SOYBEAN PROCESSING UTILIZATION AND FOR SUSTAINABLE DEVELOPMENT IN NIGERIA

IITA

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IDRC/IITA Soybean Utilization Project Phase II

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IDRC/IITA SOYBEAN UTILIZATION PROJECT

PHASE II

FINAL REPORT
(FEBRUARY 1991 - APRIL 1994)

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE
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PHASE II

Final Report
February 1991 - April 1994

S.M. Osho and K.E. Dashiell

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S.M. Osho & K. Dashiell

PREFACE

The expansion of soybean production and utilization in Nigeria is a success story. In just under ten years, soybean production in Nigeria has changed dramatically. The initial expansion of the crop began in 1986 when Nigerian government policy banned the importation of edible oil and soybean meal. Year by year since then farmers have increasingly grown soybean. The main area of production is the lowland savannas, and in the mid-altitudes of the Plateau Region. Estimated cropped area of soybean in Nigeria currently is 200,000 hectares.

To an outsider, the success story for soybean production may seem obvious or simplistic. Government policy created a market for soybean grain and farmers responded accordingly. However, the success story has another remarkable dimension, namely that utilization of soybean has gone far beyond the initial available outlets of edible oil and animal feed. Soybean, as a new food, has been incorporated into local diets and soy-products are routinely made and eaten by farm households, and rural and urban dwellers throughout Nigeria. Soybean has stimulated agri-business to such an extent that production is now demand-led.

Somewhere in the midst of this success there was a project, the Soybean Utilization Project for which IITA was the implementing agency and IDRC (Canada) generously provided funds. There also were the collaborating national institutions, working initially in south-western Nigeria (Project Phase I) and then expanding to enable Nigeria-wide coverage (Project Phase 2). These institutions were Institute of Agricultural Research and Training (IAR&T), Ibadan; National Cereals Research Institute (NCRI), Badeggi; National Agricultural Extension Research and Liaison Services (NAERLS), Zaria and the University of Nigeria (UNN), Nsukka. These institutions, are located in Oyo, Niger, Kaduna and Enugu States respectively. The combined efforts of these institutions together with IITA acting as both a facilitator and catalyser of project activities, enabled the project to achieve major impact. Through development of products and processes, testing of equipment, and training of a wide range of clients, the project stimulated soybean utilization, both in the home, and by small scale industries.

Soybean is now a household word in Nigeria. The project most certainly played its part in bringing about this revolutionary change on farmers' fields and in the eating habits of Nigerians.

On behalf of all the participating institutions, IITA warmly thanks IDRC for their extended support to this project.

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ABBREVIATIONS AND ACRONYMS

ADP	Agricultural Development Project
AOAC	Association of Official Analytical Chemists
BLRW	Better Life for Rural Women
CDC	Community Development Committee
COWAD	Community Women in Agriculture Development
DESF	Defatted Extruded Soy Flour
DF	Defatted Flour
EDSF	Extruded Defatted Soy Flour
EFFSF	Extruded Full Fat Soy Flour
FACU	Federal Agricultural Coordinating Unit
FAO	Food and Agricultural Organization
FCCC	Funtua Cotton seed Crushing Company
IAR&T	Institute of Agricultural Research and Training
IDRC	International Development Research Center
IITA	International Institute of Tropical Agriculture
INTSOY	International Soybean Program
JICA	Japanese International Cooperation Agency
KADP	Kaduna State Agricultural Development Project
KCH	Kersey Children's Home
LGA	Local Government Area
LSADP	Lagos State Agricultural Development Project
MCH	Material and Child Health Clinic
NAERLS	National Agricultural Extension and Research Liaison Services
NCRI	National Cereals Research Institute
NCRPS	National Coordinated Research Projects on Soybeans in Nigeria

NPK	Nitrogen Phosphorus Potassium
NPR	Net Protein Ratio
NSS	National Seed Service
OYSADEP	Oyo State Agricultural Development Program
PEM	Protein Energy Malnutrition
PER	Protein Efficiency Ration
PRA	Participatory Rural Appraisal
PZ	Patterson Zacchonis Industries Limited
RRA	Rapid Rural Appraisal
SPAT	Small Plot Adoption Trials
SSP	Single Super Phosphate
TI	Trypsin Inhibitor
TIA	Trypsin Inhibitor Activity
UNICEF	United Nations Children's Fund
UNN	University of Nigeria, Nsukka
UGL	University of Ghana, Legon.
WFED	Women Farmers Extension Division
WIA	Women In Agriculture

Chapter One

SUMMARY

This project has five main objectives: (a) document the status of soybean production and utilization in selected areas in Nigeria; (b) develop household and small scale technology for preparing soy-based foods; (c) develop appropriate soybean processing equipment; for household and small scale processors, (d) train and disseminate the results of the study; (e) introduce and asses the impact of the technologies developed.

Chapter 2 provides an introduction to the project, discussing the geographical definition, agricultural history and the food and nutritional situation in Nigeria. This chapter also discusses the rationale for introducing soybean utilization; the model and methodology used for dissemination of developed technologies; the nutritional advantages that soybean has, in improving the Nigerian food situation.

This chapter also reports various factors (economic agricultural, societal and nutritional) that have combined to rekindle interest in the production and utilization of soybean in Nigeria. Several national institutions and voluntary organizations have made and are still making positive efforts to encourage malnourished segments of the population to use soybeans as everyday food.

Chapter 3 summarises the activities of soybean utilization project Phase II. This chapter reports the initial planning meeting, the training of project personnel on the use of RRA and soybean processing and the distribution of new vehicles to national institutions. A baseline survey was conducted in 1991, to document the status of soybean production and utilization in selected project sites by participating research institutions (NCRI, IAR&T, UNN and NAERLS). Each research institutions carried out studies in their respective states, (Oyo, Niger, Kaduna and Enugu) using Rapid Rural Appraisal Techniques and conventional survey methods. While chapter 4 summaries the result of the monitoring survey conducted in 1992 to assess the impact of the project.

The 1991 findings of the baseline survey and the situation in the following year showed an increased production from 1991 to 1993. In addition, it was found that the availability of a reliable market was very crucial to soybean production as farmers did not want to plant if there was no market in or close to their location. Soybean processing and utilization increased significantly in all the areas where the projects were carried out. There was increase in household utilization of soybeans from 1991 to 1992.

Chapter 3 also reports all research activities that was carried out during the life span of the project (1991 - 1993). Soybean had been incorporated into traditional foods of Nigerians like soy vegetable soup, soy kunu zaki, soy-tuwo, soy opa, soy alibo, soy akpu, soy hatsi, soy cheese and there were also new products like soybean milk, soy ice cream and soy-yoghurt. These soybean fortified products have more protein and minerals than the non-fortified counterpart products and the level of acceptance was quite high. Anti-nutritional factors (phytic acid, tannin, trypsin inhibitor) were found to have been effectively eliminated by traditional processing. Most of the developed technologies have been transferred to home users and some to small scale industries. Some of the reasons household users gave for incorporating soybean into their foods were that it is nutritious, tastes nice, is a good substitute for expensive protein and is versatile.

The results from this baseline survey were used to develop a research agenda for improving traditional foods and processes with soybean and also to assess the impact of the project. This work provided a useful assessment of the status of soybean in Nigeria.
Some of the research activities undertaken included the following:

Fortification of traditional root and tuber crops (yam, cassava, sweet potatoes), white potatoes and cereals (maize, sorghum and rice) with soybeans;

Fortification of indigenous Nigerian foods using soybeans for Northern, Eastern, Western and Middle Belt States of Nigeria;

Development of soybean based weaning foods;

Development of food uses for various soy flours, (dafatted cake, extruded flour, raw soy flour, milk residue flour);

The utilization of soybean in the production of dairy-like products (yoghurt, flavoured soymilk, cheese and ice cream);

Development of low-cost, simple soybean oil refining processes that will remove foam, improve colour, improve frying characteristics and maintain oil stability;

Testing consumer acceptability of texturized vegetable protein products.

Formulation of various breakfast foods, snacks and weaning foods, using extrusion cooking;

Development of low cost soybean processing equipment (filter press of soybean milk and cheese cleaners);

Test soybean breeding lines for nutritional and food processing properties;

Evaluation of the processing and nutritional characteristics of the nil lipoxygenase soybean with several soybean foods including milk and the coagulated product, tofu.

IAR&T in South Western Nigeria developed food products like soybean eggs, soybean ogbono and soy tortillas. NCRI ("Middle Belt" Nigeria) developed weaning foods with soybeans and traditional beverages like kunu zaki were fortified with soybean. Local foods and snacks e.g gari, zanbu, masa, bambara, dankwa, chinkafa, etc were all fortified with soybean. At UNN, in South Eastern Nigeria, studies on enriching traditional foods like okpa, ora, akpu, alibo etc with soybeans were carried out. Weaning foods and breakfast cereals were developed from local cereals and extruded full fat and defatted soybean flours. NEARLS in Northern Nigeria conducted nutritional studies on traditional foods fortified with soybean e.g soy tuwo, soy wara, soy talia, soy patemasara, soy pate acha, soy ganda, soy danwake, soy nakiya. The fortified foods had increased protein content and the sensory evaluation revealed that there was no significant difference in the level of acceptance when compared with the conventional foods. In most cases, panelist and villagers were not able to detect any differences. The costing of the products developed also revealed that the inclusion of soybean reduces the total cost of many products by at least 25%.

Imported and locally produced equipment were studied to assess their efficiencies and suitability for processing soybeans. These equipment were: an extruder (INSTA-Pro Model 600 Jr), a screw press (AUII) and a soybean milk filter press (designed in Japan), which were all installed at IITA; an imported seed destoner (gravity separator for seed cleaning prior to processing) and a soybean oil filtering machine installed at Orman Industry in Ibadan; and, a locally designed soybean milk filter press which was installed at Nigerdock in Lagos.

IITA has used the extruder to process a variety of soybean flours e.g full fat soy flour, and defatted soy flour which can be used in traditional foods like egusi and used at the industrial level for baby foods and breakfast cereals manufacture.

Chapter 5 reports the number of training done in selected project sites by each participating institutions. The developed technologies were transferred to the rural and urban people in the selected soybean project sites. The training usually encompassed production and utilization with particular reference to incorporation into particular diets. The training programs were conducted in local Nigerian languages - Yoruba, Igbo, Hausa, Nupe, English and Pigin English. Other important training programs were held for hospitals, family planning groups, nutrition rehabilitation centres, secondary schools, primary schools, Obas (traditional rulers) and in some instances for Agricultural Development Programs (ADPs), Better Life for Rural People and some international organizations and small scale industries. The total number of people trained was over 47,000 out of which about 30,000 were women. to facilitate training, the IITA publication "Soybean for Good Health" was translated into Yoruba, Hausas, and Igbo.

Chapter 6 reports the terminal survey carried out at the end of the project (December 1993 - February 1994) to assess the level of adoption of soybean production and utilization. The result shows a significant difference in the number of farmers and households now cultivating and using soybean respectively when compared to baseline and monitoring survey.

This project has also had an effect on the number of retailers selling soybean. In Ibadan markets, for example, the number of retailers increased from 539 upto 824 while the price per kg also increased from₦5.70 to ₦15.50 between January 1991 to January 1993. Soybean is sold as seed and flour in the markets. This finding is based on a survey of 42 main markets in Ibadan city of about 4 million persons. In Enugu, the number of retailers also increased from 4 retailers to 107 in Ogbete main market where soybean has been retailed as raw flour and toasted flour for two years.

As a result of the dissemination and sensitization activities associated with this Phase II project, an increasing number of food processors have incorporated soybean into their products. Over 60 industries are currently processing soybeans. These are now available in markets. The production of several new soybean products are directly or indirectly linked to research efforts in Phase II. Examples of some of the processed products include soybean flours, soybean oil, high protein cake, soybean milk, soybean yoghurt, soybean based weaning foods (Nutrend, Soy ogi, Babeena, Golden Morn) chocolate candies, texturized vegetable protein, soy biscuit, livestock feed.

Finally, chapter 8 gives conclusions about the project. Results from this project conclusively show that people will adopt new technologies and recipes once they are carefully prepared, recognizing the people's cultural habits and as long as these new technologies and recipes do not increase equipment cost, processing cost, or cooking time; in addition, the new technologies and recipes also enhance nutrition.

Chapter Two

INTRODUCTION

2.0 NIGERIA:

A geographical definition

Nigeria lies completely within the tropics, between latitudes 2°N and 15°N, with the Atlantic Ocean forming the southern boundary (Fig 2.1). The country covers an area of about 94184 sq.km and measures 1127 km in its longest east-west direction (Famoriyo 1978). The tropical climate varies from humid south and dry hot conditions in the North. The southern parts of the country experience a higher rainfall over a more prolonged season (about 11 months) than the northern area (about 3 months). Temperatures increase gradually towards the North, the far north being the hottest and driest part of the country. This condition is intensified by the dry north easterly winds from the Sahara called 'the harmattan'.

