have virtually no capital to invest either in labour-saving devices or aids to efficiency. Furthermore, they are members of an extended family system which puts heavy demands on their time and on such money as they possess. They may cut bunches at the correct degree of ripeness but if it rains these may have to lie at the bottom of the palm trees for days until the weather clears. The farmer has no labour except his own or that of his immediate family to carry them to a dry place in which to store and process them. So while it is easy to criticise the producer, one must also bear in mind his limitations.

Even if the weather is good, social factors may be involved to limit his time at the farm. For instance, a death or a funeral celebration or another family festival in the extended family may necessitate him being off the farm for several days while the f.f.a. in the oil in the bunches

at the foot of the trees in his farm continue to rise.

The absence of capital also affects the method by which the small producer extracts the oil from the fruit. In some textbooks there is a division of methods into those producing so-called "hard oil" and other methods producing "soft oil." In fact, however, there are wide variations of these methods employed.

The "hard oil" methods consist essentially of allowing the bunches of fruits to ferment in heaps or in long boxes or troughs. Fermentation may last for several days broken by intervals when the bunches are pounded with pestles to loosen the fruits in the bunch and to damage the tissues of the individual fruits to make easier the subsequent release of the oil. Finally the fruits are all removed from the bunches, mixed with a large volume of water, and the whole is heated till the water boils. The oil, or rather some of it, is removed from the damaged cells and it rises to the top of the water. There it is skimmed off and finally boiled to remove water skimmed off with the oil. Inevitably the method is wasteful, with much of the oil still remaining in the fruits. Also there is a large and variable amount of vegetable matter incorporated in the oil.

In the "soft oil" process the fruits are boiled in water in large earthenware pots with pounding, before and after boiling, to loosen the fruits and damage the cells to enable the oil to be removed. The pounded fruits are again treated with water and heated and the oil rises to the top and is skimmed off. It is treated to remove the water as in the other method.

Some producers, or groups of producers, have hand or power-operated presses including the well-known curb press. This is dealt with by Hartley.[6/] These do enable a much higher proportion of the oil to be removed

from the fruits and, given adequate maintenance, can prove profitable investments.

In recent years there has been an increase in the number of palm oil plantations with fully mechanised oil mills as an integral part of the project. These do produce oil of a much better quality and many of them are well managed and are profitable investments. The firm of Sork Gbr. Germany usually supplies the equipment which is well-adapted to West African conditions.

They replace the older Pioneer mills which were used in the 1930's and for the first few years after World War II. Some Pioneer mills are still operating and do not use centrifugation to remove water from the oil at the final stages. Boiling is therefore necessary. One mill manager told me that he boiled his oil for eight hours to remove the last traces of water! I hope that my face did not show the astonishment which I felt at this costly exercise and one which would seriously affect bleachability of his oil. It was a state-owned mill and no doubt the unit cost of the oil would receive less attention than in the private sector.

As has been pointed out by Coursey[7/] one further difficulty is the temperature of the oil in storage before shipment and also the nature of the containers used. The containers are often mild steel drums slightly or heavily rusted. The ferric oxide acts as a catalyst for autooxidative changes which affect bleachability especially at the high temperature of storage.

It is therefore not an easy matter to produce good quality palm oil in Nigeria for world markets even in a large, well-equipped mill. When you are a poor farmer the odds against you are formidable!

It is fair, I think, to put to this group of food scientists and technologists the question: What can be done about it? Immediately one must admit that there is no easy answer to the problem of producing

a dry oil of low f.f.a., uncontaminated with suspended vegetable matter, and of good bleachability. It is being done in other parts of the world. Locally, however, it might not be possible without creating serious sociological problems and injection of much capital into the agricultural sector.

What is possible is for the Produce Marketing Board to set up mini refiners into which all oil destined for export could be channelled. If the bleachability was above a certain value as checked in a laboratory, the oil would be diverted for home consumption. Other oils would be centrifuged to remove water and vegetable matter and then given a short refining neutralisation to get rid of f.f.a. Thereafter it would be chilled, held in cool storage, and transported in cool tankers to the ports. This is probably only a dream and those who know how Marketing Boards operate will share my scepticism at how well or otherwise such a scheme would be operated. I believe, however, that given the determination on the part of government and people it would be done. But the will to succeed must be there!

In fact a scheme such as this was in operation in Eastern Nigeria. Iwuckukwa[8/] in a paper read to the London Symposium dealt adequately with the measures in operation to improve the quality of palm oil before shipment in cleaning plants set up at the ports. These measures included removal of moisture and vegetable debris. The figures given in Iwuckukwa's paper show that, for example, the oil exported had a water content of 0.09 percent and a dirt content of 0.001 percent.

Hartley[9/], however, refers to one mill, operating under conditions of high efficiency in Nigeria, as producing oil with a moisture content of 0.4 percent and dirt (vegetable debris) of 0.02 percent. It is not easy, therefore, to reconcile these figures with those of bulk oil as given by Iwuckukwu.

At present no figures are available as much of the routine control operations in the eastern part of Nigeria were out of operation during the civil war in the late 1960's.

In addition a quite dramatic change has taken place in the production and export of palm oil as the following table shows:

Table V

Exports of Palm Oil (in tons)

Year	1963	1971	1972
Palm Oil - edible grade	118,921	11,309	14
(Value in Naira)	(17,910,850)	(2,120,580)	(2,990)
Palm Oil - inedible technical grade	6,762	8,601	1,885
(Value in Naira)	(819,412)	(1,267,760)	(242,716)

If the trend continues then obviously Nigeria will become a net importer of palm oil. In fact this has not yet happened (at least by March 1974) but the export figures are disquieting.

Groundnut Oil:

Although this is a matter of the utmost importance for Nigeria and for other West African countries I will need to deal with it in a very few minutes. I remember very vividly about two years ago making an extended visit to the north of Nigeria primarily to look at the high protein food industries--meat production, fish processing in the Lake Chad area, and the groundnut crop. At the end of that visit my main impression of the groundnut crop was the low level of its use for food in Nigeria.

A few years ago Nigeria was a very large producer of groundnuts and total crops of the order of one million tons were probably harvested

although the amount purchased by the Marketing Board was less. You will note that for the year 1972 the tonnage handled was 104,478 tons and this probably represents about four-fifths of the crop. The other one-fifth would be held by growers for their own use, local sale, and for seed for the following year. So the total crop would be about 125,000 tons.

Figures are not very easy to arrive at, but of this total, one-fifth would be exported as HPS (hand picked selected) nuts to Western Europe, mainly for confectionery purposes. Most of the remainder would be crushed for groundnut oil and for groundnut cake. This useful oil and cake should be used to enhance the diet of Nigerians, but this is not so!

Onely 40 percent of the oil extracted--the first pressings--are used as cooking fat. The remainder goes for export to be made into soap and other non-edible purposes.

The press cake from which the oil has been extracted is then milled and is exported to the U.K. or elsewhere in Western Europe for incorporation into cattle food. Recently, small quantities have been incorporated at Ikeja into cattle food by Pfizer Ltd. and this may develop into a large industry.

To anyone interested in the effective utilization of the agricultural resources of Nigeria it seems particularly unfortunate that some, at least, of the potentially valuable press cake with a high concentration of good quality protein does not become available for human consumption.

It must be added, of course, that the aflatoxin content in the meal will, at times, be above the level recommended internationally for human consumption. This is in turn the result of deficient agricultural practice in the field, mainly the fact that the nuts are allowed to remain in the ground after they are ripe. It is evident during this period that invasion of the nuts by mould takes place.

It is interesting to enquire why only 40 percent of the oil reaches the edible grade standard. It is not due to aflatoxin since this is not fat soluble. The answer is not known but is probably a combination of many factors such as market demand, quality of the nuts, and possibly of the crushing facilities available. This situation is certainly not in the best interest of the producing countries. A technological study should therefore be made of the quality of the oil and the factors governing its quality.

DEVELOPMENTS IN THE WEST AFRICAN FISH PROCESSING INDUSTRY

by

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In discussing this topic, both a retrospective and prospective view of developments in the West African fish processing industry will be taken.

It would be logical to start by considering the current state of development of the industry and to lead into a brief discussion of present and future problems.

This audience already appreciates the major role of fish in all forms as a protein source in West Africa. Table 1 will help to reinforce this appreciation. The West African states are arranged in order of decreasing per capita consumption of fish protein. Although the figures are for 1964-1966 they were published by FAO in 1971 and are the most recent available in Ghana.

The production of fish is a considerable industry. Tables 2 and 3 indicate the league table amongst West African countries in terms of total production (Table 2) and in terms of production per 100,000 population (Table 3). Note the importance of Senegal and Ghana as producers of marine fish and of Chad, Mali and Nigeria as producers of fresh and brackish water fish.

One must appreciate that these statistics can only give a broad indication of catch and consumption levels and that nobody lays claim to great precision for fishery or population statistics in the region at the present time. Most West African states and particularly the coastal ones are net importers of fishery products. Chad, Mali, Niger and The Gambia were the only net exporters in 1968-1969 and most of their exports went to

other West African countries. In other countries, however, demand for fishery products supports a sizeable import trade, although the recent trend shows a steady decline.

The last 25 years has been a period of dramatic change in many facets of the fishery industry while other sectors, particularly that of artisanal processing, have been little affected.

Both the introduction of nylon nets from the early 1950's onwards and the increasing use since about 1954 of outboard motors have greatly increased landings by the traditional canoe fishery. In-shore trawlers started operations during the 1950's and the 1960's saw the general growth of landings by modern deep sea boats either locally owned or on contract from Europe or Japan. These landings introduced sea-frozen fish to the region on a considerable scale.

This development was one of the factors responsible for the relatively recent diversification of the fish processing industry throughout West Africa and particularly in coastal West Africa. Twenty-five years ago it was almost exclusively artisanal in nature and found only in the immediate vicinity of the coast or inland waters.

The coastal processing industry was and still is characterised by its use of smoking as a method of preservation. The main products are a hot smoked fish which undergoes up to a 30 percent total weight loss and is destined for immediate sale, and a dry-smoked product processed to 25 to 30 percent of its original weight. The latter achieves considerable lowering of water activity which imparts increased stability and allows long distance transportation, or long-term storage. The latter is facilitated by regular resmoking to maintain a low moisture content.

Sun drying is only utilized for very small fish of the anchovy type and for larger salted fish where the deterioration occurring during the drying process is deliberate, and imparts the strong flavour to the product compatible

with its end use as a condiment rather than a major ingredient.

In contrast, the inland artisanal processing industry depends to a much greater extent on sun drying, although smoking, or scorching in the case of Banda, may be used as an adjunct.

Two other major sectors have been added to the processing field in the past years, both as a result of increases in marine fish production in the region. The first is a capital intensive canning and related products industry based principally on tuna, herring and mackerel types. Senegal is undoubtedly the leader in this field with 12 canning plants in operation by 1969 and total exports of canned fish on the order of 10,000 tons per annum.[1/] Ivory Coast has one principal fish cannery which utilized 2,300 tons of fresh tuna in 1968.[2/] Two concerns in Ghana have the potential for fish canning and there is a third unfinished cannery. One is a very small-scale plant, initially being part of a factory ship but later transferred to a land-based operation. The second, State-owned, was built in 1966 with the high potential capacity of 12,000 tons of canned product a year,[3/] but is only now being commissioned after a period of inactivity, and on a considerably reduced scale. In Nigeria, a canning industry is in the process of being established, one cooperative factory in S.E.State recently being announced.[4/] Sierra Leone had one small tuna canning plant in operation[5/] although there is no confirmation that it is still in production.

Industrial processing other than canning is extremely limited, catch volumes not being capable of supporting a fish meal industry based on waste products, although there is very limited production in Senegal and Ghana. In Ivory Coast, Nuoc-Mam, a fish hydrolysate of Vietnamese origin, is produced on a small factory scale for both the local market and for export.

The second recently-developed sector of the processing industry is that concerned with deep freezing and cold storage. The increased landings of

sea-frozen fish in the 1960's initiated the establishment of the now sizeable infrastructure of the cold chains in all West African countries. These deal both with fish for local consumption and with tuna for transhipment overseas. The establishment of the cold storage industry in turn gave birth to shore-based freezing facilities to deal with a proportion of the in-shore fisheries catch. Ice-producing facilities have also been established to service both the in-shore trawlers and to facilitate the distribution of fish to inland areas. One important part of the shore freezing industry is that dealing with crustacea, this also involving thermal pretreatment in most cases. This sector is principally export-oriented and is realizing the potential for this kind of fishery all along the West African coast.

CURRENT PROBLEMS AND POTENTIAL ACTION AREAS:

1. The Industrial Processing Sector

The West African fish canning industry encounters, in the main, problems common to the industry in any other part of the world and solutions are available for all but the fundamental research problems. This applies particularly to factory procedures, determination and adherence to process parameters, and to quality control. Straightforward product development may be involved, particularly in the cast of products for the local market where there is a preference for strongly-flavoured products. There does not appear at the moment to be the need for considering the utilization of other species by this segment of the industry apart from the tuna, herring and mackerel already canned.

The implementation of solutions to processing problems is of course another matter. This raises the point of the need for properly trained technologists as real here as in other sectors of the industrialized food processing industry. The provision of such technologists will, I am sure, be discussed in Dr. Woolfe's paper.

I would suggest that the current size of the industry does not justify basic research being conducted in West Africa although the cooperation of all bodies, including Universities, competent to help in the application and modification of advances developed elsewhere and to the resolution of the more mundane processing problems, is very necessary.

One field which is of concern both to the canning and to the freezing industry and which does need a local practical scientific approach to its problems is the question of raw material quality. Two problems present themselves here -- the quality of fish pre-freezing or pre-canning, and the maintenance of quality once frozen.

In the case of sea-frozen fish, the need for careful handling and minimum delay before freezing is really a question of education in the correct quarters. Poor packing of freezer compartments results in considerable damage, evident at least in the cartons of frozen fish available in Ghana. Sardinella in particular are relatively fragile and poor handling prior to freezing can only lead to significant wastage if they are later to be utilized for canning.

Land-based freezing operations, the canning of fresh fish, and indeed the larger question of the marketing of fresh fish all have the same quality problem. Fish landed from canoes and in-shore trawlers is usually in remarkably good condition. For multi-day voyages it is vital that spoilage mechanisms be arrested as soon as possible after the catch is taken from the sea. This also applies if the fish is to be transported prior to traditional processing or fresh sale, or if it is destined for quality processing by canning or freezing. Icing is the only answer.

Recent studies conducted at Britain's Tropical Products Institute have shown that the use of ice applied immediately after catching can extend the shelf life of certain tropical species caught in the Gulf of Guinea for at least 28 days.[6/] The temperature decrease to well below the normal ambient

of the enzyme and bacterial systems present is the suggested reason for the considerably reduced reaction and growth rates. These studies have confirmed that the use of ice is extremely effective in maintaining quality and has potential value as an alternative to freezing for intermediate storage periods or for long distance transportation. The choice between freezing and icing now seems to be a problem for feasibility planners and economists to deal with. Assurance of the correct icing techniques is again primarily a question of extension education.

Minimising the deterioration of frozen fish is a matter of good quality control. This involves ensuring the proper maintenance of cold storage temperatures and, therefore, of good working practices in the stores, and, secondly, achieving adequate stock rotation. The need for quality control personnel in cold stores has been realized by Ghana Cold Stores Ltd., the largest cold storage company in this country. In cooperation with the Food Research Institute an attempt is being made to establish a suitable system within the company.

The quality controller does, however, need to have an indication of the potential shelf life of the products handled under different temperature conditions. Here is a research need. While information exists for certain species, many of the tropical water species have not been studied in detail nor have techniques for quality assessment been evolved. Of particular concern are those fish high in lipids. A comprehensive study of the effect on shelf life of factors such as seasonal compositional changes, pre-freezing treatment and freezing and storage treatment is needed. This would help to avoid, for instance, the situation found in Ghana early in 1973 when considerable stocks of Sardinella spp. frozen the previous August-October were unsaleable.

2. The Artisanal Processing Sector

There has over the years been a series of development programmes

concerned with the fish smoking industry funded principally by FAO, although IDRC of Canada is currently supporting a major project in Ghana. Their aim has been to attempt to improve processing practices. Work has concentrated principally on smoking oven development and on process modification aimed at improving product quality. To date, however, in nearly all cases the impact has not been great. While existing types of oven design are undoubtedly inefficient in fuel useage and labour input and produce a highly variable product, the mere designing of more efficient small-scale ovens achieves little. It is the acceptability of those ovens by a significant proportion of the smoking population that is important, and people take a lot of convincing. After two years of contact with rural fish processing, I am increasingly aware of the importance of cost-benefit analysis techniques applied to proposed improvements and to the greater need for long-term extension work if worthwhile improvements are to be adopted. In the case of the rural fishery of Ghana's Central Region (and I suspect this may be true of a lot of other West African states) there is serious doubt whether there is an adequate, all year round supply of fish to justify the initial capital expenditure involved in an improved, controllable oven. With the increasing availability of frozen fish and the growth of the in-shore trawler fleet, however, the situation is gradually improving.

If fish volumes do justify consideration of improved ovens, there is a need for an evaluation of existing models available world wide rather than research on yet more improved small-scale designs. Concerted and long-term extension work could then be aimed at the introduction of the best design. The question of extension work is one currently much neglected, but is vital if improvements not only in smoking but also in general hygiene, improved transportation, packaging, etc., are to be achieved.

One of the fields which might benefit from extension work is that of hygiene. This is another field where basic information is lacking with

reference to fish processing and which needs professional investigation to highlight danger spots and help draw up and implement codes of practice.

In this sector the short shelf life of hot smoked products does not create as many problems as that of the smoke dried, longer shelf life product, e.g., Bonga, Sardinella, anchovy. There is a need for information on the factors affecting shelf life, and for the development of measures to extend shelf life, while minimising physical and organoleptic deterioration and insect infestation. Work has been undertaken at the Institute for Tropical Agricultural Products Technology and Industrialisation in the Ivory Coast on the changes in fish lipids during dehydration and storage.[7&8] Here in Legon we have been looking at the possibilities for introducing a simple, low-cost sealed polyethylene pack procedure for the long-term storage of dry smoked Sardinella spp. which would be operable on a village scale.[9] This should also have application to the storage of Bonga and Anchovy. The preference of Southern Ghanaians for a higher moisture content smoked fish has also initiated an investigation for a simple pasteurisation/sterilization measure for fish packed in a flexible package aimed at achieving considerable shelf life extension. The great problem here, of course, is that of the anaerobic spore forming bacteria. Chemical changes during processing and storage are being followed, particularly in the case of lipid oxidation.[10]

Insect infestation by Dermestes beetle has always been a problem of dried fish in tropical areas. While it is certainly present amongst dried marine fish in Southern Ghana, it is not a serious problem. In contrast, infestation amongst the sun dried fish of the inland artisanal fishery is one of the most serious problems. The West African Stored Products Research Unit estimated in 1961 that the Lake Chad fishery of Nigeria suffered up to a 50 percent loss of protein as a result of infestation.[11] The 1964 FAO report by Aref indicated the seriousness of the problem in Mali.[12] Quality improvement of dried fresh water fish is probably another area where extension work implementing existing suggestions for the reduction of infestation is urgently

called for.

The importance of the processing sector in the inland fishery continues to broaden as the new lakes are created and as fish culture schemes proliferate. Additionally the use of ice in this sector has possibilities if a quality market can be established although no industrial scale operations at the level found in East Africa are yet contemplated.