There are four broad vegetation zones: the low-lying Mangrove Forest on the Coastline of the South; the tropical rain forest characterized by high levels of rainfall and dense forest; the Guinea Savanna of the middle-belt, the Sudan Savanna zone of the northern parts of the country.

Nigeria is endowed with favourable agricultural conditions in terms of land and climate. One will therefore want to know how these resources have been exploited over the years and the reasons for the food and nutrition problems, despite the apparent agricultural advantages.

The Nigerian Agricultural History

In pre-colonial Nigeria, pure subsistence production was dominant. Colonial control brought about some development in agriculture. Prior to independence in 1960, Nigeria produced enough food for her population and for her export (Nwoko 1977). The driving force behind the primary sector-agriculture, livestock, fishery and forestry. The strength of the economy was dependent upon revenue obtained from export crops - cocoa, rubber, palm products, groundnut and cotton. At that time attention was devoted more to the development of these crops only and this continued into the post - independence era.

The assumption that the food sector could take care of itself, despite the development in the economy and population growth, led to a decrease in the agricultural contribution to economic development. This was aggravated by the outbreak of the civil war in 1966 and the situation became worse with the advent of petroleum. The contribution of agriculture to the Nigerian economy was further depressed by the outbreak of 1972/73 Sahelian drought.

It was at this juncture that the country's food problem became obvious. Various expedients (Operation Feed the Nation, National Accelerated Food Production Programme, Structural Adjustment Programme, Green Revolution) have been launched by the government to improve the situation. These various expedients have recorded little or no impact on the economic development of the country.

The Food and Nutritional Situation in Nigeria

A constant threat to human survival is the apparent difference between the rate of food production and that of the growth of human population. Nigeria is not exempted from this global threat. The Nigerian government reported in 1981 that the Nigerian population was growing at the rate of about 2.8% annually, while the per-capita income was growing at about 6.5% and the overall demand for food at the rate of 3.5% per annum (Atobatele, 1981).

The current agricultural production growth rate is about 1%. This is much below than the rates of population growth and food demand. This represents the food gap and by implication has led to a heavy reliance on the import of food items to supplement domestic production. For example, since 1981, 2.6 million tons of grain have been imported annually. In 1982, Nigeria imported 470,000 tons of oil seed products. and 28,000 tons of protein meal, valued at 260 million US dollars. Approximately 540 million US dollars were spent to import soybean products in 1983. The food situation became more serious in 1984 because of the increasing difficulties in meeting import bills, and because of the decline in the foreign exchange earnings. The effect of this foreign exchange problem was seen in the scarcity of imported vegetable oil and soybean meal, thus their prices rose by 500% in the early 1980s.

According to the recommendations of FAO, the minimum nutrient requirements per day are 2191 kcal and 53.8 grams of crude protein. Data show that consumption in Nigeria falls short of these recommendations. In 1972, the food balance sheet showed the average Nigeria consumed 2083 kcal and 53.8 grams of crude protein daily. Another food balance sheet estimate for 1980 showed a daily calorie intake per capita of 1964 kcal and 46.7 grams crude protein intake. Food balance sheet[1] is defined as the National Summary of food production, adjusted for foreign trade and changes in stocks and foodstuff utilization. The consumption of essential micronutrients (minerals and vitamins) is also inadequate.

The results of an inadequate food intake are problems of under-nutrition and malnutrition. Under-nutrition is defined as a pathological state arising from an inadequate intake of food, and hence of energy. Malnutrition is defined as a pathological state as a result of relative deficiency or excess of one or more essential nutrients (Omololu 1973). Nutritional diseases range from protein energy malnutrition to avitaminoses, and they all have serious adverse effects. Protein energy malnutrition (PEM) is caused by protein and energy deficiency and it affects not only physical conditions but may also eventually seriously impair intellectual attainment. In general, clinical surveys and hospital records indicate that malnutrition is most severe among infants, pre-school children, pregnant and lactating women.

It has been estimated that 7300 children die of malnutrition annually in Nigeria, before they reach the age of 4 years, while between 73,000 and 84,000 of children born every year are suffering from malnutrition (Omololu 1973). A conservative estimate produced by Omololu showed that 60-80% of Nigerians are malnourished (lacking in calories and/or more of the essential food nutrients). Picture 1 shows some severely malnourished children at one of the selected project sites in Ikoyi, Nigeria.

The distribution of these nutritional deficiencies in Nigeria follows geographical conditions and agricultural activities in each region. In the northern savanna, millet and sorghum are the staples; maize and groundnut and rice are subsidiary foodstuffs. Fat consumption is also very low. In the forest zone, the staple foods are beans and tubers/roots of yam and cassava. Sweet potatoes and cowpea are subsidiary foods. There is an overall shortage of protein in this region. There is evidence of calorie deficiency in the coastal zone, where fishing and farming are combined. In the whole country there is a deficiency of the B vitamins, especially riboflavin which is associated with insufficient intake of animal foods (Masse, 1973).

The poor nutritional situation in Nigeria is caused primarily by the poor food situation and the low purchasing power of the people. Most people are not able to purchase enough food to feed well. Even for those with an averagely high income the ever increasing food prices (inflation) serve to reduce the value of their income and therefore its purchasing power.

Socio-cultural factors are also important when the quality and quantity of food consumed by a member of the community are considered. These factors include the social position of each individual, who has the first choice of the food, that sequence in which meals are served, attitudes towards food, food as an expression of prestige, taboos, and the obligations of hospitality. Usually the family head has the largest proportion of each meal. This leads to maldistribution of food among members of the same family. There is a poor level of nutrition education in the country. Most people do not know the importance of consuming a particular food item, compared with the other. There are few programs to educate people on the ideal food intake and combination.

1 Food balance sheet is defined as the National summary of food production, adjusted for foreign trade and changes in stocks and food stuff utilization.

Picture 1 Some severely malnourished children in Ikoyi Ogbomoso, Nigeria

VEGETATIONAL ZONES OF NIGERIA

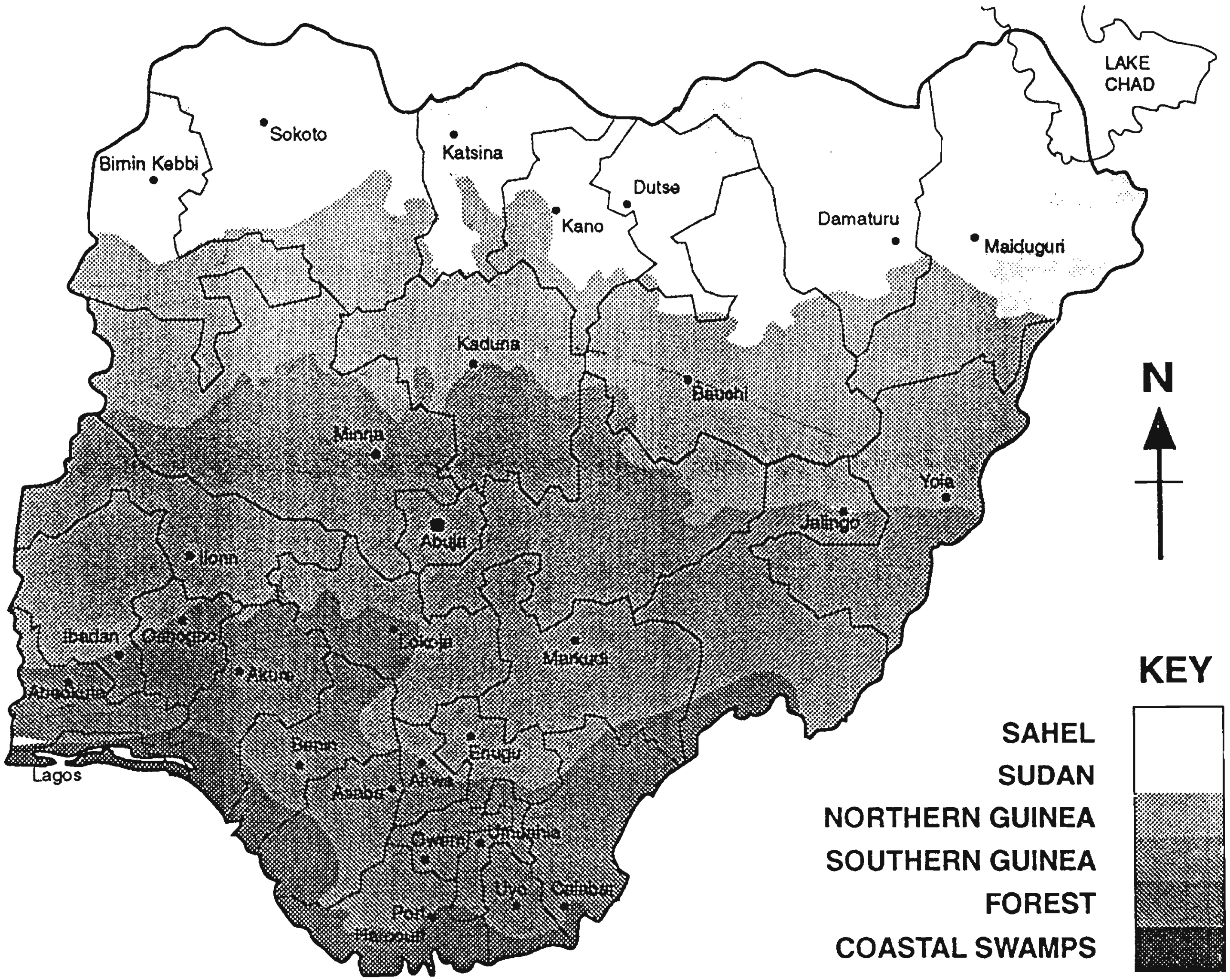


Figure 2.1 The map of Nigeria showing its ecological zones

Rationale

This high cost of imported soybean products, coupled with existing inadequacy in the production of protein-rich foodstuffs and world-wide inflation, has resulted in increased malnutrition, especially among the rural population. A UNICEF-Nigeria survey reported that in 1983, 15% of Nigerian children had a low birth weight, while this figure increased to 25% in 1987. One of the reasons for this is the very high cost of conventional protein sources (Tables 2.1 and 2.2).

A comparative cost study of the major sources of protein in Nigeria as shown in Tables 2.1 and 2.2 revealed that the commodities in prices were fairly stable in the first four years (1987-1990) of the project while very high and unstable prices were recorded in the early nineties (1991-1994).

While commodities such as pork and poultry had a price increase of over 200% between 1987 and 1988, soybean only increased by 50%. Soybean commanded the lowest price in the period (1987-1990). Prices of commodities symbolize the costs incurred by the producer/supplier and also represent the amount which buyers/consumers are ready to pay for such commodity. In the light of this, the astronomical prices commanded by the protein-based commodities in the early nineties (1991-1994) were reflections of hyperinflation and economic instability in socio-economic facets of the country, Nigeria. These commodities recorded a price hike of between 300 and 500% over 1990/91 financial year except soybean which had 50% increase.

As first-class protein sources such as beef, pork, poultry, and milk became increasingly expensive over the years, many homes could not afford them. Soybean remained the most easily affordable commodity despite this yearly minimal price increment.

Market studies show that powdered milk's high cost was due to quite a number of factors. Foremost is the fact that the dairy industry has not developed to the level of its local production in the country, so it is imported from the Western world. The foreign exchange scarcity and weak value of the naira necessitated its prohibitive price.

The high cost of beef also can be linked to under-development of cattle rearing in the country. The nomads that are the major rearers are not well-equipped to breed for desired use purposes. Also, local supply falls short of demand, therefore the little local production has to be augmented through importation from neighbouring countries such as Niger Republic and Chad.

Poultry and pork production is also dependent on foreign inputs in the form of feed formulation. Groundnut-cake that used to be the major protein base in livestock feed is still being imported to augment local production. The scare foreign exchange situation eventually translates into high poultry and pork prices.

Cowpea production cost are currently high. Farmers need improved varieties, mechanical aids and chemicals - fertilizers, pesticides etc., in order to obtain high yields and bumper harvests. All these necessities, especially modern agricultural implements/tools and chemicals, are also sources externally.

Apart from the high cost of alternative sources of protein soybean is still a new crop in Africa and literature shows that highly accepted processing techniques have been developed for soybean at the home level in Asia and at the industrial level in Europe and North and South America. However, most of these processing techniques are not appropriate for Nigeria because: (1) soybean foods made at the home level in Asia use processing techniques that are different from those used in African homes and also the taste of the food is not preferred, and (2) most of the industrial processing techniques developed in Europe and the Americas require large capital investments. There has been very little research in soybean processing/utilization methods that are appropriate for Africa, particularly Nigeria.

Project objectives

The IDRC-funded soybean utilization project was conceived with the main general objective: to develop and encourage the use of soybean utilization technologies appropriate for rural and urban households and small-scale processing enterprises in Nigeria in order to stimulate increased production and to improve economic and social benefits of the population.

Specific objectives were:

(a) to document the status of soybean production and utilization in selected areas of Nigeria;

(b) to apply the experience gained in Phase I in evolving further home-level and small-scale industrial processing technologies for production of soybean-based products;

(c) to develop and introduce appropriate soybean processing equipment for household-level and small-scale processors;

(d) to train national research and extension personnel in soybean processing and utilization techniques; and

(e) To disseminate the results of the study to interested government bodies, development organizations, and individuals within and outside Nigeria.

Soybean pocessing and utilization model and methodology

The operational strategy for the development and introduction of new soybean products is shown in Figure 2.2. This strategy involves the collaboration with National programs and Institutes to accomplish the specific objectives of IDRC project. IITA collaborated with IAR&T Ibadan; NCRI, Badeggi, NAERLS, Zaria, UNN, Nsukka, to develop household uses and small-scale processing technologies for soybean. These institutions, located respectively in Oyo, Niger, Kaduna, and Enugu states of Nigeria, made a choice of project sites on the production level of soybean in each site Table 2.3 and Figure 2.3. Linking with these Institutes enabled the project to have greater national coverage. Thus the scope of the project was broadened and it became highly interdisciplinary in content and execution. The key words in the model are **baseline survey, product development research, training and extension programs,** and **assessment of impact of the project.** The **baseline survey** was an up-to-date review on the state of knowledge on the status of soybean production and utilization and a study of the socio-economic characteristics of soybean producing and non-producing households. Rapid rural appraisal methodologies (RRA) were also used to conduct monitoring surveys. Baseline investigations were also conducted on traditional foods, providing information on chemical composition, and thus identifying those foods that needed to be fortified with soybean. Our research activities have shown that household processing effectively eliminated trypsin inhibitor activity and reduced the levels of phytic acid and tannin. Soybean-based food products were found to have higher protein and mineral levels than non-soy containing foods.

Product development research was carried out to incorporate soybean into traditional/local foods of different regions in Nigeria. Several new food products were also developed and tested analytically at laboratory level, and for acceptability. If a new soybean-based food product showed high acceptability scores then it was introduced to the project site (village).

Training and extension activities were also used to strengthen the use of soybean at household and small-scale levels. These extension programs were used to educate people on soybean processing and utilization. Programs were conducted in the local language or in English, depending on the audience. To facilitate training, recipe books in all the Nigerian local languages were developed. Over 167,000 people have been trained on the uses of soybean in Nigeria.

Assessment of the impact of project activities is essential to ensure the acceptability of soybean and potential sustainability of the program. Assessment of soybean technologies has shown that people will adopt new technologies and recipes once they are carefully prepared, recognizing the people's cultural habits. Other important assessments show that some of the new technologies and recipes do not increase equipment or processing costs and cooking time, and that these new technologies and recipes enhanced nutrition. Impact indicators include the increase in soybean production, increase in retail outlets, increase in household uses, and increase in small-scale industries processing soybean.

Table 2.1 Comparative cost of selected commodities that are sources of protein (and that of their protein) in Nigeria (1987-1990)

Source	Cost per Kilogram (₦)			
	1987	1988	1989	1990
Beef	9* (45)**	17 (85.0)	18 (90.0)	20 (100.0)
Pork	6 (50.0)	16 (133.3)	19(158.3)	19 (158.3)
Poultry	6 (30.0)	17 (85.0)	20(100.0)	20 (100.0)
Milk (powder)	8 (22.2)	12 (33.3)	15 (41.7)	15 (41.7)
Cowpea	3 (15.0)	5 (25.0)	5 (25.0)	5 (25.0)
Soybean	2 (5.0)	3 (7.5)	4 (10.0)	4 (10.0)
Fish	7 (39.9)	13 (72.2)	14 (77.8)	17 (94.5)

* Cost of the raw material obtained from Bodija Market, Ibadan, Nigeria
** Cost per kg of protein in the raw material, based on % protein estimates

Table 2.2 Comparative cost of selected commodities that are sources of protein (and that of their protein) in Nigeria (1991 - 1994)

Source	Cost per Kilogram (₦)			
	1991	1992	1993	1994
Beef	55* (275.0)**	70 (350.0)	80 (400.0)	110 (500.0)
Pork	50 (416.7)	58 (483.3)	60 (500.0)	70 (583.3)
Poultry	67 (335.0)	70 (350.0)	85 (425.0)	90 (450.0)
Milk (powder)	90 (250.0)	125 (347.2)	200 (555.6)	250 (694.4)
Cowpea	15 (75.0)	20 (100.0)	28 (140.0)	33 (165.0)
Soybean	6 (15.0)	12 (30.0)	13 (32.5)	13.5 (33.8)
Fish	40 (222.2)	55 (305.6)	60 (333.33)	100 (555.6)

* Cost of the raw material obtained from Bodija Market, Ibadan
** Cost per kg of protein in the raw material, based on % protein estimates

Table 2.3 Phase II project sites and institutions

Institution	Soybean Production	Non-Soybean Production	Urban Center	State	Region
IAR&T	IKOYI	IGANGAN	IJAIYE	OYO	SOUTH WESTERN
		IMOTA	IDIMU	LAGOS	SOUTH WESTERN
NCRI	DIKO	MUNGOROTA	BIDA	NIGER	MIDDLE BELT
NAERLS	KURMIN MASARA	MAKERA	KAYA	KADUNA	NORTHERN
UNN	OKUTU	OZALLA	ENUGU	ENUGU	SOUTH EASTERN

Soybean: The answer to malnutrition

Soybean is a source of high quality and inexpensive protein (about 40%) while the oil is high in essential fatty acids and devoid of cholesterol. The relevance of soybean for solving, Nigeria's food problem has been established (Osho, 1988). Soybean's greatest potential is its incorporation into local Nigerian diets.

Soybean, *Glycine max* (L. Merill) is the world's most valuable oil-seed legume. Originating from China about two thousand years before the birth of Christ, it is now internationally acclaimed as the miracle crop, the cow of China, the Cinderella crop of the West and the Pearl of the Orient, all because of its versatility (Ogundipe and Osho, 1989).

Soybean production and utilization have been on the increase in the world. China, Indonesia, Japan, Korea, East and Southeast Asia and the United States of America are the world's major producers of the crop. It became an important commercial crop in the USA in the 1930s.

Soybean production and utilization have been on the increase in Nigeria. This has been made possible by the successful development of improved soybean varieties that can grow well in Nigeria by IITA and other Nigerian institutions.

Other catalytic factors responsible for an increase in soybean production and utilization include government policies that banned the importation of vegetable oils and the economic policies of government which has made imported protein-rich foods such as milk, frozen fish, baby food and baby-milk become expensive to many Nigerians.

Chemical composition and nutritive value of soybean

Soybean occupies a unique position among leguminous crops in having 40% protein and 20% oil in mature seeds. Hence, it occupies an intermediate position between legumes and oil seeds in having more protein than most of the oil seeds. The mature soybean seed has three major components, the seed coat (hull), the cotyledon, and the embryo axis (hypocotyl). As such it can be rightly considered as a protein concentrate even without defatting (Table 2.4). The unique physio-chemical characteristics of the constituents of soybean offer tremendous possibilities for their use in food, feed, and industrial applications.

(a) *Protein*

The protein content of soy foods is quite high ranging from 40% in full fat soy flour to 90% in isolate. The protein content is considerably higher than in meat or dairy products, fish, eggs, etc. Besides the quantity of soy protein it is also important to know the quality of soy protein and the quality of the foods to which soy protein is to be added. The quality of soy protein can be discussed in terms of amino acid composition.

Soy protein is somewhat deficient in methionine and cystine which is one of the eight essential amino acids, i.e., the sulphur-containing amino acid, but they are generally high in lysine content, which is the limiting amino acid in cereals. The fortification of soybean with cereals at the rate of 25% soy to 75% cereal will complement each other and constitute a well balanced amino acid content (Table 2.5). Soy protein can also be used to upgrade the protein and consequently the nutritive values of starchy crops such as rice, yam, cassava, and others.

(b) *Oil*

The average oil content of soybean is 20%. The composition is similar to other vegetable oils such as sunflower and groundnut. It is highly digestible, high in poly-unsaturated fatty acids and contains no cholesterol. It is believed that the use of poly-unsaturated fats in the diet reduces the level of cholesterol in the blood and thus a reduction in susceptibility to cardia-vascular disease. Soybean oil is composed of about 85% unsaturated and 15% saturated fatty acids. About 60% of soybean oil is composed of essential fatty acids. The term "essential fatty acids" refers to three fatty acids: linoleic, linolenic and arachidonic acids which are essential because they have multiple functions in the body. The amount of linolenic acid required in a normal diet is about 5-6 grams a day. Soy oil contains over 50% linoleic acid. Soy oil can be used for processing margarine, mayonnaise and salad dressing.

(c) *Carbohydrates*

Soybean contains about 35% carbohydrate (sugars). The insoluble carbohydrates consist of cellulose and hemicellulose. The soluble carbohydrates (sugars) consist of sucrose, oligosaccharide, stachyose and raffinose. The fermentation of oligosacchides occurs so as to be absorbed by the intestine. This process produces flatulence, composed of carbon dioxide, hydrogen, and small amount of methane. The elimination or reduction of flatus from soybean foods is needed to increase the acceptance of soy.

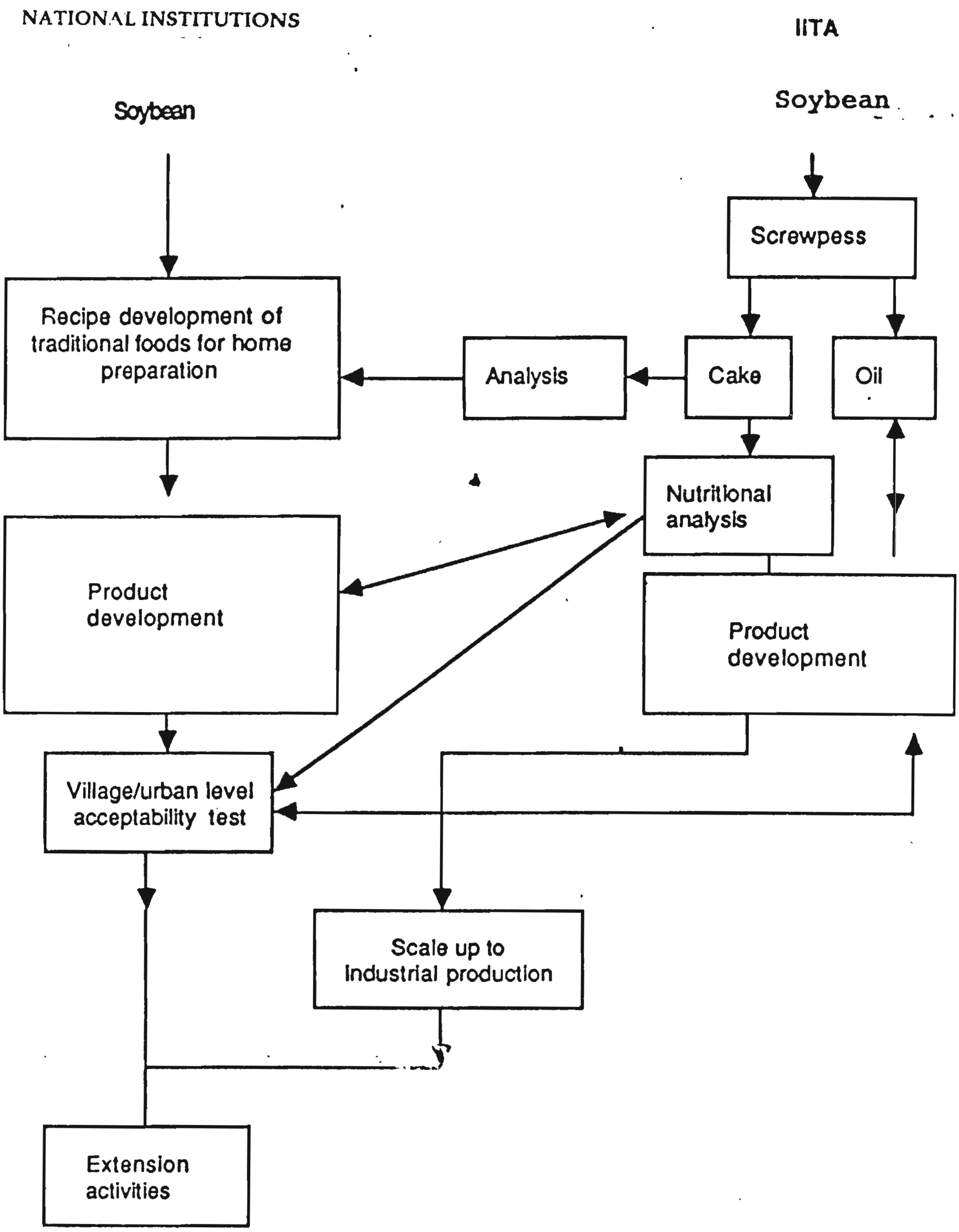
Soybean can be processed so that flatus is reduced by removing the oligosaccharide. A low level boiling with tap water or 0.5% sodium bicarbonate solution will remove some of the oligosaccharide.