3. Training Needs

No one questions the fact that fish handling and processing in West Africa and indeed all tropical Africa could be improved. The greatest training needs lie at two different levels. The first is at the producer level by extension education. So much is already known about potential solutions to the problems and yet so little has been done to implement these solutions by serious long-term extension work in its widest sense, i.e., taking a total look at all the problems -- technological, social and financial. The establishment of national fisheries processing extension services could be part of a broader food technology extension service for which there is need.[13/] Universities and national food research organisations would be the prime movers, and possibly operators, of such a service, thus serving the community in a positive way and avoiding the criticism of being introspective.

The existence of extension services requires trained personnel to run them. While university courses are available in Food Technology as a broad subject I wonder if a case can be made for one African university department to offer specialised training in fishery technology, perhaps both at a diploma level and at a post-graduate level. Perhaps such a course should be offered by the proposed Organisation of African Unity's Centre of Excellence (Competence) in Food Science, if and when it is established. Such courses would provide African fisheries workers the chance of studying within the environment they will encounter on their return.

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TABLE 1 DEVELOPMENTS IN FISH PROCESSING

Average Net Per Capita Consumption of Fish Protein in West African States - 1964-66

State	Net per capita consumption fish proteins g/day	Fish protein as percentage total non-veg. protein	Fish protein as percentage total protein
Senegal	9.8	46.0	14.9
The Gambia	8.1	55.5	12.8
Sierra Leone	6.0	66.0	12.05
Chad	5.7	41.3	7.25
Ivory Coast	5.6	43.5	9.34
Ghana	4.3	59.0	9.84
Mali	4.1	27.4	5.95
Dahomey	3.9	48.8	7.45
Liberia	3.7	43.5	8.9
Nigeria	3.3	64.8	5.59
Togo	3.2	45.5	6.20
Upper Volta	0.9	17.0	1.25
Niger	0.2	16.0	0.25
(United Kingdom)	4.3	8.1	4.85
(France)	5.8	10.3	5.9
(Japan)	14.5	59.3	20.0

Source: Calculated from data presented in FAO Food Balance Sheets, 1964-66, FAO, Rome, 1971.

TABLE 2

DEVELOPMENTS IN FISH PROCESSING

Nominal Catch of Fish by West African States - 1970-71*

(Catch in thousand metric tons)

State	Total	Marine	Marine as % of total	Inland	Freshwater as % of total
Senegal	214.5	195.1	91.7	19.4	9.3
Ghana	195.9	158.9	81.2	37.0	18.8
Nigeria	155.8	62.3	40.0	93.5	60.0
Chad	120.0	-	-	120.0	100.0
Mali	110.0	-	-	110.0	100.0
I. Coast	60.25	55.0	91.3	5.25	8.7
Dahomey	32.2	9.45	29.0	22.75	71.0
S. Leone	30.6	29.6	96.7	1.0	3.3
Liberia	23.0	19.0	82.6	4.0	17.4
Niger	10.25	-	-	10.25	100.0
Togo	7.45	4.7	63.0	2.75	37.0
The Gambia	5.9	5.1	84.3	0.8	15.7
U. Volta	5.0	-	-	5.0	100.0

* The average of the nominal catches for 1970-1971 has been given. Nominal catches include all fresh and frozen fish landed in the ports of the states concerned.

Source: Calculated from data presented in Year Book of Fishery Statistics, Vol. 32, 1971, FAO, Rome, 1972.

TABLE 3

DEVELOPMENTS IN FISH PROCESSING

Nominal Catch of Fish per 100,000 Population
by West African States - 1970-1971*

State	Population in Millions (1971)	Nominal catch (m. tons) per 100,000 population
Senegal	4.022	53.3
Chad	3.800	31.6
Ghana	8.858	22.1
Mali	5.143	22.0
The Gambia	0.375	15.75
Liberia	1.571	14.7
I. Coast	4.420	13.7
S. Leone	2.600	11.8
Dahomey	2.760	11.7
Togo	2.022	3.68
Niger	4.126	2.9
Nigeria	56.510	2.75
U. Volta	5.491	0.91

* The average of the nominal catch for 1970 and 1971 has been given.

Source: Calculated from data presented in Yearbook of Fishery Statistics, Vol. 32, 1971, FAO, Rome, 1972.

INDUSTRIAL DEVELOPMENT IN FRUIT AND VEGETABLE PROCESSING IN NIGERIA

by

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INTRODUCTION:

In preparing this paper I found myself inexorably drawn to shift from a broader West African focus to just that of a single country -- Nigeria. I have taken the liberty to yield to this impulse in the firm belief that regional generalizations, qualitative or otherwise, based on the existing body of agricultural and industrial statistics will not advance the fundamental objectives of this gathering very far. This statement needs to be qualified in respect of the major foreign exchange earners such as cocoa in Ghana and crude petroleum in Nigeria for which international commerce furnishes a fair amount of reliable data. However, in respect of food crops such as fruits and vegetables which do not feature prominently in international trade, the paucity of existing information and its inherent inaccuracies constitute a major handicap and pose far-reaching challenges for professional bodies concerned with economic and/or technological development in West Africa. Needless to say, Nigerian national statistics upon which much of this paper is based is fraught with the same basic dangers. However, in claiming an appreciation of the character and limitations of the Nigerian data, I consider it a much safer spring-board from which to proceed.

Fruit and Vegetables Classified:

On account of the contextual application of the terms "fruit and

vegetable" in food technology, it seems necessary that we should establish at the outset the extent of the range of products with which we are concerned in West Africa when these terms are used.

Food processors, marketing laws and the consuming public, in the somewhat sophisticated eating habits of much of the developed world, make the distinction between fruit and vegetable largely on a usage basis. Those plant items that are generally eaten with the main course of a meal and which are commonly salted or at least not sweetened are classed as vegetables. Those botanical fruits which have fragrant aromatic flavours and are either naturally sweet or are normally sweetened with sugar before eating, i.e., which are essentially dessert items, are classed as fruits.

These normative criteria appear to have received wide acceptance among food technologists in the tropical world.[1/] Table 1 is an attempt to put together a comprehensive list representing commodity categorization suggested by current eating habits in West Africa.[2&3/] The list need not be complete since it is bound to grow as regional food habits in West Africa assume higher levels of sophistication.

Within the vegetables it is possible to distinguish a sub-class of the various starchy commodities which assume the role of staple foods in West Africa. Prominent among these are cassava, yams, plantains and cocoyam. Cassava, in the form most popular in West Africa, is probably better considered a fermented starchy product rather than a vegetable. Because of their textural similarity to the potato, yam, cocoyam and sweet potato hold a considerable potential for innovation by food technologists. A recent article[4/] explored this possibility at length with particular reference to yams. In the last three years or so, Cadbury (Nig) Ltd., one of the major food manufacturers in this region, has made

considerable progress with the manufacture of pounded yam flakes. This is a product made in much the same manner as mashed potato flakes, using the same basic technology. The yam is peeled, sliced and cooked by steaming. The cooked yam is riced or mashed, then pounded to a heavy dough of high visco-elasticity. This dough is diluted for convenient application on a double steam-heated roller dryer where it is flaked. The flakes reconstitute to a pounded yam acceptable by any standard.

Similar research in Puerto Rico,[5/] the Caribbean[6/] and at the Tropical Products Institute, Culham, England, has elaborated a process identical to the one described above for the manufacture of mashed yam and mashed sweet potato flakes. These developments obviously hold interesting possibilities for food technologists in West Africa. They are indicative of the tremendous value of adaptive research as a powerful instrument of technological change. However, it is not really the more obvious aspects of this development which concerns me in this paper. Perhaps of far more significance are lessons that can be drawn concerning the dual role which food technology must play in upholding the traditional, while promoting a gradual and constructive evolution of the food habits of our people. Developments in yam processing provide a classic case study of this dichotomy.

Certainly yam fufu will long continue to play an important role as a traditional starchy staple in West Africa. The challenge to preserve yams and advance the preparative techniques for yam fufu beyond current traditional methods is being met by food technology. Flaked pounded yam is conceived as a packaged, preserved, convenient, hygienic product which will satisfy African tastes and prejudices. It should be economical to use if its processing also provides one effective means of stemming the

present staggering tide of storage losses sustained with the yam crop in West Africa.[7/] The second important side of this development deals with a desire by the food industry to cater to the needs of a small but growing class of people of relatively high purchasing power whose tastes are in a state of flux. This class would use yam and its processed forms in much the same way that potatoes are eaten in more sophisticated diets--as a vegetable, mashed in some cases, boiled in others, but always served with meat or fish or as an ingredient in a salad.

It seems clear that both kinds of challenge will need to be met. As far as the food industry is concerned, it is reasonable to assume that the direction and tempo of its development will be dictated in the final analysis by vital profit incentives. However it is hoped that food technology will recognize, at an early stage, its responsibility to provide services not only to an elite minority whose purchasing power is likely to provide the greatest financial gain, but also to the general public, which is fundamentally impoverished.

SOME STATISTICS:

Present Status of Fruit and Vegetable Processing in Nigeria

Estimates of total domestic supply of fruit and vegetable in Nigeria for 1968 have been placed at 1,298,056 metric tons.[8/] This figure excludes maize, potatoes, yams, cocoyams, plantains and cow peas from the list of commodities considered as vegetables. Another 5,221 metric tons of fruit and vegetables of the same general description were imported in processed form. This can be seen from Nigerian import statistics (see Table IV) in the 1968/1969 period. Estimates put together from an enquiry made from processing companies in Nigeria are summarized in Table III. This table shows that a total quantity of 761 metric tons

or processed fruit and vegetable products were manufactured by all domestic sources in the period under reference.