(d) *Minerals/Vitamins*

Whole soybean contains 1.6% potassium, 0.3% calcium, 0.3% magnesium, 110 ppm iron, 50 ppm zinc, and 20 ppm copper. The minerals present in soy products can contribute to the overall requirement especially for children and pregnant women. Besides the quantity, the availability of minerals must be considered. Phytic acid present in whole soybean can chelate divalent ions such as calcium, iron, and zinc, and lower their availability.

The vitamins present in high amounts in soybean include thiamine (11.0-17.5 µg/g), riboflavin (3.4-3.6 µg/g), niacin (21.4 µg/g), and pantothenic acid (13.0-21.5 µg/g). Vitamins are unstable and they are sensitive to processing conditions. Generally home cooking leads to a great loss of vitamins and minerals. Operations such as dehulling, grinding, blanching, etc. make significant contributions to mineral and vitamin losses.

Fig. 2.2 The operational strategy for the development and introduction of new food products made form soybean



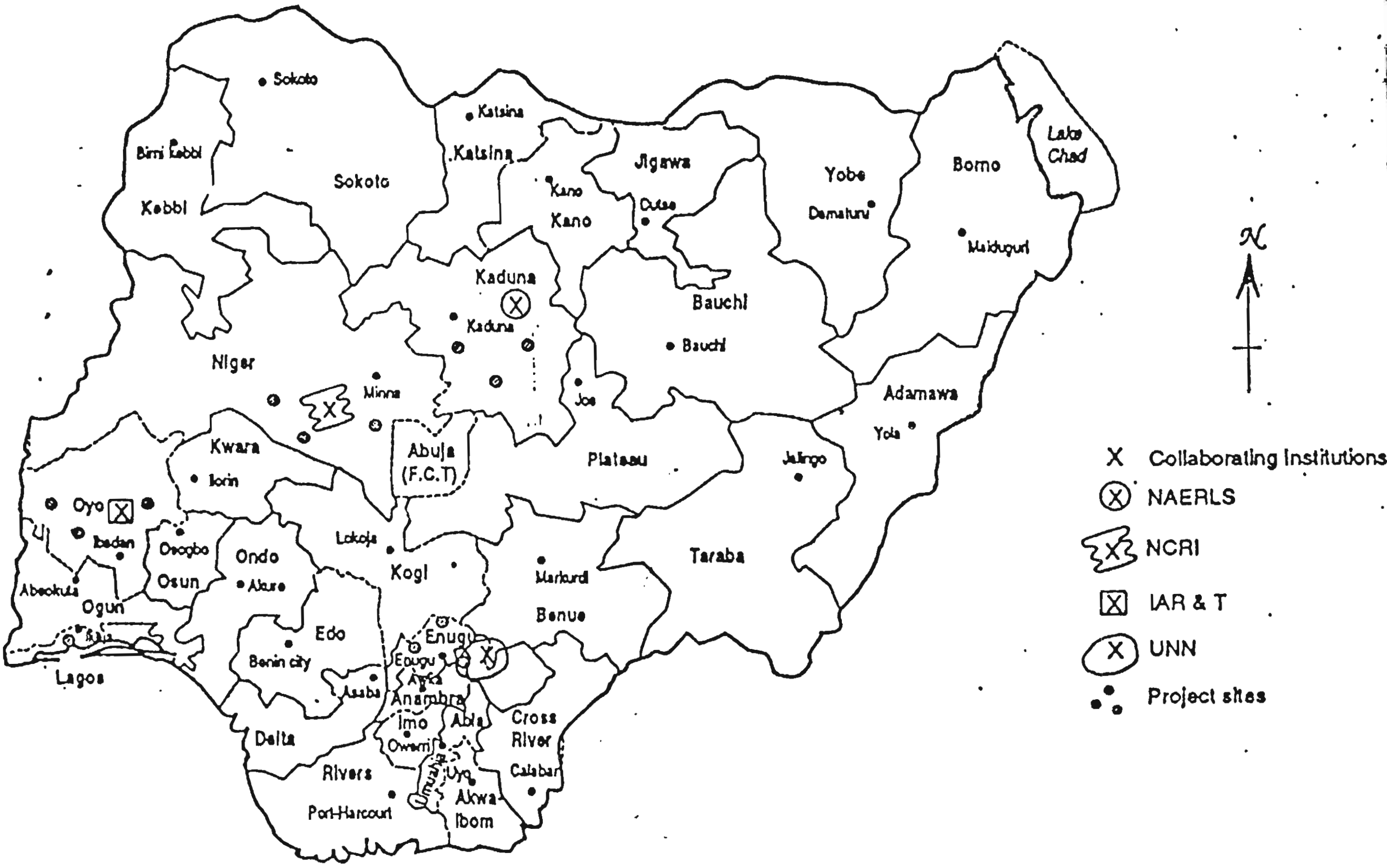


Fig 2.3 Collaborating Institutions on IDRC/IITA Soybean Utilizatjon project in Nigeria.

Picture 2. Soybeans

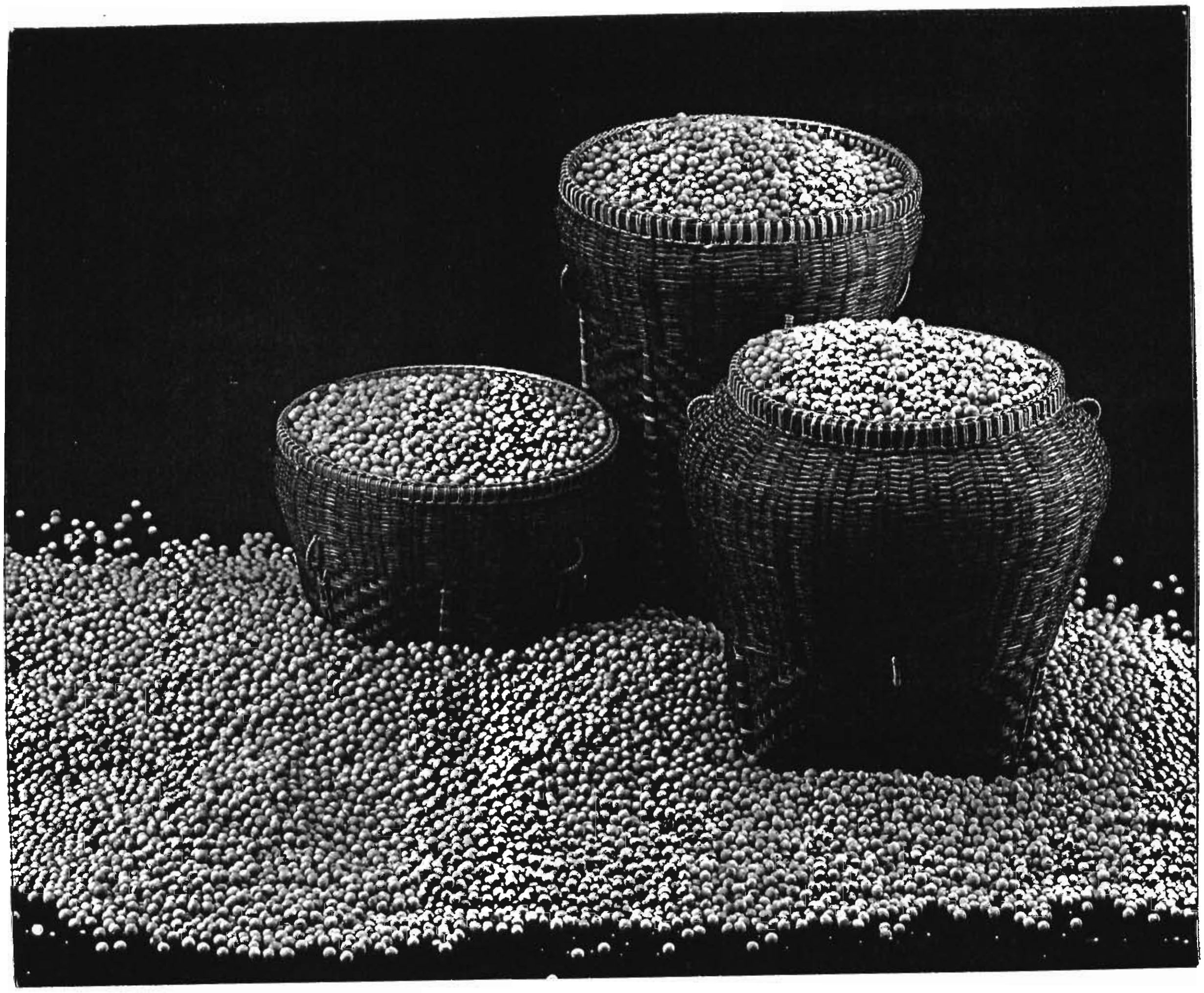


Table 2.4 Chemical composition of whole soybean

	Protein (N x 6.25) (%)	Fat (%)	Carbohydrate (%)	Ash (%)
Whole bean	40	20	34	4.9
Cotyledon	43	23	29	5.0
Hull	8.0	1	86	4.3
Hypocotyl	41	11	43	4.4

Table 2.5 Amino acid profile of soybean protein gram/of amino acid/16 g of nitrogen

Isoleucine	4.5
Leucine	7.8
Lysine	6.4
Methionine	1.3
Cyrstine	1.3
Phenylalanine	4.9
Tyrosine	3.1
Threonine	3.9
Tryptophan	1.3
Valine	4.8
Arginine	7.2
Histidine	2.5
Alanine	4.3
Aspartic acid	11.7
Glutamic acid	18.7
Glycine	4.2
Proline	5.5
Serine	5.1

Source: FAO (1985)

Antinutitional factors in soybeans

These are referred to as "biologically active substances" or antinutitional factors. These substances are not "toxic", however, it may inhibit the availability of desired substances that are otherwise useful to the body. Some of these substances are trypsin inhibitor, hemagglutinins, phytic acid, goitrogens, and urease.

(a) <u>*Trypsin inhibitor*</u>

Soybean trypsin inhibitor is present in raw soybean at 1.5%. Trypsin inhibitor (TI) depress growth and causes hypertrophy of the pancreas in animals. It reduces digestibility of protein, thereby lowering the nutritive value by increasing the sulfur amino acid requirement. Trypsin inhibitor is inactivated by heat. Moist heat is more effective then dry heat. Boiling for 20 minutes will inactivate most of the trypsin inhibitor. The rate of denaturation increases with rising temperature. About 100°C atmospheric steam for 15 minutes will inactivate 95% of the TI activity.

(b) <u>*Hemagglutinin*</u>

Soybean contains a protein which agglutinates red blood cells and thus is called hemagglutinin. Some hemagglutinin are toxic to animals, and in soybean it makes up to 1-3% of the protein. It is easily destroyed by heat. Soybean hemagglutinin does not affect the nutritional quality of soybean protein.

(c) <u>*Phytic acid*</u>

Soybean contains about 2% phytic acid, which decreases the availability of divalent cations, such as calcium, zinc, and iron by forming a insoluble protein complex that is not readily broken down and may pass through the digestive tract unchanged. The poor availability to animals of zinc present in soybean is attributed to phytic acid. Phytic acid does not interfere with the bio-availability of minerals added to soy foods. Therefore, mineral supplementation of soybased infant formulas and baby foods is an effective way of increasing the mineral bio-availability of these products.

(d) <u>*Goitrogens*</u>

There is an unknown component in soybean which can cause enlargement of the thyroid gland (goiter) in animals and human beings. It can be partially destroyed by heat. This problem can be eliminated by supplementing soymilk with iodine. In the USA, it is recommended that soybased infant formula be supplemented with 5-75 micrograms iodine/100 kilocalories of formula.

(e) <u>*Urease*</u>

This enzyme is found in large amounts in raw soybean. It will degrade urea to form ammonia, a very toxic compound. Urease is only a problem when raw soybean are fed along with urea to cattle. Urease requires longer heat treatment than trypsin inhibitor to activate it.

Soybean in Nigeria

Soybean (*Glycine max.* L. Merrill) was first introduced to Nigeria in 1908, in Ibadan (Oyekan 1987). The first attempts to grow soybean were made at the Moor plantation experimental sites but were unsuccessful (Ezedinma, 1965). Soybean varieties from Malaysia were introduced to Samaru-Zaria in 1928 while the Malaysian variety was introduced to the area of the present Benue state a little later (Nyiakura, 1982).

In the 1950s, as export demand for soybean increased, commercial production of soybean spread to other parts of the northern region including Keffi, Zankwa, Abuja and Suleja (Oyekan et al. 1990). By the mid-1970s, soybean varieties that could grow successfully in southwestern Nigeria were identified (Afolabi, 1971).

In 1977, collaborative research was initiated between IAR&T and IITA on soybean variety production trials. This collaborative work resulted in the development of improved high-yielding soybean varieties with better seed-strong ability coupled with the ability to nodulate freely with strains of Rhizobium bacterium abundant in most Nigerian soils (Kueneman, 1981). The collaboration also resulted in the National Soybean Improvement cooperative trials of 1980 and the Nationally Coordinated research projects on soybean in 1982.

Dashiell (1987) reported that soybean production in Oyo state was near zero and by 1986, there were between 3,000 and 4,000 farmers who planted approximately 1,000 ha with a total yield of 800 tons.

Dashiell and Oyekan (1990) reported that soybean can now be commercially grown in all the states in Nigeria including Abuja in areas with a rainy season of at least 100 days and soil pH 5.0 or above. However, the profitability of growing soybean in any of these areas depends on other factors, such as knowledge of soybean production methods by the farmers, availability of good quality seed of recommended improved varieties, and ready access to markets.

While soybean production in Nigeria dates back to 1908, utilization of the crop was started in the 1980s by IAR&T and NAERLS, Samaru-Zaria. The major uses of soybean in the early 1980s was in the making of daddawa, a traditional soup condiment. Research in the Zonkwa-Kafanchan area of Kaduna state by Mebrahtu and Hahn (1987) has indicated the major role of women in the processing and marketing of daddawa as a major income-generating activity. It is also known as iru or ogiri in Yoruba land. Soybean was used as a substitute for Locust bean (*Parkia filicoides*) because the parkia tree grows wild and it takes several years to mature (Oyeleke, 1987).

Soybean Processing Utilization (Phase I) 1987 - 1990

Intensive use of soybean at household and industrial level started in 1987 with a three year of collaborative research effort on soybean by IITA and IAR&T in Ibadan. This research was funded by IDRC Canada with the primary purpose of promoting utilization of soybean in the diets of Nigerians. This project was referred to as IDRC Soybean Utilization project Phase I.

This project has five main objectives: (1) document the status of soybean utilization in Oyo State, Nigeria; (2) develop household technology for preparing soy-based foods; (3) develop small-scale processing technology for soy-based foods; (4) introduce and assess the impact of household food technologies in rural areas and (5) disseminate the results of the study.

Various factors (economic, agricultural, societal, and nutritional) have combined to rekindle interest in the production and utilization of soybean in Nigeria. Several national institutions and voluntary organizations have made and are still making positive efforts to encourage malnourished segments of the population to use soybean as everyday food. Despite these commendable efforts, very few Nigerians were actually utilizing soybean as food in 1987; this was probably due to lack of knowledge and/or lack of appropriate processing technology.

At the end of the Phase I project, soybean had become a household food in Oyo state where the project was implemented and the following were some of the results.

(1) Soybean production in Nigeria before 1984 was confined to Benue and Kaduna states. Also at that time there was a lack of knowledge on the methods of using soybean. There was also a lack of market for soybean.

(2) A baseline survey was conducted in 1987 to document the status of soybean production and utilization in three main villages; Ikoyi, Igangan, and Ijaiye, Oyo state. Soybean cultivation was found to be relatively unimportant in the farming systems of farmers at the time of the baseline survey. About 17% of the farmers cultivated soybean in Ijaiye and 40% in Ikoyi, while no farmer cultivated soybean in Igangan. According to the farmers, the motivating factors in the cultivation of soybean are a ready market (26%), multipurpose use (26%) profitability (24%), nutritional value (20%), and knowledge of its cultivation (4%). With respect to soybean utilization, the survey revealed that the Ikoyi community was the most conversant with soybean utilization; consumption of soybean in Ijaiye was very low, while no one in Igangan consumed any soybean product during the time of the survey.

(3) Some households in Oyo state are involved in soybean cultivation. These households consist of about 11 people, between 30-40% of them were children under 10 years. Men

and women work together during planting and harvesting of the crop, while women and children are responsible for weeding and fertilizer application. The women in these households are responsible for all forms of food preparation using soybean.

(4) Soybean was the most profitable crop to grow in Ikoyi, Ijaiye, and in Igangan. Many soybean-growing households consume soybean as a substitute for egusi (melon seeds). Soybeans were found to be cheaper than melon seeds.

(5) In 1988, there was a small increase in both the number of soybean farmers and total hectarage under soybean cultivation. The positive effect of training resulted in higher consumption level of soybean products locally.

(6) Soybean was being gradually integrated into the farming systems of these communities. The consumption level has increased over the 3-year period, especially in Igangan, where little or nothing was known about soybean at the start of this project.

(7) A baseline investigation on the chemical composition of some Nigerian traditional dishes was conducted. This baseline investigation showed that the selected Nigerian traditional dishes were quite low in protein; hence there was a need for fortification. When soybean was incorporated into traditional dishes, the levels of antinutritional factors were monitored during processing. The results showed that processing effectively eliminated the trypsin inhibitor activity (TIA) and reduced phytic acid and tannin to acceptable levels. Soy-based products generally had higher protein and mineral levels than the non-soy containing foods. There was no significant difference in the level of acceptance of soybean-based products: soy gari (soybean and cassava), soy vita (soybean and maize), soymilk (plain, chocolate, and vanilla flavoured), soy bread, soy-egusi soup, and soy oil, when these were compared with the corresponding traditional foods that they were simulating. These are a few examples of products that the project developed and introduced with an encouraging level of acceptability and adoption.

(8) With the increase in the home-level production of soymilk, there is a corresponding increase in the level of available soymilk residue. In order to justify the use of soymilk residue for food, a nutritional evaluation of the soymilk residue was conducted. It showed that the protein is very high (19%), while the TIA suggests that the heat treatment was adequate. Presently, the milk residue is being used to prepare the very popular egusi soup, where it replaces melon flour, which is becoming very expensive and generally unavailable. Some other foods that have been fortified using soymilk residue include moinmoin, akara, and ogi. There is an increase of protein content of these traditional foods, with the addition of soymilk residue. About 72 new recipes were developed, introduced, and evaluated.

(9) Soy milk, was one of the major products of soybean developed, tested and transferred to project sites. Soymilk was being processed from full fat soybean flour, as opposed to processing it only from the grains. Processing soymilk from soy flour was developed to reduce processing time. In general, soymilk has shown high acceptability among all classes of people and has proved highly acceptable when compared with leading milk brands in the Nigerian market.

(10) Soy gari, soy vita, soy musa, soymilk, soy extruded products and soy oil are all small-scale products of soybean developed for commercial utilization. These products have high protein content when compared with the conventional products, and have shown high acceptability, not only at the rural level but also at urban level.

(11) Soy oil was extracted using a screw press, and the extruder (Instal-Pro 600 Jr. model) was used to developed commercially processed foods. The flours were later tested for acceptability in the three main villages and chemically analyzed for protein, oil, trypsin inhibitor minerals, tannin, and phytic acid. It was determined that partially refined soy oil is highly acceptable to the middle and low income groups, while the high income class will buy soy oil with further refining. In the villages Ikoyi, Igangan, Iroko, Adana, and Oniyo, both crude and partially refined soybean oil were found acceptable; however, partially refined oil was preferred to the crude soy oil.

(12) Dry extrusion and screw press technology for producing fully cooked soy products, usable for both human and livestock food, was developed and tested. The products of the extruder have been shown to be nutritionally superior to other soybean foods, because their protein is of high quality. The products, which were later formulated to local recipes, were tested for acceptability in some project sites; soybean/maize blend was accepted as a gruel (children's food), soy full fat flour, in akara (a popular cowpea product) as a substitute for cowpea flour, and defatted soy flour as a substitute for melon seed in egusi soup.

(13) Also several new products were developed and commercialized. Examples of such products are soy gari, soy bread, sorghum/soy biscuit, soy vita, soymilk, soy musa (a plantain-based baby food), and soy oil.

(14) Soybean has been accepted not only at the rural level but also at the urban level. It is now found in all most major markets in Ibadan. The marketing data show that the total number of increased from 1 in 1987, to 419 retailers in 1990, during the 3-year project. The price soybean also showed an increased from ₦1.50 in 1989 to ₦4.25 per kilogram in January 1990. Soybean is now being sold in form of grains and flour in most of the local markets.

(15) There has been an increase in commercial products of soybean found in the Nigerian market. The products now range from soy ogi and Nutrend as baby foods, soymilk , and soy flour. These products are now available as a result of popularizing soybeans; for human food. About twenty five industries were processing soybeans in 1990, as against only one industry using soybean as raw material in 1987.

(16) The final survey on soybean production and utilization was conducted in 1989/1990, to re-assess the degree of interest the rural people have in soybean production and utilization. The survey revealed that in 1989 about 80% of the soybean farmers had soybean farm sizes less than 1 hectare. They obtained planting seeds from PZ, IAR&T, University of Agriculture, and IITA. The most popular practice by the respondents (46%) was sole planting of soybean on heaps. Other farmers intercropped soybean with other crops, such as maize, cassava, and melon, on ridges or flat land. Two or three weeding were generally carried out on the respondents' soybean farms. Pests (mostly rodents and birds) and pod shattering were cited as major problems.

(17) The study revealed a remarkable increase in the level of awareness of soybean utilization locally in Igangan, Ikoyi, and Ijaiye communities between 1987 and 1990. Consequently, the consumption level increased greatly over the 3-year period, especially at Igangan where little or nothing was known about soybean at the onset of this project. This positive change came as the villagers realized that soybean is highly nutritious and cheaper than other commonly eaten foods. In addition, they realized that the preparation of most soy-based foods does not require additional time.

(18) Companies such as Oja Farms and DLOB Oils, have adopted the use of the technologies developed during the first phase of this project and now serve as models for others in the country. These companies also served as pilot projects to document their experiences. Evaluation using rapid rural appraisal (RRA) methodologies indicates that these technologies and the end products are acceptable.

(19) As far as assessment and transfer of soybean processing technologies are concerned; adoption of soy foods at rural level is high, adoption of extruded products shows the potential of extrusion cooking to be a rural level technology. Soy oil has proved to be a highly acceptable cooking oil among all the class income groups in Nigerian society.

(20) Training activities were used to educate people on soybean processing and utilization. Programs were conducted in Yoruba (local language) or English depending on the audience. To facilitate training, various recipes were developed. These include IAR&T recipe book (English), IAR&T recipe book (Yoruba), *Soybean for Good Health* in all the national languages Yoruba, Hausa, Igbo and English, *Soybeans in Nigerian Foods* which contains 72 recipes complied as a result of fortifying our local foods with soybean.

(21) A national training program for the Agricultural Development Project officials across the country was used to disseminate information on developed soybean technologies during the Phase I project. About 27,720 people were trained during the life of the project.

(22) Finally, there was evidence to suggest that, at government level there was a growing and significant support for soybean production and utilization. For example, in Nigeria there was a directive that the production of soybean should be stepped up in the 1990 production season. Also the government was giving more support to research institutes involved in soybean research and to the Nigerian Soybean Association.

(23) Results from this project conclusively show that people will adopt new technologies and recipes once they are carefully prepared, recognizing the people's cultural habits and as long as these new technologies and recipes do not increase equipment cost, processing cost, or cooking time; in addition, the new technologies and recipes also enhance nutrition.

Chapter Three

SECTION 1

Summary of Soybean Utilization activities Phase II

The successful completion of the Phase I project on soybean utilization in Oyo state Nigeria led IITA into collaborating with four other national institutions (NAERLS, NCRI and UNN, and IAR&T) in the second phase of the soybean utilization project.

The aim of the Phase II project was to develop and encourage the use of soybean utilization technologies appropriate for rural and urban households and small-scale enterprises in Nigeria in order to stimulate increased production and to improve economic and social benefits for the population.

Several scheduled activities were undertaken during the life of the project. These include:

- Initial planning meeting at IITA - February 1991
- Training of project personnel on use of rapid rural appraisal at IITA-March 1991
- Training of project personnel on soybean processing at IAR&T - August 1991
- Distribution of new vehicles to National programs at IITA - March 1991
- Conducting and analysing baseline surveys using conventional survey and RRA by each Institution (IAR&T, NAERLS, UNN, NCRI) April - August 1991
- Production Development Research (August 1991-December 1993)
    - incorporating soybean into traditional foods. (household utilization of soybean)
    - development of small-medium-scale technologies from soybean
    - use of extruders and screw presses to formulate soybean based foods
    - development of small-scale equipment for soybean processing
- Demonstrations in rural areas, extension, training, and workshops on soybean processing (August-April 1993)
- Socio-economic monitoring yearly by each institution (IAR&T, UNN, NAERLS, NCRI)
- Overall and terminal survey of project sites by each institutions (IAR&T, UNN, NAERLS, NCRI)
- Many review meetings to assess the progress of project.