This figures indicate that less than 1 percent of the total domestic supply of fruits and vegetables was processed by commercial firms in Nigeria in 1968. Expressed as a percentage of all processed fruit and vegetable products consumed in that year, domestic processing accounted for approximately 13 percent. From 1968 domestic production began to experience a welcome upsurge brought about by two apparent factors. First, the entry into the manufacturing business of a small number of new firms; and secondly, an observed steady climb of annual output by each plant. As a consequence, domestic production figures rose to a total of 4,314 metric tons or 8,629,000 (No. A2) cans of processed products in 1971/1972. In this period, domestic processing thus accounted for approximately 30 percent of all processed fruit and vegetable products consumed in Nigeria. Although this rise is very small when considered in terms of gross national consumption, it is somewhat commendable if its substitutive function for imports, as well as the associated linkage effect to domestic employment, are considered.

Table II shows that a surprisingly small number of firms are involved in fruit and vegetable processing in Nigeria. It is important to place those firms briefly in a proper industrial and historical context.

Lafia Canning Factory: Lafia Canning Factory in Ibadan, Western State, Nigeria, was started in 1954 as a general cannery for fruit and vegetable products. The factory has a designed annual capacity in excess of 20,000 tons of raw materials which can be finished into canned fruit and vegetable pieces, slices, segments, juices, purees and concentrates. It is owned by Western Nigerian Development Corporation, a wholly-state government corporation. The plant has a permanent staff of about 60 including a manager, accountant, clerks, plant engineer, process foremen and maintenance staff; a field department responsible for procuring raw

materials; and a quality control laboratory which is not adequately staffed. Unskilled process labour is employed on a daily basis.

In the 1971/1972 processing season, only 2,000 tons of raw material were processed using an average unskilled labour force of 10,000 man-days (5- workers/ton is required by government regulation) on a fixed daily wage of ₦ 0.80/worker. This volume, representing only 10 percent of the plant annual capacity, was processed over a period varying from six to eight months depending on the pattern of availability of raw fruits and vegetables in a particular year. The plant runs consistently under capacity throughout this period. Grapefruits, oranges and lime are processed from November to April, mangoes in May and June and guava from July to September.

The primary problem with this plant is clearly inadequate supply of raw materials. This accounts for the fact that in recent years its best performance has been achieved while producing just 10 percent of its rated capacity (1971/1972). Its products are in very high demand as can be seen from order requests in company files far in excess of annual output.

Cadbury (Nigeria) Ltd.: This is one of the three leading food firms in Nigeria. It has operations in other parts of West Africa, notably in Ghana. In both Ghana and Nigeria, Cadbury's primary interest until recently has been in cocoa-based beverage products (Pronto and Bournvita) and a line of sugar confectionery goods. In 1968 this company began a new line of canned tomato sauce product consisting of hot pepper in tomato puree with a brand name of "Tomapep." Initially this product was manufactured with locally-grown and dried red pepper, and imported tomato puree. In 1968 a total of 380 metric tons or 760,000 (No.A2) cans of "Tomapep" were marketed. By 1973 this figure rose to an impressive

value of 2,124 metric tons or 4,247,191 (No. A2) cans with an additional 382 tons or 464,045 (No. A2) cans of tomato puree.

Once the brand name achieved a certain measure of acceptance, Cadbury then proceeded to establish a 60-tons/day tomato puree plant in Zaria, Northern Nigeria. Although the plant was completed nearly two years ago, it has not begun full production because of a lack of adequate supplies of raw materials.

In the last one and a half years, a contract procurement programme for raw tomatoes for the factory involving a large number of small holders has been initiated. The company supplies seeds, fertilizers and other inputs including the services of agricultural advisers. This method is now well established in the developed world as an effective approach to raw material supply problems. It has been applied with success in the tobacco industry by the Nigerian Tobacco Company. However, as far as food crops of high perishable character are concerned, Cadbury's experiment is a pioneering one which holds interesting possibilities.

One of the real problems of this arrangment is the inability of illiterate farmers to understand their responsibility to a contract partner. During the last season when the first good crop came in many farmers sold their tomatoes to outsiders willing to pay double the contract delivery price of ₦ 0.02/pound. Although this naturally upset Company expectations, there seems to be general optimism at Cadbury that given time these farmers can be educated to appreciate the mutual benefits of a contract arrangement and honour its obligations.

Cadbury has also recently started a black-eye beans (cowpeas) in tomato sauce line with the brand name of "Beano." After only one year of production and marketing, this line has had to be suspended because of astronomical

rises in the price of dried beans. The rise is not unconnected with the current drought which has had such a profound effect on agricultural productivity in the Sahelian zone. "Beano" was also plagued from its inception by insect infestation problems which made the manufacture of a completely wholesome product almost impossible. It is not quite clear whether this line will revive with the passage of the current drought.

Some mention was made at the beginning of this paper to a flaked pounded yam product now almost reaching marketing stage at Cadbury. Even at this uncompleted stage in its development, this product has demonstrated the adaptability of food technology to meet African food needs.

Vegetable and Fruit Processing Ltd., Gombe, North Eastern Nigeria: This firm is about five years old and was started as a joint venture between the North East State government and private investors. The company runs an estate of several thousand acres with most of it in citrus fruits, but parts under irrigation are planted with assorted vegetables -- tomatoes, onions, lettuce, cabbage, carrots, radishes, etc. A 50,000-tons/year processing plant for manufacturing canned fruit and vegetable products has been completed. Although the company has had tomato puree on the market for well over two years, it seems to be undergoing some serious teething problems which appear to be both managerial as well as political in nature.

In 1973, following a government investigation into the affairs of the company, its operation was temporarily stopped. It has commenced production again in the last few months but as yet makes only a small contribution to the domestic production figure.

Scanty reports available at the time of writing this paper indicate that inadequate supply of raw materials to sustain the operation of the factory is central to its problems. The company had at one time run into difficulties with the Nigerian Standards Organization over the problem of marketing reconstituted tomato powder as tomato puree. This once again underlines the raw material supply problem.

Other Firms: Two other organizations deserve mention in this report. One of them is Blaize Memorial Institute of Abeokuta, Western Nigeria, which has marketed jams, marmalades and orange squash produced from its small processing plant for a little over two decades. Blaize Memorial is a non-profit organization involved in the development of rural resources and rural manpower. The processing plant was developed along with about 50 acres of citrus plantation as a means of raising funds to support other projects of the institute. Over the years, both the plantation and the processing plant depreciated without refurbishing. The operation appears to have finally collapsed two years ago when no person or organization could be found to make a substantial financial loan needed to revitalize it. Products from Blaize may still be found occasionally in the market.

Moon Enterprises, started in 1972 at Ibadan, makes a product with the brand name of "Obese" which is a mixture of ground pepper and onions in tomato sauce. This firm, probably best described as a cottage industry, is housed in a small hut on the outskirts of Ibadan on the motorway towards Abeokuta. Its resources appear to be very meagre and its operation clearly suffers from inadequate managerial attention. Estimates of total production in this factory in its first year of existence are placed at below 50,000 (No. A2) cans.

PROBLEMS OF THE FRUIT AND VEGETABLE PROCESSING INDUSTRY:

After outlining the evolution of the existing industry, it is now appropriate to attempt an analysis of its major problems. In spite of continuing expectations, fruit and vegetable processing in Nigeria has not yet come of age as a successful industry. There are many problems which must be overcome before these high hopes become a reality, among them those connected with raw material supplies, choice of technology, infrastructures and capital investment. I do not propose to consider all of these problems in this paper but will attempt a comprehensive coverage of the first three in the short time available to me.

1. Raw Material Supply:

The basis for a successful processing plant is the availability of raw material. Acute shortages in the supply of produce to fruit and vegetable processing factories constitute the most serious problem to the industry. The heart of the problem lies in the security of supply, at a reasonable price, in the necessary quantity and high quality, for an extended period.

The three major fruit and vegetable companies as we have seen are Lafia, Cadbury and Vegetable and Fruit Processing Ltd. The three plants have processing capacities ranging between 18,000 and 50,000 tons of raw material yearly. All three plants are very much under-utilized at the present time. In 1972/1973, Lafia achieved only 10 percent of its rated capacity. The much newer plant at Gombe achieved barely 40 percent of its rated capacity.

Lafia uses an open-market purchasing method for procuring over 95 percent of its raw materials. Its continuing difficulties over 20-odd years of existence show conclusively that the present conditions of agricultural production in Nigeria cannot guarantee security of supply of raw

materials to the factory at a reasonably low price. It is no longer valid to think that seasonal surpluses guarantee a successful processing industry.

Cadbury's contract-purchasing arrangements in the North represent one possible alternative approach to a difficult problem. Education appears to be an essential prerequisite to the success of this approach. Learning is required at both ends of the contract; on the part of the farmer is understanding his obligations in a contract, on the part of the firm in correctly appraising the farmer's psychology. Everything we know about the Nigerian farmer points to a strong moral commitment to verbal contracts between familiar persons or communities. Does this same moral code hold in the case of a contract between a farmer and an impersonal corporate giant? The provisions of a contract may need to be quite different from those laid down in a Western culture.

The Vegetable and Fruit Processing Ltd. uses a plantation approach. Its problems appear to be mainly on the agricultural side. Good management together with expertise on both the processing and agricultural ends are essential requirements.

No sustained experience in the so-called nucleus estate approach has been identified so far in Nigeria in relation to fruit and vegetable processing. One option of this arrangement which recommends itself strongly in our circumstance is that in which an estate of sufficient size is developed to satisfy the break-even requirements of the processing plant. Such an estate strives to enter into contract arrangements with small holdings on its fringe for additional supplies to the plant. This pattern permits the plant to retain crucial control over its security while its profits margin is defined by the extent of contract arrangements or magnitude of open-market purchases.

Packaging Material: The rising cost of tin cans must be viewed with the utmost concern by the fruit and vegetable industry. Although alternatives to tin plate have been a subject of research in the developed world for some time, no effective substitute to it seems likely just now.

In Nigeria, this difficult situation is made even worse by two factors. One of these is the relatively high import duty imposed on tin plates or empty flat cans. Recent revisions which have reduced the level of these taxes constitute a step in the right direction. However, food technologists can do something to further reduce or even eliminate these taxes by actively educating the government about the nutritional implications of such taxes for the poor consumer.