Anticipated results and beneficiaries

The following results were anticipated from the Phase II soybean project.

(a) Documentation will be made of soybean production and utilization in Nigeria

(b) More people in Nigeria will be aware of the possible economic and social benefits of soybean.

(c) More expertise will be created in the countries on the production and use of soybean among researchers, processors, extension agents, policy-makers and the general population.

(d) An increase in production, home utilization and small-scale industrial processing of soybean is expected at both the rural and urban levels.

(e) The nutritional status of women and children in the project areas should be improved, thus reducing illnesses amongst these groups.

(f) Economic benefits should be gained by many farmers through the anticipated increase in demand and possibly in market price of soybean.

(g) A research methodology will be available for use in transferring research results among projects within and among countries.

SECTION 2

Summary of First Planning Meeting for IDRC Soybean Utilization Project Phase II 19-20 February 1991

This meeting was the first activity undertaken when the project commenced on 18 February 1991. Participants for this meeting were drawn from national institutions in Nigeria and Ghana as shown in Table 3.1.

The objectives of the meeting were:

1. to provide opportunities for participants to become acquainted with each other.

2. to review document and agree on basic elements for collaboration within the project; and

3. to set out the schedule of activities for the Phase II.

Dr K. Dashiell and Dr S.M. Osho welcomed the participants to IITA and to the IDRC project. Short background into the phase I of the project was mentioned. Emphasis was given to the memorandum of understanding signed by each Director of the respective institutes, stating their interest in collaborating on the project, and assuring IITA, that the respective project personnel would be cooperative.

The project document was approved by project personnel in all the various institutions and a new schedule of activities was drawn up. The project sites that were selected by each institute were on the basis of no soybean production, soybean production, and an urban center. It was agreed that IAR&T, should select new urban centres in Lagos State and continue to monitor activities in their old project sites, Ikoyi, Igangan, and Ijaiye.

Dr. H.O. Ogundipe discussed some of the results of the Phase I project. Soybean production and utilization was very low in Oyo state. There were few markets where soybean was sold and only two food products were manufactured from soybean by one company. However, after three years of the project, production had increased significantly, with over 65% increase in the number of soybean traders in the state.

The final survey on soybean production and utilization conducted in 1989/90 revealed that about 80% of soybean farmers had soybean farm sizes less than 1 hectare in 1989. About 46% of the respondents planted soybean on heaps solely while others intercropped it with maize, cassava, and melon on ridges or flat land. 1989 to 1990 witnessed a remarkable increase in the level of soybean utilization in Igangan, Ikoyi, and Ijaiye communities with Igangan taking lead considering the complete ignorance of the seed in the town three years ago.

This positive and sudden change was attributable to soybean nutritive quality low cost and virtually absence of additional cooking time of some of its products.

The survey also showed that 65% of traders had less than four years of trading experience in soybean. They recorded the highest soybean sales between October and December each year and the average price was ₦2.50/kg during harvesting period, ₦4.00/kg in off-season.

The studies also revealed that soybean can be successfully introduced into Nigerian traditional recipes without deleterious effects. Dry extrusion and screw press technologies can be used to produce inexpensive and high quality soy oil, snacks, baby foods and breakfast foods.

About 25 companies such as Oja Farms and DLOB Oil have adopted the use of technologies developed during the first phase of this project and now serve as models for others in the country. Results from this project conclusively show that people will adopt the technologies and recipes once they are carefully prepared, and monitored towards people's cultural habits.

Woodworth, on IITA Agricultural Extensioner, reported at the meeting on soybean expansion in Benue state as follows:

Since the mid 1980s there have been reports of large increases of soybean production on Benue state. A survey program was carried out to document this expansion, and determine what factors were responsible for this expansion. Through three series of interviews from April 1989 to August 1990 many facts came to light:

Since the early 1980s a large majority of farmers have adopted the production of soybean. The second and third surveys from this program interviewed 110 soybean producers of eastern Benue state. Only 15% of the sampled farmers had been growing soybean before 1983. By 1985, the growing soybean had increased to 25%. The majority of the farmers (58%) started in the 3-year period, 1986-1988.

Their production levels have followed this same dramatic increase. This group of soybean producers had gone from a total production in 1982 of approximately 7.9% to 18.5% by 1985 (an increase of over 134%). By 1989 this same group was producing approximately 58.5% per year (an increase of over 216% since 1985).

Production increased mainly because many more farmers were growing soybean. No less than 70 of these producers were expanding their production, helping to give the group's total production an increase of 640% from 1982 to 1989.

Four major factors have induced these producers to adopt and/or increase their soybean production.

1. Soybean has improved its ability to meet the farmers' cash needs relative to other competing cash crops because a domestic market has been developed and the price of soybean has increased more rapidly than the price of other competing crops.

2. Soybean has improved its ability to meet farmers' food needs because soybean utilization programs have convinced the rural populace about its superior nutritional qualities. These programs and some indigenous recipes have provided acceptable ways of incorporating it into the local diet.

3. Relative to competing crops, soybean is economical in its use of resources which are scarce in the eco-system. Many farmers consider soybean production more favourable than some of their other crops because it requires less labour and fertilizer inputs.

4. Soybean input requirements are compatible with other major crops in the ecosystem. There is little conflict between the labour calendar of soybean and the farmers' other important crops.

The status of soybean utilization was presented by participants in each institution. The summary of their presentation is as follows:

University of Nigeria, Nsukka by Dr (Mrs) A.C. Uwaegbute and Mrs N.J. Enwere report

Soybean production and utilization is still fairly new in Enugu and Nsukka because the Institute is located in an area where soybean production is low. However, efforts have been made by the Agricultural Development Projects in the zone to promote the production and use of the crop. They sponsored some workshops on soybean utilization. In 1988, Ford Foundation sponsored a training program on food crops production, utilization, and nutrition. Soybean production, processing, and utilization were strongly emphasized for nutritional benefits. In 1989, a survey was conducted by the nutrition team in the Department of Food and Nutrition, UNN, and found that those in the high income group (educated people) seem to use soybean more. Soybean has been incorporated into their traditional foods.

National Agricultural Extension and Research Liaison Services by Mrs V.B. Dunmade and Mrs. H.J. Chindo report

This Institute is based in Samaru, Zaria, and coordinates extension for Nigeria. The institute has been involved in soybean processing and utilization since the 1970s. This has led to a lot of training programs and workshops being held in these institutes and also at the rural level. A recipe book titled *Soybeans in the Nigerian Diet* is a new publication by their institute. Most of these training programs have been sponsored by Ford Foundation, UNICEF, and also the Nigerian Government.

National Cereals Research Institute by Miss I.U. Awuja and Mrs C.F. Ndaeji report

This Institute is situated in the middle belt of Nigeria which is the best ecology for soybean production. The staff of the Institute have been involved in soybean processing and utilization since the 1980s. They also have the Federal Government mandate for soybean improvement in Nigeria. They have been involved in soybean processing and utilization by incorporating soybean into traditional foods. Training programs have been conducted at the rural level (particularly in Niger state). They have also successfully introduced soybean milk processing to a Women Training Center which is now processing and retailing soymilk. They have found that soybeans products, especially soymilk, soy cheese, and soy daddawa, are highly acceptable to the people in this area. The Institute has a recipe book titled "*Processing and utilization of soybeans*".

Institute for Agricultural Research and Training (IAR&T), by Mrs V. Obatolu report

IAR&T is an Institute within the Obafemi Awolowo University with a mandate to carry out multicommodity and multidisciplinary research and to disseminate results. It has been active in the identification of soybean suitable for various ecological zones. Soybean utilization research started in the 1970s and recently has collaborated with IITA (Phase I) on a soybean utilization project to develop household level processing and small-scale processing of soybean. The Institute conducted training at project sites, and workshops on soybean production and utilization and also developed soybean-based foods for our traditional taste. Recipe books in English and four local languages have been published.

Women Farmers Extension Division Ghana by Miss Rosette Tetebo

This Ministry is specialized in extension work for women and have introduced a lot of crops, including soybean. They have collaborated with the Food Research Institute and Ministry of Health to conduct training on soybean. Soybean has been incorporated into Ghanaian dishes; such foods have been documented in a recipe book published by the Ministry of Agriculture, Ghana.

More training and demonstrations have been conducted since IITA held a workshop on soybean processing and utilization in 1989 in Kumasi, Ghana. The participants from government and the private sector expressed their interest in soybean processing and utilization.

SECTION 3

Summary of Rapid Rural training for Project Participants

This is a report of a Rapid Rural Appraisal (RRA) training organized 10-17 of March 1991. In recent times, scholars interested in action-oriented research have advocated the need for a paradigm shift to include methodologies that enable relevant and reliable data to be collected within a relatively short period. Among such methodologies is the RRA.

The technique has been developed over the last ten years in response to concerns over the commonly encountered pitfalls to conventional approaches for rural research and development (McCracken, 1988). The RRA had been defined as a systematic but semistructured activity carried out in the field by a multi-disciplinary team designed to learn relatively quickly from rural people so as to generate new hypotheses about any given situation. RRA technique has been applied in the design of community nutrition programs, farming systems research and in agricultural marketing and food systems (Holtzman, 1986; Kashyap and Young 1989).

Thus, in the attempt to improve nutrition in the project communities, the RRA methodology was be used:

1. to document the status of soybean production and utilization in selected areas in Nigeria, and;

2. to periodically monitor, evaluate, and assess the impact of the 3-year project.

Table 3.1 Participants at the 1st Planning Meeting for the IDRC Soybean Utilization Project Phase II

S/N	Name of participant	Profession	Name of institution
1.	Mrs V.A. Obatolu*	Home Economist	IAR&T
2.	Miss I. Uche Awuja**	Food Technologist	NCRI
3.	Mrs C.F. Ndaeji	Home Economist	NCRI
4.	Mrs V.B. Dunmade**	Home Economist	NAERLS
5.	Mrs H.J. Chindo	Food Technologist	NARLS
6.	Dr (Mrs) A.C.Uwaegbute*	Nutritionist	UNN
7.	Mrs N.J. Enwere	Food Technologist	UNN
8.	Dr Sefa Dedeh**	Food Technologist	University of Ghana, (UGL) Legon
9.	Miss Rosette Tetebo**	Home Economist	Women Farmers Extension Department (WEFD), Ministry of Agriculture, Ghana
10.	Dr Ken Dashiell	Soybean Breeder	IITA
11.	Dr O. Nakayama*	Food Technologist	"
12.	Dr H.O. Ogundipe*	Food Technologist	"
13.	Mrs S.M. Osho**	Food Technologist	"
14.	Mr I.G. Adenekan	Food Technologist	"
15.	Mr J. Woodworth**	Agric. Extensioner	"

* Institutional Project Coordinators
* Left before the end of the project.
** Ghana withdrew from the project after the RRA training.
** Project Coordinator.

The training workshop

With this objectives in mind, a training workshop on RRA was organized for project personnel in Nigeria and Ghana. The training program was held between 10-17 March 1991, with participants drawn from the collaborating institutions. The venue of the training was IITA Conference Center, Ibadan, and the fieldwork was undertaken in Ogbomoso Local Government Area LGA, Oyo state. This workshop lasted seven days, which included three full days spent in the villages doing an exploratory RRA and testing a variety of techniques from the RRA tool kit. Picture 1 shows three typical Nigeria villages. The results of the fieldwork, which was also presented on the last day, provided insights into soybean production processing and utilization in Ogbomoso. Some of the members were using RRA for the first time while about five of the participants had already used the methodology two or three times before. Both the methodology and its execution were appraised at the end of workshop. The general opinion of the participants was that this was an effective methodology for baseline surveys.

The training objectives were:

(1) to learn techniques for information gathering and analysis using RRA, and
(2) to practise the methodology in the field by evaluating the status of soybean production, processing, and utilization in Ogbomoso LGA.

Other objectives were:

(1) to immerse participants in the subject matter in the use of RRA;

(2) to expose participants to as many of the RRA field techniques as they could replicate and/or adapt in their various institutions.

(3) to create an atmosphere of cooperation and mutual respect, particularly with regards to the potential of "teaming up" with people from different disciplines; and

(4) to provide opportunities for participants to become familiar with each other's experiences, perspectives, and contributions to the work to be undertaken.

Selection of participants

The participants at the workshop were selected from the collaborating institutions on the soybean utilization project. The NCRI, UNN, IAR&T, NAERLS, UGL and WFED, and IITA. A multidisciplinary team, comprising a food technologist, home economist, or nutritionist, socio-economist or agricultural economist and an agronomist, was invited from each institution. Most of the researchers have Masters or Doctoral degrees in their technical fields. Dr Asem of the Obafemi Awolowo University participated as a facilitator during the workshop. Until her death she was the socio-economist attached to the project. Project 3 shows participants at the RRA training.