The second problem has to do with local manufacturing of tin cans in Nigeria. Countries like Tanzania and Kenya have been making cans for many years through their national subsidiaries of the British Metal Box Company. In Kenya, recent information 10/ indicates that the unit price of No. A2 cans is in the range of £ 0.03 (sterling) early in 1974. This figure compares very favourably with current prices in England. The Nigerian Metal Box Company has been in existence for many years and appears from my recent visit to their factory to be running an efficient and relatively up-to-date plant. However, costs of cans remain significantly higher than their overseas equivalent.

The more favourable outlook in Kenya appears to derive first from a more lenient import tax policy, and secondly because the volume of business in canned foods in that country is much bigger, thus giving it the benefit of economies of scale. By F.A.O. estimates, the minimum size of an economic can making plant in 1965 was one producing between 15 to 20 million

cans per year.[11/] By 1973 figures, Nigerian can requirements in the fruit and vegetable industry was at the 10 million level. The speaker has not examined the potential needs for tin cans in other commodity lines of the food industry. The prospect, however, exists that an increase in domestic requirements for tin cans will hopefully stimulate higher volumes of production with attendant lowering of unit production cost. The effect of all this on the competitive position of canned fruit and vegetable products will certainly be interesting to see.

2. Appropriate Technology

The problem taken up here addresses itself to the fundamental question of choice of technology in food processing. It poses the following question: Of the four routine techniques for fruit and vegetable preservation, namely dehydration, sugar and salt preserves, canning and freezing, which is the best from an economic and social point of view? The question does not appear to have been considered fully before the canning plants came into Nigeria.

To aid a systematic examination of this problem, a comprehensive check list of the important parameters of choice is presented in Table 5. If the factors considered are indeed the critical ones, then dehydration in its simplest forms features convincingly as the optimal choice in our circumstances.

Drying processes in simple tray and tunnel dryers constitute a logical modernisation of traditional sun drying practised in all villages of this country. Dehydrated products are already well accepted at all levels of the society, and consequently the introduction of an assortment of new dried fruit and vegetable products should bring very few, if any, difficulties. Packaging of dried products in plastic bags is inexpensive and will ensure a reasonable shelf life. Although the nutrient quality of

dehydrated foods are generally considered somewhat inferior to canned and frozen foods, they are actually superior when considered in terms of nutrient conservation per unit of currency spent. Cruess[9/] stated in his book that dehydration made it possible to provide a healthful, varied diet to the allied forces during the Second World War in spite of the serious shortage of freighter ships. It will probably remain a mystery why food technology in developing countries in the aftermath of World War II failed to take a cue from the tremendous industrial developments in fruit and vegetable dehydration which took place during the period of that war.

The relative simplicity of drying technology suggests that a good proportion of its hardware can be developed and fabricated locally. The raw material requirements for dehydration plants are, qualitatively speaking, far less stringent than those demanded for canning or freezing processes. Technological simplicity implies lower capital costs when a new plant is set up. Dehydration therefore lends itself well to the establishment of small-scale food industries in rural areas. Overhead costs for such operations are low, and the effects of raw material scarcity where they exist are not as pronounced as they could be for bigger plants or more complex processes.

Dehydrated fruit and vegetable products retail at between 30-35 percent of the price of their canned equivalents in American supermarkets. Estimates are that these figures can be reduced to between 10-20 percent in Nigeria. If the cost breakdown for a typical canning operation presented in Table VIII is examined, at least two major savings can be made. The first is involved with a change of packaging from No. A2 cans currently priced at ₦ 0.08 in Nigeria (when ordered in 1,000/lot) to a 0.004 inch thick

polyethylene bag sealed thermally, at a current price of ₦ 0.004 when ordered in 1,000 lots from Nipol, Ibadan. Considerable cost savings will secondly be made in packaging on account of volume and weight reductions of between 3 and 20 of their original values brought about by drying. Other manufacturing costs can be reduced to perhaps as low as one-fifth the value shown in Table VIII. This statement is based on American unit production figures[12/] which place the average cost of drying in 1973 at 1.00 American cent per pound of water lost from fruits and vegetables during dehydration.

These cost figures are important especially when considered in the light of the steep rises in the cost of empty cans taking place over the last 30 years. Table VI shows that the cost of tin cans has quadrupled in this period. Table VII depicts a further astronomical mark-up in the price of cans upon importation into Nigeria. These factors, coupled with excessive overhead costs dictated by under-capacity operation of expensive canning plants, will ensure that canned fruit and vegetable products will always remain out of reach of low income families. Such families constitute over 90 percent of Nigeria's population.

When considered in those terms, the choice of appropriate technique becomes a most serious and fundamental one for food technology in countries such as Nigeria. In the application of food science and technology for the benefit of developing countries, attention will need to be given to indigenous products and to socio-economic conditions under which these products are utilized. Although the industrial sector continues to strive to establish food industries mainly to cater for the needs of a small but growing middle class with the right purchasing power, or else for export trade, food technology as a profession must not lose sight of its responsibility to cater to the welfare of the general public. There is

need therefore to give careful consideration to what the majority of people have been eating for centuries and to encourage and assist in improving this traditional diet. Improvement should be in the form of modernisation of traditional procedures by the development of equipment for the manufacture of local products. This, in my view, is the most crucial way in which food technology can best serve African needs, i.e., by aiding the economic and social development of all the people.

One hypothesis proposed which could give an important index for deciding when a food processing technique is appropriate or not for a country is:

"Any food processing technique which cannot market its product at an average annual cost cheaper than its fresh equivalent is probably the wrong technique."

At least one economist at Ife thinks that this statement sounds right. If applied to the fruit and vegetable canning operations in Nigeria, it does not hold.

3. Problems of Infrastructure:

These relate to difficulties arising from unavailability of certain essential services. Such problems are obviously not exclusive to the fruit and vegetable sector or in fact the food industry alone, but pervade the entire industrial community of any developing country. In the case of Nigeria real serious problems persist in respect of the following specific matters:

Water - Difficulties persist in the supply of sufficient volumes of water of high enough purity for processing. Factories in towns such as Ibadan must find ways of operating in spite of almost weekly interruptions in city water supply. Factories in rural communities must develop their own pumping wells and water treatment plant. This is usually expensive.

Waste Disposal - Very little attention has been given by food technologists to the serious problem of liquid waste disposal in Nigeria. All food factories without exception at the present time operate without any form of waste treatment facility. This trend must be viewed with serious concern from a sanitation point of view. For food factories located on a farm estate, the easiest solution to this problem is to provide a holding aerobic lagoon for the period of the rainy season. Crops are then irrigated from the lagoon during the dry season.

Generally, solid wastes from fruit and vegetable processing do not pose serious difficulties since these are easily fed to livestock.

Transportation - Difficulties in transportation still persist. Access roads to farms do not exist and often must be contracted by a processor who wants to take delivery of raw produce from a remote farm. Current improvements now taking place on major roads in Nigeria will be of considerable help.

Railway facilities in Nigeria are still very inadequate and this is likely to remain so for well into the future.

Power - Electric power supply to rural districts is inadequate. Rural factories must have their own plant for power generation. In cities where power is available, factories still run their own supporting generation plants as the only way to cope with frequent power failures.

Training, Research and Extension - These are just beginning in food technology and it will be a long time before an effective level can be expected. The lack of extension will hamper developments in the small and medium size industries which can benefit most from government-sponsored extension services.

Finance - Credit facilities are still difficult to obtain, although improvements seem imminent, with the establishment of federal agricultural and industrial credit banks. Also the major private banks such as Barclays and Standard have opened up new divisions of agricultural credit. The requirements for collateral guarantees by these banks still constitute major difficulties that must be surmounted. The indigenization decree currently being implemented could hold new possibilities for fruit and vegetable processing.

Food Legislation: A sub-committee has been set up by the Nigerian Standards Organization in 1974 to develop draft standards on fruit and vegetable products. The author was fortunate enough to have been appointed a member of this committee. Drafts for processed tomato products are now in the final stages of completion. These drafts are essentially adaptations of the Codex Standards. If properly conceived, these standards could be an effective way to get steady improvements in product quality.

Distribution and Marketing: The necessary information regarding the extent and nature of demand are not available. Market studies and analysis of sufficient scope have not been done. This will be one problem the industry will take some time to solve.

CONCLUSION:

This paper has attempted to chart the development of the fruit and vegetable processing industry in Nigeria. In surveying the past history and present status of that industry it is hoped that a base for projecting future developments can be established.

A number of parameters have been identified. Solutions to these

problems, it is believed, hold the key to the development and prosperity of an industry which has not quite found its feet. Solving the problem of raw material supply to existing factories is crucial for their survival in the short term. Possible approaches to this problem are considered. However, it is contended that the problem of correct choice of technique most suitable to our national needs is a much more fundamental one which the industry must face in the long run.

The author originally set out to explore the West African fruit and vegetable processing industry, an undertaking which soon proved too ambitious for the time and resource material available to him. What has been covered is therefore restricted in this sense. However, many of the problems raised have regional relevance and it is hoped that the thoughts offered will generate useful dialogue from which a better regional picture will emerge in due course.

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TABLE I

Fruit and Vegetables Defined in Terms of Common or Potential Usage in the West African Context

FRUITS	VEGETABLES
Avocado	Bean, pea (legumes)
Banana	Carrot
Date	Cucumber
Pineapple	Egg plant
Mango	Lettuce
Guava	Garlic
Pawpaw	Onion
Orange	Pepper
Grapefruit	Okras
Lemon	Tomatoes
Tangerine	Spinach and other green leafy vegetable
Cashew apple	Sweet corn
Passion fruit	Yams, Potatoes, Sweet Potatoes, cocoyam
Soursop	Plantains
Pomarac	Squash
	Bread Fruit

TABLE II

Nigerian Firms Manufacturing Fruit and Vegetable Products

Firm	Products Currently Manufactured
1. Lafia canning factory, Ibadan. Owned by Western Nigeria Development Corporation. Started in 1955. Potential capacity 20,000 tons of raw fruit per year. Capacity achieved in 1973: 2,000 tons. Raw material procurement mainly by open-market purchasing.	Manufactures an assortment of canned fruit products and a small quantity of whole, peeled and tomato juice in cans. Main line is given as follows: Citrus: Orange juice, lemon juice, lime juice, squashes, grapefruit juice (sweetened and unsweetened), grapefruit segments. Pineapples: juice, crushed, slices, pieces (tidbits). Mangoes: juice, pieces and slices. Guava: nectar. Tomatoes: whole peeled and juice. Cashew nuts: salted and fried nuts in plastic bags. Palm oil: tinned.
2. Cadbury (Nig.) Ltd., wholly private. Started to make Tomapep in 1968. Potential capacity at the Zaria plant: 60 tons/day of raw tomatoes. Raw material procurement through contract purchasing from small farmers.	Tomato products: Tomapep, puree. Blackeye beans (cowpeas): In tomato sauce ("Beano")

TABLE II (Continued)

Firm	Products Currently Manufactured
3. Vegetable and Fruit Processing Ltd., Gombe, North East State. Joint venture between State Government and private interests. Started in operation in 1970. Potential plant capacity 50,000 tons of raw material/year. Capacity achieved in 1973 - 27,000 tons. Raw material obtained wholly from own plantation.	Tomato products: puree Company produces onions, radishes, cucumbers, lettuce, cabbage, etc., for fresh market.
4. Blaize Memorial Institute, Obeokuta, more than 20 years old. Owned by a non-profit organization. Closed a year and a half ago because of inadequate funds.	Jams, marmalades and orange squash.
5. Moon Enterprises, Ltd., Ibadan. Wholly private. Very small and not as yet fully established.	Obese - mixed pack of onions and pepper in tomato juice.
6. Others: There is one factory already installed at Upper-Ogun, 60 tons/day capacity for tomato puree. Plant has not been running due to raw material supply difficulties. Another factory is being planned at Abeokuta. Several other plants are probably being planned in all 12 states of the Federation. For example, in Kano the Nigerian Canning Company has begun processing canned tomato and mango products in addition to their regular meat line.	

TABLE III NIGERIAN PRODUCTION FIGURES FOR CANNED FRUIT AND VEGETABLE PRODUCTS - 1967-1973

Manufacturer	Tonnage raw material processed in metric tons	Production in metric tons of canned goods	Production in total no. of can (A2) manufactured	Type of Products Manufactured
Lafia Canning Company	1304	1967/68 238	472,640	Pineapples: Juice, pieces, slices and crush. Grapefruit: Juice (sweetened and unsweetened), segments and broken pieces. Oranges: Juice and squash. Lemons: Juice and squash. Mangoes: Juice, pieces and slices. Guava: Necta (juice) Tomato: Juice and whole peeled.
Other Companies		100	200,000	Orange squash, jams, marmalades, mainly from Blaize Memorial
Total for 1967-1968		338	672,640	
Lafia Canning Factory	1544	1968/69 281	562,000	Same as above
Cadbury		380	760,000	Tomapep
Others		100	200,000	Orange squash, jams, marmalades, mainly from Blaize Memorial
Total for 1968-69		761	1,522,000	

TABLE III (Continued)

Manufacturer	Tonnage raw material processed in metric tons	Production in metric tons of canned goods	Production in total no. of can (A2) manufactured	Type of Products Manufactured
Lafia Canning Factory	1700	1969/70 309	618,000	Same as above
Cadbury		852	1,704,000	Tomapep
Others		200	400,000	Orange squash, jams, marmalades and some tomato puree from V.F.P. Ltd.
Total for 1969-1970		1361	2,722,000	
Lafia Canning Factory	1798	1970/71 327	654,000	Same as above
Cadbury		1686	3,372,000	Tomapep
Others		500	1,000,000	Orange squash, marmalades and jam from Blaize. Tomato puree from Gombe.
Total for 1970-1971		2558	5,026,000	

TABLE III (Continued)

Manufacturer	Tonnage raw material processed in metric tons	Production in metric tons of canned goods	Production in total no. of can (A2) manufactured)	Type of Products Manufactured
Lafia Canning Factory	2350	1971/72 425	851,000	Same as above
Cadbury		2839	5,678,000	Tomapep and tomato puree, and Beano
Vegetable & Fruit Processing Ltd.		1000	2,000,000	Tomato puree
Others		50	100,000	Squash, marmalades, jams, tomato puree in the form of Obese from Moon Enterprises.
Total for 1971-1972		4314	8,629,000	
Lafia Canning Factory	2256	1972/73 410	820,225	Same as above
Cadbury		2839	5,678,000	Tomapep, tomato puree and Beano
V.F.P. Ltd.		1365	2,730,000	Tomato puree
Others		50	100,000	Obese and tomato puree from various sources
Total for 1972-1973		4664	9,328,225	

TABLE IV NIGERIAN IMPORTS OF FRUITS AND VEGETABLE PRODUCTS a/ (1965-1971)

	1965		1966		1967	
	Quantity (long tons)	Estimated Cost (₦)	Quantity (long tons)	Estimated Cost (₦)	Quantity (long tons)	Estimated Cost (₦)
Vegetables						
Tomato, fresh or chilled	195.00	51,390	275.15	74,154	280.00	54,324
Tomato puree and paste	6,389.10	1,363,844	6,159.20	1,514,724	3,794.15	885,138
Roots and tubers (preserved or prepared)	1,387.65	440,962	1,319.50	417,880	983.35	311,560
Sub-total for Vegetables	7,971.75	1,856,196	7,753.85	2,006,758	5,057.70	1,251,022
Fruits						
Fresh fruits	12.65	65,338	18.56 b/	95,884	22.25 b/	114,898
Canned fruits c/	3,345.50	303,726	555.50	173,218	860.25	217,968
Fruit juices (in gallons)	61,270.00	152,830	79,717.00	144,320	25,377.00	110,814
Jams and Marmalades	1,051.10	153,970	297.45	89,394	418.00	110,800
Sub-total for Fruits	4,682.78	575,844	1,207.39	502,816	1,413.79	554,480
Sub-total for processed fruits	4,670.13		1,188.83		1,391.54	
Total for processed fruits and vegetables	12,641.88	2,432,040	8,942.68	2,509,574	6,449.24	1,805,502

a/ 1 gallon of fruit juice is assumed to weigh 10 pounds
b/ Tonnage figure is an estimate based on the 1965 price per long ton
c/ Table is based on Nigerian Import Statistics

TABLE IV (Continued)

1968		1969		1970		1971	
Quantity (long tons)	Estimated Costs (₦)	Quantity (long tons)	Estimated Cost (₦)	Quantity (long tons)	Estimated Cost (₦)	Quantity (long tons)	Estimated Cost (₦)
4.00	1,102	6.9	1,888	8.0	2,506	112.90	33,006
2,159,45	445,292	277.35	7,128	606.75	152,368	5,355.90	1,310,896
1,399.20	492,596	1,242.30	888,898	1,726.10	279,454	3,932.70	953,900
3,562.65	938,990	1,526.55	897,914	2,340.85	434,328	9,401.50	2,297,802
b/ 0.43	2,212	0.17	894	b/ 0.27	1,420	5.57	28,782
536.35	149,108	307.60	109,852	46.80	12,140	417.30	142,170
29,482.00	117,950	80,348.00	258,250	46,205.00	306,618	36,899.00	344,420
416.50	85,456	368.75	119,420	376.80	117,138	731.10	223,586
1,084.90	354,726	1,035.22	488,416	630.14	437,316	1,318.70	738,958
1,084.47		1,035.05		629.87		1,313.13	
4,647.12	1,293,716	2,561.60	1,386,330	2,970.72	871,644	10,714.63	3,036,760

TABLE V COMPARING TECHNIQUES OF FOOD PRESERVATION APPLIED IN FRUIT AND VEGETABLE PROCESSING

Feature	Dehydration	Canning	Preserves	Freezing
1. Technological Complexity	Tray and tunnel drying are technologically simple both in content as well as operation. (related to sun drying)	Fairly complex requiring considerable expert knowledge to operate. Totally foreign and strange.	Simple but technique is foreign and not related to any previous experience.	Complex in content and operation. New and not related to any previous experience.
2. Capital Requirements	Low technology is simple and component parts few. Drying shell can be fabricated locally.	High capital investment. A boiler is a must and equipment is specialized and designed to take high steam pressure. Steamer is expensive.	Jacketed kettles are specialized and expensive stainless steel equipment. Relatively high capital requirement.	High capital cost for specialized equipment.
3. Maintenance & Servicing Requirements	Low and easy to effect.	More difficult technology is more complex.	More difficult.	Most difficult of the techniques
4. Adaptive Index	Technology is very similar to what people have always done (drying in the sun). Adaptation is easy.	Completely new, therefore low index of adaptation.	Completely new.	Completely new
5. Raw material requirements	Quality requirements not as demanding as others. Low overhead costs permit operation to cope better with produce supply problems and circumstances in which under-capacity operation is unavoidable.	Quality requirements are high. High overhead costs do not fit well with extreme under-capacity operation because of scarcity in raw material supply.	Quality requirements are high. Large quantity of raw materials essential to sustain operation.	Very high quality requirements. High overhead costs.