Seven days were scheduled for the theoretical and practical work by the project coordinator. The training of RRA commenced with a three-day seminar where lectures on the theoretical and philosophical bases of RRA as well as critical exercises to underscore the theory were given to a total of 22 participants. These comprised of four members each from the participating institutions from Nigeria, two representatives from Ghana, and two observers from IITA. This seminar aimed to identify and use the appropriate tools and strategies to conduct a community-based research through which soybean processing and utilization techniques can be defined and analyzed.

During the early part of the seminar, participants were introduced to RRA definitions, genesis, and rationale. This alternative methodology originated, primarily in disillusion with the biases of rural development tourism, and with misleading information generated by many large surveys. Most of the lectures were delivered by Dr (Mrs) Selina Ajebeng-Asem (deceased).

The participants were also introduced to RRA techniques and tools during the seminar. These techniques include secondary data, direct observation, participant observation, semi-structural interviews, diagrams, historical profiles, and so on. Emphasis was placed on RRA to be cost effective in terms of funds, time, and energy.

Finally, for the seminar, participants were divided into groups and they practiced formation of a check-list or a semistructured questionnaire.

Both the lecture and field training were organized with a set of daily objectives each aimed to achieve a specific objectives, of the overall goal of the Phase II project. At the end of each day, participants were asked to evaluate the day's objectives in the light of activities undertaken. Their responses and comments were incorporated into the setting of the next day's objectives, and so on.

After the theoretical exposure, the core group, 18 in number, was divided into three multidisciplinary groups. Each group was given a specific case study in a different study site. These group were also given guidelines as to the expected output at the end of each day and at the end of the field-work. Group 1 was assigned to document soybean production trends in Ikoyi. Group 2 was to investigate household-level processing trends of soybean in Iluju, while Group 3 had to assess the status of soybean utilization in a nutrition intervention center (Kersey

Home) in Ogbomoso town.

Some of the results of the groups are as follows:

Group 1 - This group found out that soybean production was first introduced to the people of Ikoyi (Figure 3.1) in 1981 by Dr Oyekan of IAR&T through Mr. Abodunrin of Ikoyi. From Ikoyi, the production spread to the surrounding villages. Initial production training was provided by IAR&T, and initial planting seed was provided by PZ (Patterson Zacchonis) through IAR&T. The result also showed that IDRC/IITA/IAR&T soybean utilization project initiated the utilization of the crop in the area. It was reported that less than 30% farmers were growing soybean in Ikoyi, while about 90% were growing soybean at Ogede, Oniyo, and Onikoko, the surrounding villages. Among constraints reported by the farmers were labour problems, and inadequate provision and high cost of tractor-hiring services. Emic recommendations were made by farmers and the ethic recommendation by the survey teams.

Group 2 - A courtesy call was made to the village Chief before they started interacting with the villagers. In the surveyed area (Iluju Figure 3.2), crops produced by farmers were maize, sorghum, yam, cassava, pepper, melon, vegetables, and soybean. The villagers came to know about soybean processing through extension workers and from Kersey Home. The soybean processed was either grown or purchased from the local markets. Soybean was retailed as grain and flour. The price was about ₦4.00 per Kobiowu (3 kg). The people of Iluju processed soybean into soy flour, soy milk, soy cheese, soy akara, soy vegetable soup, soy amala, and soy ogi. Respondents also described how some of the products were prepared. Among equipment used for processing were motor-driven grinding machines and grinding stones. The limiting factors in the use of soybean as food in Iluju village were the non-availability of soybean grains, processing and storage techniques and lack of market for soy products.

Group 3 - This group prepared a historical profile of the clinic (Kersey Home) Fig. 3.3 and 3.4. It shows the location of Kersey Home in Ogbomoso and the layout of the home respectively. It was founded by a missionary nurse called Miss Ruth Kersey in 1926. The home started as a Motherless Babies Home at the women's ward of the Baptist hospital, Ogbomoso, following the death of several women after childbirth.

In 1984, when malnutrition was noticed in the home, soybean utilization was introduced to Kersey Home by Neil Monday who came to IITA from Cornell University, New York. This was done by taking Miss Womach who was in charge of the home to IITA for training on soybean utilization. Since then, the Home has been known for using soybean in the treatment of malnutrition in children. Some of the patients were admitted with their mothers who were trained in the use of soybean while some were out-patients. As of the time of this case study, the Home uses about twenty five tons of soybean annually. The grain was purchased from Gboko in Benue state.

Among the problems faced by the Home were storage constraints, poor water supply, and problems of consumption when soybean products were first introduced to patients.

The case studies were purposively selected to reflect the objective of the project, that is, to study soybean production, household level processing and small-medium-scale processing and utilization.

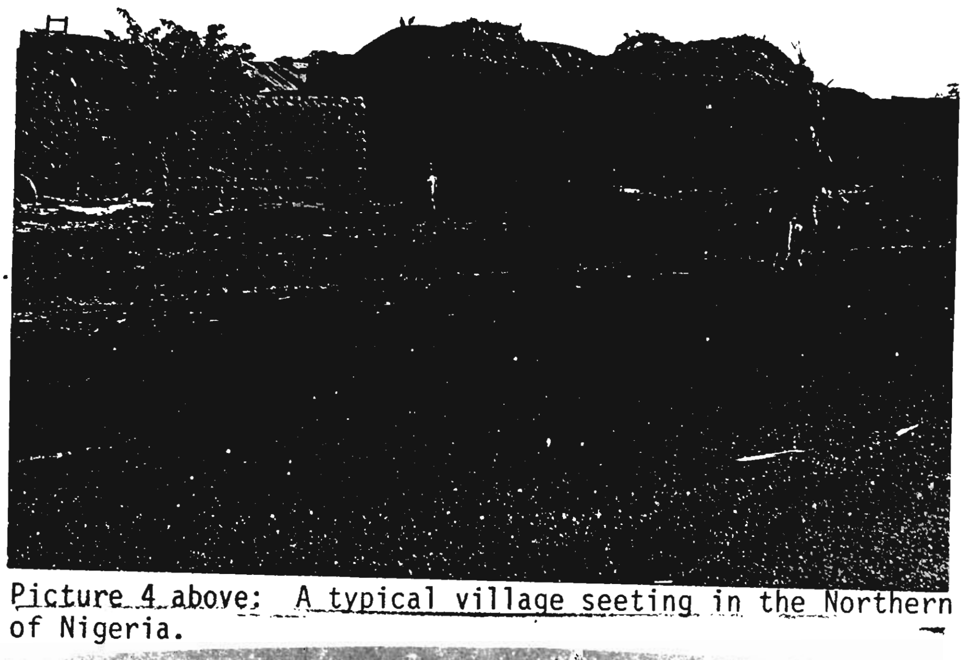
At the end of the 7 days' training, participants had been able to gather fairly useful and reliable information about soybean production, processing, and utilization in the study areas. The results of these studies are reported fully in year 1 technical report (1991).

Apart from the general information gathered on the specific case studies, it became apparent that participants had gained useful theoretical and practical knowledge of the RRA methodology. Their rating of the lecture, field experience, and other relevant information with regard to the training shows that the RRA methodology is an effective and reliable tool for social analysis.

At the end of the training, 82.35% of the participants rated the training course as very useful while 17.65% said it was not useful. The consensus of opinion was that RRA was indeed a valuable tool for social analysis. It was found to be effective, relevant, quick, accurate, and cheap.

Participants also observed that the length of time for both the seminar and field practice was too short and recommended that more days should be given to future training.

Picture 3 above: A typical village setting in the Southern part of Nigeria.



Picture 4 above; A typical village seeting in the Northern part of Nigeria.

Picture 5: A village hut in the North

Picture 6: Participants during the the RRA training at IITA.