TABLE V (Continued)

Feature	Dehydration	Canning	Preserves	Freezing
6. Unit cost of production	Lowest (without packaging drying is only half of the manufacturing cost of canning).	High	High	Very High
7. Cost of packaging	Very low compared with canning. Is estimated as low as 2% of the cost of empty can.	Very Expensive	Expensive even though glass jar is reuseable.	Expensive, somewhat cheaper than canning.
8. Storage requirements after processing.	Easy to store	Easy to store.	Easy to store.	Very expensive storage, under continuous refrigeration
9. Transportation & handling Costs	Very low because product is light.	High	High	Very high. Transported under refrigerated conditions.
10. Nutrient Conservation	There are difficulties with labile components such as carotenoids and ascorbic acid which are sensitive to oxidation; riboflavin is unstable to light and thiamine is destroyed by SO_2. Nutrient retention is therefore very closely associated with storage conditions. Nutrient level considered acceptable.	Good	Good	Very good

TABLE VI

U.S. Prices for Empty Cans on 1,000 Lot Basis
(Based on Continental Can Co. and American Metal Market Data)
(1946-1973)

Year	CAN TYPE			
	No. A1	No. A2	No. A2½	No. A10
1946	$13.00	$22.00	$28.00	$57.00
1958	$20.00	$36.00	$46.00	$115.00
1973	$58.00	$72.00	$96.00	$192.00

TABLE VII

U.K. and Nigerian prices per unit of empty can compared in 1974

Country	CAN TYPE			
	No. A1	No. A2	No. A2½	No. A10
U.K.	£ 0.020 (Sterling)	£ 0.03 (Sterling)	£ 0.04 (Sterling)	£ 0.08 (Sterling)
Nigeria	£ 0.04 (Sterling)	£ 0.05 (Sterling)	£ 0.07 (Sterling)	£ 0.14 (Sterling)
	₦ 0.06	₦ 0.08	₦ 0.11	₦ 0.22

TABLE VIII ESTIMATED COST PER POUND OF PROCESSING (CANNING) AT LAFIA (1973-1974)

	Sales price per pound	Profit Mark-up (15%) 1/	Pkg. cost of empty can (A2)	Average cost of Raw Material 2/	Other Manufacturing Costs 3/
Pineapple slices	₦ 0.310	₦ 0.047	₦ 0.08	₦ 0.041	₦ 0.142
Pineapple pieces	0.310	0.047	0.08	0.041	0.142
Pineapple crush	0.300	0.045	0.08	0.041	0.134
Pineapple juice	0.290	0.044	0.08	0.041	0.125
Grapefruit segments	0.290	0.044	0.08	0.031	0.135
Grapefruit broken parts	0.300	0.045	0.08	0.031	0.144
Unsweet. Grapefruit juice	0.300	0.045	0.08	0.031	0.144
Sweet. Grapefruit juice	0.310	0.047	0.08	0.031	0.145
Orange juice	0.300	0.045	0.08	0.041	0.134
Mango slices and pieces	0.300	0.045	0.08	0.060	0.115
Mango juice	0.290	0.044	0.08	0.060	0.106
Guava Necta	0.290	0.044	0.08	0.070	0.096
Tomato juice	0.310	0.045	0.08	0.110	0.075
Average Unit Cost	0.300	0.045	0.08	0.048	0.126

1/ Usually the fruit and vegetable industry overseas assume a 20% mark-up, 15% is assumed reasonable for our circumstances.

2/ A computed conversion ratio of 5.5 from raw fruit and vegetables to finished product is assumed.

3/ Other manufacturing costs include labour, administrative, depreciation, marketing, insurance, etc.

S E C T I O N III

FOOD SCIENCE AND TECHNOLOGY EDUCATION IN WEST AFRICA

THE ROLE OF FOOD SCIENCE AND TECHNOLOGY EDUCATION IN THE FOOD INDUSTRY OF WEST AFRICA

by

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Many of the previous papers have already anticipated the points raised in this paper. However, since they are important points they are worth repeating.

This paper will probably raise questions rather than supply answers and is not intended to solve the special problems of university education or its relation to the problems of the West African food industry; it will reflect the views of the author and some of his colleagues.

Teaching Programmes

The kind of programme which is adopted will depend on the objectives to be achieved; in other words, on the type of graduate required by local needs. All too often syllabuses which should be locally oriented are based on those of more developed countries where the needs are quite different.

In Ghana, the food industry had a relatively early start due mainly to Ghana's achieving independence and the desire of the late President Nkrumah to industrialise the country. Hence the Department of Nutrition and Food Science has been in existence since 1962 when it was founded as the Department of Biochemistry, Nutrition and Food Science. It has been producing graduates since 1966, and to date has 133 General Degree graduates (including biochemists); this includes 33 Honours Degree Nutritionists and Food Scientists. Many of these graduates have been absorbed into government institutions such as the Food Research Institute, Ghana Standards Board and

Chemical Laboratory as well as various Ministries. Others are working in the food industry in various large organizations such as Cadbury, Nestle and the state canneries and sugar factories (usually in quality control, and less frequently in production management). Therefore the Department has played its role in the development of the food industry by supplying the relevant staff.

Table 1 gives an outline of the new three-year course in Food Science. This degree is part of a more general scheme which encourages wider subject combinations. However, only the relevant food science subjects are listed. Table 2 shows the courses outlined in two other departments in Nigeria.

TABLE 1. FOOD SCIENCE COURSE OUTLINE

Year 1 a/	Year II, Part I	Units b/	Year III, Part II c/	Units b/
General Science	Principles of food Preservation	9	Meat, fish and animal products	Commodities
Usually Chemistry	Principles of Nutrition	18	Fruit, vegetables and tubers	
Biology	General Mic -biology	6	Sugar, beverage crops	
Physics with Maths.	Food Chemistry	9	Cereals, legumes, oilseeds	19
			Food Engineering	12
			Food Analysis	4
			Food Microbiology	6
			Seminars	5
	Students take equal number of units in another subject. Biochemistry is the usual one		Research Project	9
			Stored Products Entomology	3
			Optional Courses	
			Plant management	2
			Irradiation and microwave treatment	3
			Sensory evaluation	4
			Food Toxicity	3
			Biometry	2
			Industrial Fermentation	4

a/ Students are not registered in the Department.

b/ 1 Unit = 5 hrs. lectures or 15 hrs. of practicals.

c/ Honours Food Science course only; at the end of Year II students can choose to do Honours Food Science or Honours Nutrition or combination of the two, or combination of either one with another subject taken in Year II.

TABLE 2

UNDERGRADUATE COURSE OUTLINE AT THE DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY THE UNIVERSITY OF IFE (ABRIDGED)

YEAR I	YEAR II	Units a/	YEAR III	Units a/	YEAR IV	Units a/
Intro Food Science	Fruit, vegs. & cereals)		Food chemistry & analysis	4.0	Food Engineering	4.0
General Science in:	Meat, fish & poultry) Commodities		Food Microbiology	3.0	Quality control	3.0
Chemistry	Dairy products)	4.0	Principles of Nutrition	3.0	Management	3.0
Maths.	Biochemistry	3.0	Food Engineering	4.0	Food Processing II	4.0
Biology	Intro. Microbiology	2.0	Physical Chemistry	2.25	Research project	3.0
	Chemistry	3.25	Food Processing I	3.0	Selected topics in food science	2.0
	Engineering	3.0				
	Livestock Management	3.0				

a/ 1 Unit equals 1 lecture or 1 practical per week per two half sessions (about 26 weeks).

UNDERGRADUATE COURSE OUTLINE IN FOOD TECHNOLOGY AT THE INSTITUTE OF APPLIED SCIENCE AND TECHNOLOGY, UNIVERSITY OF IBADAN

YEAR I	YEAR II	Units a/	YEAR III	Units a/	YEAR IV	Units a/
General Science in	Basic Engineering	31	Applied & Basic Engineering	14	Industrial Economics	4
Maths	Intro Food Technology	2	Commodities Technology including Food Processing)	13	Uuman Nutrition	3
Chemistry	Intro Microbiology	2	Animal Products Processing)		Quality Control	7
Physics and	Food Analysis	2	Cereal Technology)		Applied Technology (Design)	6
Agriculture	Biochemistry	4	Computer Science	3	Industrial Fermentation	4
					Food Industries	6
					Project	2

a/ 1 Unit equals 10 hrs. lectures or 30 hrs. practicals.

The Legon course is strongly biased towards food science and nutrition. The Department has always considered that in a developing country food science and technology should be closely linked with nutrition, as a graduate will most probably require a knowledge of both subjects. However, the approach of Ibadan and Ife in emphasizing the course towards engineering has greater advantage in applying food science and technology. This could account for the relatively slow start of graduates working in the food industry in Ghana because employers more easily accept the latter approach.

Problems in Course Teaching Programmes

Since food science and technology is such a wide subject embracing many disciplines and topics, problems can arise. Before a student graduates, he should be familiar with and knowledgeable about most of the branches of food science. This usually means in practice that a course has to be spread very thinly, with the student often knowing only a little about each topic. In trying to achieve a wide education students may not receive a basic grounding in the principles behind the subject. This is a dilemma which faces many applied courses.

The problem of basic principles and basic science raises the other question of whether food science and technology should be taught at the undergraduate level at all. Might it not be preferable to take a graduate with a background in pure science, biological science or engineering, and give him a concentrated course in food science and technology? Post graduate conversion courses are popular in the U.K., and there is little reason why they should not be introduced into Africa, especially for engineering graduates. Since the students already have the background knowledge and principles, the application of these to food science should be easier and more rapid than at the undergraduate level.

I would expect that one of the main criticisms leveled at new graduates is not how much they know but the way in which they apply their knowledge. Teaching application of knowledge within a tight lecture time table is difficult. It has to be left to practicals, tutorials and vacation training. In this Department an effort is made to present undergraduates with the sort of problems they would face on leaving the University and taking up a job in the food industry, for example, the organization of quality control. Students are helped to tackle this problem by visiting a new factory which itself is in the process of developing quality control facilities, and then being required to put forward their own plans. Vacation training is also valuable experience for a student, as it gives him an insight into working conditions inside a factory. Often it is the only contact the Department has with many food companies. Better relations would also be achieved by reciprocating this training. The University should organise courses in the summer vacation to help food processing personnel to learn and understand more about the work they do as well as widen their knowledge of food science.*

Relevance of Teaching Programmes to Food Problems in West Africa

The standard of living of the majority of West Africans is such that they are unable to afford most of the products of the large-scale food industry. Many live as subsistence farmers, while others have a limited purchasing power from the sale of cash crops. There is an increasing urban population bringing with it the problems not only of food distribution but water supplies, housing and unemployment. It is the supply of food to these sectors of the population which is the challenge of the present and future.

* Such a course was successfully organized by the Department in July 1975.

There are in fact two types of food industries in West Africa. The first has been mentioned in most previous papers, i.e., large-scale food companies operating canning factories, cold stores, oil mills, breweries, etc. The second is the production of food consumed by most of the population. These are the local village industries usually run by women -- the bread bakers, gari and kenkey makers, fish smokers, vegetable oil producers and many others. These cottage industries are run by skilled people who have, however, no fundamental knowledge of the foods they are handling or the processes they are using or even hygienic procedures they should apply.

West African countries are still basically raw material producers and suppliers to more developed countries of the world. The level of industrialization is still small, but it is increasing slowly. This creates problems in the food industry. Foreign exchange is used to import expensive machinery. In addition to this an expatriate operator is also employed until a local operator can be trained to take his place. Spares and servicing are great problems and result in long production delays. Usually the factory also requires one or more of the raw materials to be imported, tin plate for example. A combination of those factors makes the selling price of the manufactured product as high or higher than the imported equivalent.

Another more important problem is the size of factories. These are often so large that there are not sufficient raw materials in the vicinity of the factory to enable them to run efficiently. This is well illustrated by Dr. Ngoddy's paper.

Whereas industrial development will bring with it the ability for technical independence as well as a high standard of living, and therefore a need for a more sophisticated food processing industry, problems have to be tackled at this moment. One method is to develop food processing

using a lower level of technology. It has been suggested that low capital, labour-intensive industries are most profitable for developing countries. These raise employment, cut foreign exchange spending, and hopefully cut down servicing problems.

To the educator this poses a great dilemma. On the one hand he has a responsibility to provide graduates to run the present food industry. On the other hand the only way to solve the present food problems is by a different approach. This usually means improving the small-scale processes by intermediate or appropriate technology. Therefore a postgraduate course in appropriate technology would be one solution. As Hawthorn (1972) pointed out, such a course would come under strong criticism by university faculty boards. It would be lucky to be accepted as a Postgraduate Diploma. This would mean that many good graduates would probably not apply for such a course. Moreover there is no point in offering a course without any prospect of employment for graduates upon completion. The governments must give their full support in the creation of posts which graduates can very usefully fill. The importance of setting up a food technology extension service to parallel agriculture and home science extension has been outlined by Youngs (1974).

Areas of Research

Until such courses become established, Honours students should at least be made aware of these needs and current problems of intermediate technology. Therefore, in the Department at Legon, time is allotted whenever possible for solving problems through short projects.

It is important to realize that the food situation could be improved almost immediately without the need for any research if application of information already available was implemented.

Losses of crops during storage due to pests, infestation and micro-organisms are up to 75 percent in many rural areas. Inexpensive storage silos have to be developed from locally available materials and farmers encouraged to use them.

During food distribution heavy losses can again be caused by bio-chemical changes and physical damage. Distribution problems will increase as the urban population increases. Development of simple and effective packaging as well as modification of the lorries carrying the food would yield significant results, as any observer watching local transport carrying produce to the cities would be aware.

An appreciation of the sociological side of home production of processed food is also important. Efforts should be made to help and not to displace the rural processor. More studies of traditional food processing should be undertaken, an understanding of this being essential before improvements can be made. Efforts should be made to take as much of the drudgery out of food preparation as possible, as well as improving yield and quality. One example students have considered is the production of shea butter, a local fat produced in the north of the country from the kernel of the shea fruit. The extraction process is long, taking two days, and involves a hot water treatment to separate the fat from the kernel. The yield by this process is also relatively low. The use of a simple press would help to eliminate many stages of the process as well as a lot of hard work. Shea fat has a melting point just above body temperature, hence the press must be heated. The students not only considered the design of the press in terms of the technological problems, i.e., kernel and hardness, locally available materials, etc., but also press size in terms of the amount of shea kernels handled by an average processor.

The introduction of new industries should also be encouraged. As already pointed out, these would succeed if they were on a small scale. Two examples have been considered by the students of the Department. The first is the development of dehydrated vegetables and spices using solar energy in an improved simple drier. The second is introduction of small-scale sugar processes. Sugar cane is widely grown in many southern parts of Ghana, especially in the Accra plains and in the Central Region. Although there are two large factories, these continually run into raw material problems. Sugar cane is consumed in rural areas in a raw state. The Indian subcontinent has been using small-scale preparation of crude sugar, called jaggery, for a long time. The process requires a small crusher and boiling pans. The clarification and concentrating steps are done during boiling. The end product is a brown mass of sticky crystals. This can either be consumed locally or sent to the factories for further refining. The use of cost-benefit analysis is an integral part of any consideration given to proposed new industries and should be understood by students.

It is my view that tackling problems by such "grass roots" technology will surely be more successful than the introduction of unconventional sources of protein and novel foods that are being considered as a solution to the world food shortage.

In conclusion, if governments are bent on industrialisation western-style, then food science and technology courses will be designed to cater for them. However, as soon as governments realise that there are other simpler ways of solving the food problem, then a change in emphasis of courses must be made. In the meantime universities have a role to play and a challenge to meet in both areas.

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DISCUSSION ON FOOD SCIENCE AND TECHNOLOGY EDUCATION IN WEST AFRICA

P. O. NGODDY: I would like to suggest that the heads or representatives of other programmes give the rationale behind those programmes.

G. R. HOWAT: Our philosophy at Ife is different to the one at Legon. At Ife we have set ourselves to produce graduates who will meet future as well as present needs. We felt it was best to train people with an orientation towards technology, people to run food plants. Our students should know how to apply their practical knowledge, for example to draw a plant layout. The big technical areas such as breweries, oil mills, large-scale bakeries, etc., are only part of the whole food situation, but we feel that there is a case for the big-scale food industries in urban areas such as Lagos which has a population of one million. Economic laws will apply as effectively in Nigeria as in Western Europe. The course is not geared to bringing changes by means of some form of extension service.

Our students require three "A" levels in chemistry, physics and mathematics. These subjects continue in their first year, plus engineering drawing and biology. In the second year, food science is begun and the third and fourth years consist mainly of food science. In the fourth year, management and quality appraisal courses are also taken. Our degree may be too oriented towards the urban situation, but we cannot undertake everything.

E. I. BANIGO: At Ibadan we believe that with a background in engineering, students can handle problems better than if they take just food science. We have the same requirements at "A" level as Ife. In their first year, students take engineering courses. Students can then specialise in food technology. They are introduced to the processing, handling and storage of foods, and can be employed in existing industries. We have a professional

industrial placement officer who follows the students' progress and makes sure they are well grounded in food technology. The students are exposed to innovations and can then apply their knowledge to grass-roots technology as well as to the more sophisticated industrial techniques. Students should also be able to work as extension officers in the relevant areas of ministries. They can also take specialist courses in management, economics, etc. Such courses should be an integral part of their training. We designed the program to meet present and future needs. At present we need technicians to go to the factory and handle problems there, as well as having a strong scientific background.

E. K. ANKRAH: Food Science students have difficulty in obtaining jobs in Ghana. With an engineering background, students could set up their own food processing industries. If they prove to be successful, the rest of the industry would show more interest in the Departmental graduates. Therefore a science background only is not sufficient.

M. L. WOOLFE: I think we are being a little pessimistic; although the numbers of graduates working in industry has been less than expected, in the past few years it has increased quite markedly.

D. Y. DAKO: The problem is that in the present economic climate, science as well as food science jobs are rapidly reaching the saturation point, given the size of the food industry in Ghana. However there still is a lot to be done in publicising the cause and educating the the employers as to the role of the food scientist.

E. O. IDUSOGIE: Lack of prominence given to food science by governments is probably a result of the strong agricultural emphasis in West Africa and the ignorance of food technology.

A. OFI: If we want students to be acceptable in the job market, practical training is not all we have to teach, but we must make sure they are adaptable to the different jobs.

P. NGODDY: I would like to raise three points. The first is that in training engineers in Africa a lot more effort has to be applied. This is because most Africans have not had the background and contact with machines as in other countries, also the teaching staff themselves may have very little industrial experience and so lack manipulative skills; they must be aware of their own deficiencies.

Secondly, stress has been laid on the raw material supply problem being at the heart of the growth of the food processing industry. Students should be aware of agricultural problems and be able to opt for either plant or animal science for one year.

With regard to the graduate programmes, what should be the orientation and achievement of such programmes? It may help to relieve pressure on the undergraduate programme, or enable a student to study a subject in greater depth.

D. Y. DAKO: We are assuming that the graduate is given a great deal of responsibility from the beginning. Is this always true? Any deficiencies in a course can be made up by experience whilst working in the industry.

A post-graduate programme is about to be presented at Legon. How should this be organized? Should it be just an extension of the undergraduate work or should it be more specialized, e.g., fish processing, quality control, etc.? Could courses be designed to work within sociological conditions? The role of the food scientist is also to help the other 95 percent of the population.

W. WURDEMANN: Could undergraduates do management jobs and extension work as part of their degree course, then do large-scale industrial developments as a post graduate course? The role of the University is difficult in having to maintain standards, but on the other hand wanting to tackle the real task facing the country.

M. L. WOOLFE: The growth of the food industry will eventually come; perhaps it will be slower in Ghana than Nigeria because of lack of oil capital. In the meantime the gap has to be bridged by extension work to farmers and setting up small-scale rural processes.

APPENDIX

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APPENDIX 2

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