Fig 3.1. Map showing Ikoyi and surrounding soybean producing villages

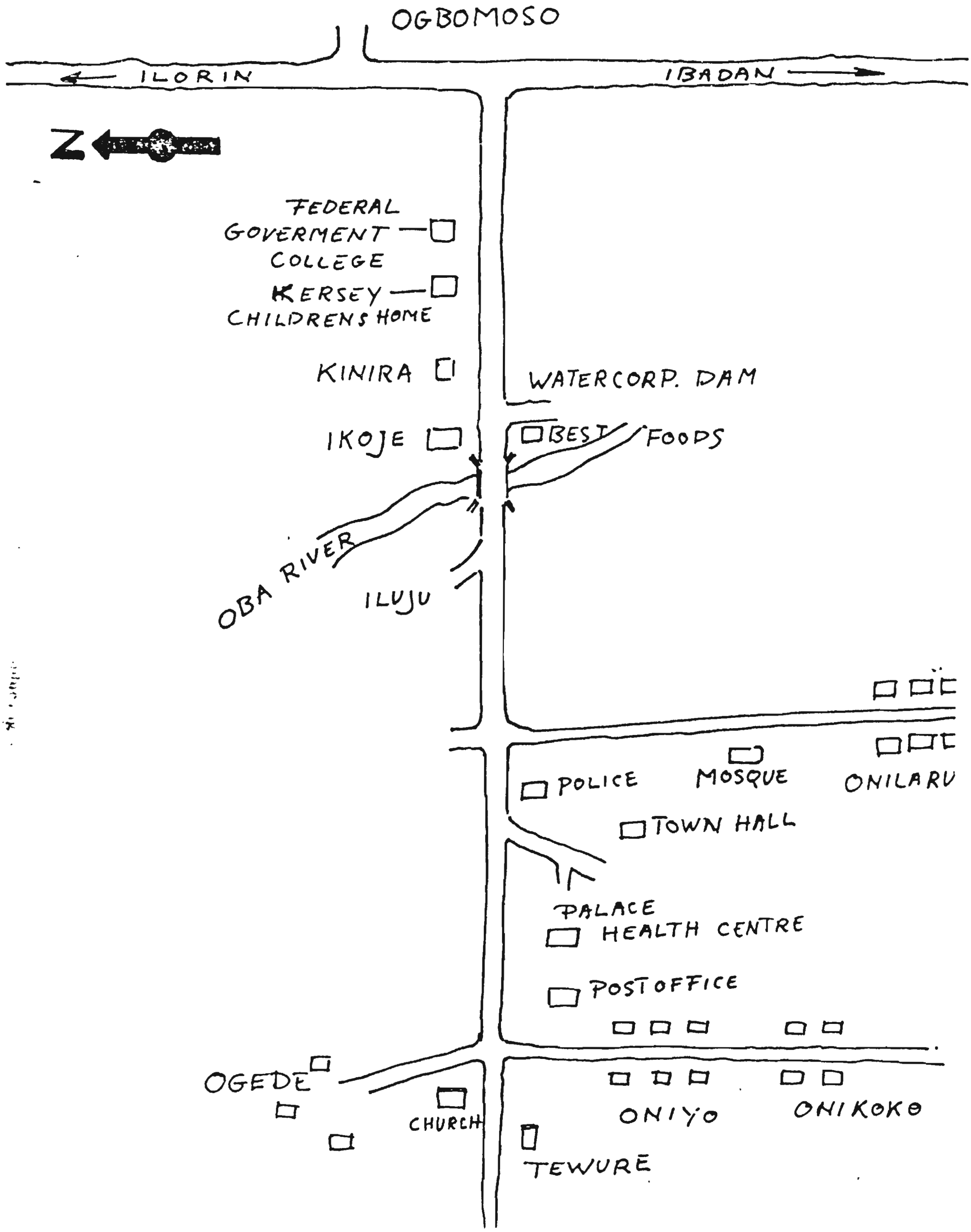


Fig 3.2 Sketch of Iluju Village

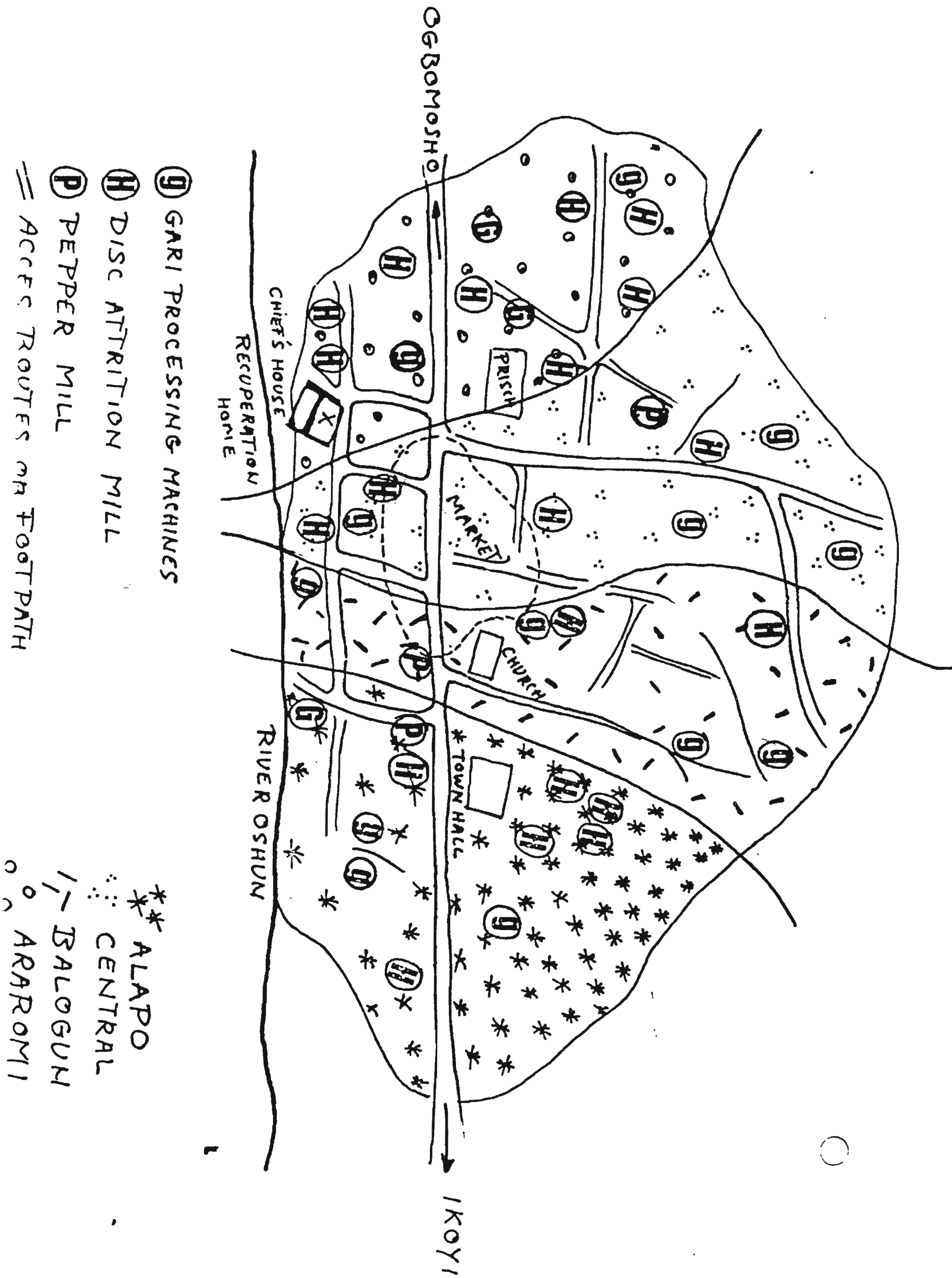


Fig 3.3 Location of Kersey Children's Home

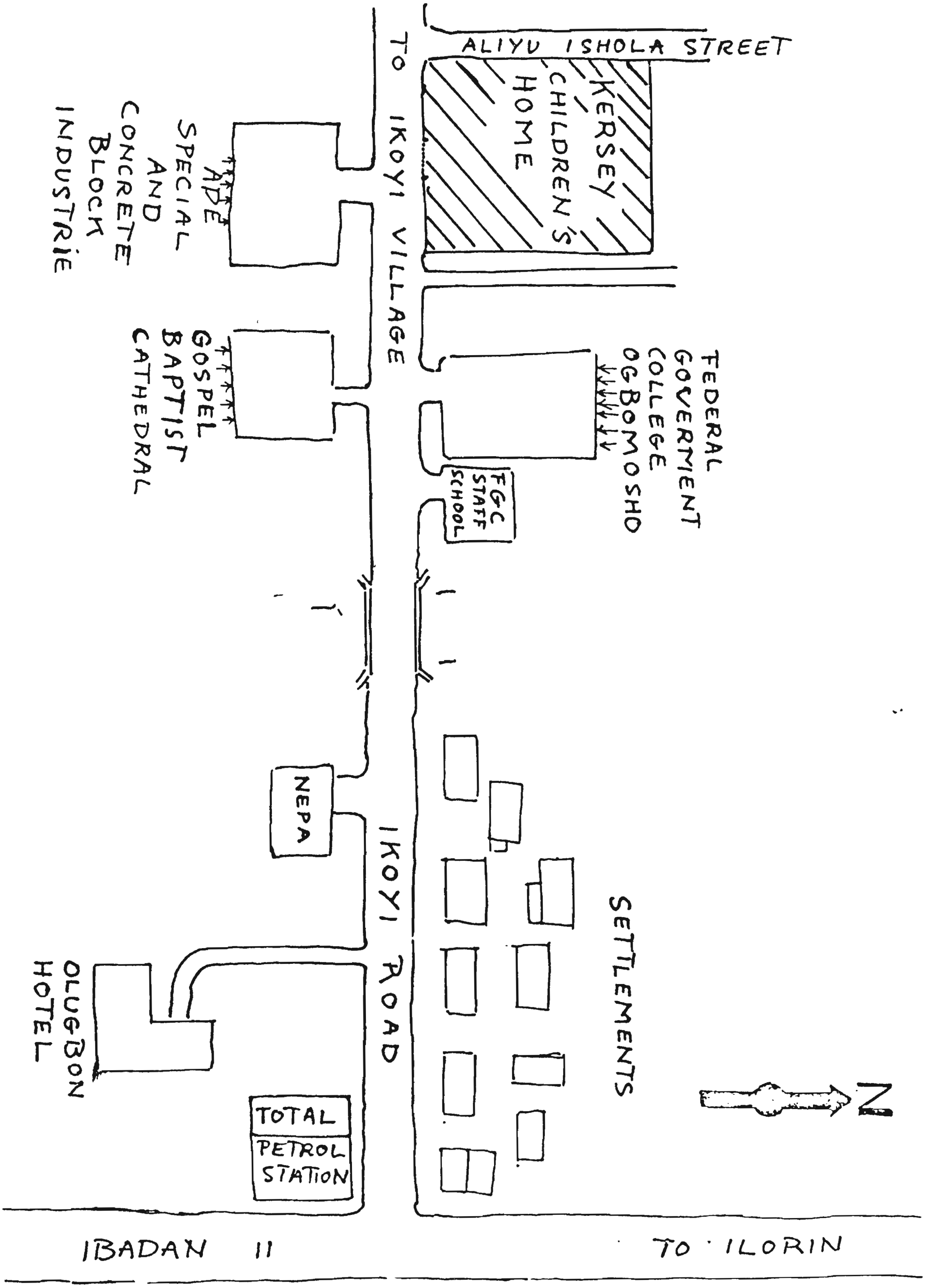
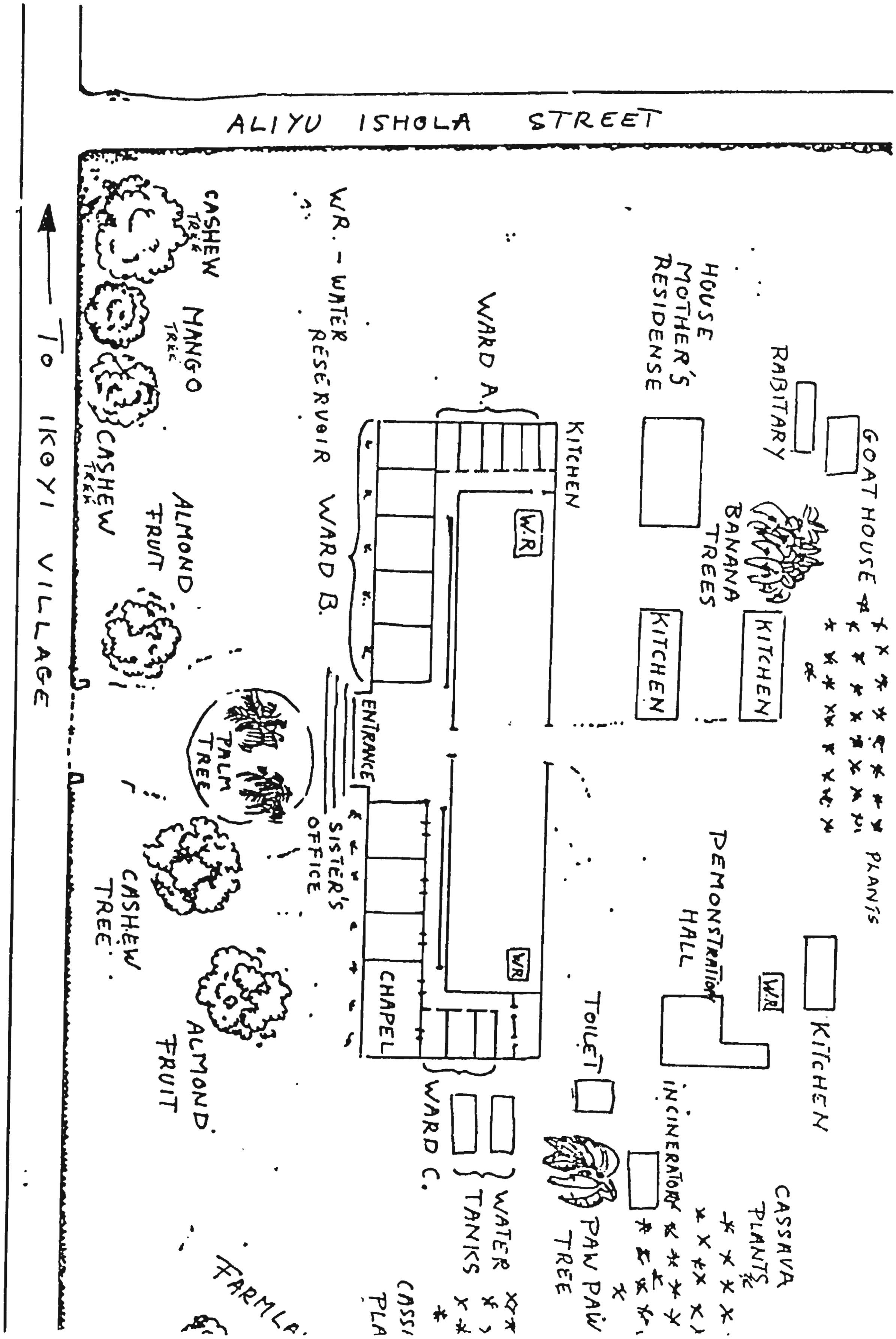


Fig 3.4 Transect of Kersey Children's Home



SECTION 4

Training of Project Personnel on Soybean Processing and Utilization, 26-30 August 1991

The 5-day training workshop was organized for the food technologists and home economists in the National programs collaborating with the IITA in Phase II. These institutions are NCRI, UNN, NAERLS, and IAR&T.

The main objectives of the workshop were to increase the awareness of soybean as an important source of protein and to disseminate processing technologies of soybean which have been developed.

The Director of IAR&T, Prof B.O Adelana, welcomed participants and was pleased that this training was held at IAR&T. The institute had been the first to conduct research on soybean and to benefit from IITA's collaborative research work.

Dr. P.O. Oyekan presented the status of soybean production in Nigeria. To facilitate his training, he distributed books on *Soybean Seed Production in Nigeria* an IAR&T Research Bulletin No. 2, and *Guidelines to Soybean Production in Nigeria*, an IAR&T integrated farming systems publication. In his presentation he talked about planting soybean, the type of seed for planting, the time of planting, recommended varieties, seed rate and spacing, fertilizer recommendations, weed control, harvesting, (threshing), yield, and storage.

The technical sessions of the workshop, e.g., lectures, practical, and demonstrations on soybean processing and utilization were delivered by S.M. Osho, H.O. Ogundipe, and V.A. Obatolu. Technologies were presented for soybean flour processing, soymilk processing, soy gari processing, diet improvement using soybean etc. In the practical sessions soy-moinmoin, soy akara, soy cakes, soy yam balls, soybean vegetable soup, soy eba, soy cheese etc., were practised. To facilitate training, a booklet of abstracts of the IDRC/IITA/IAR&T Soybean Utilization Project Phase I was distributed. The booklet summarized all the activities undertaken in Phase I and gave participants insight into how to plan their respective programs.

Field trips took project personnel to Jomotex, a soymilk processing plant, Oluyoro Hospital, Moniya Gari Processing Factory. A village demonstration was undertaken at Ikoyi, Ogbomoso. This trip emphasized the use of soybean at the household level and as an industrial crop, and also as a nutrition intervention crop. The project personnel also visited. IITA, where the emphasis was more on the use of the extruder and the screw press for oil extraction. Food products developed in phase I were also on display.

The soybean utilization workshop was very successful. Picture 4 shows participants and some of the activities undertaken during the training of project personnels. The project personnel were enthusiastic about the uses of soybean and amazed at the quality and quantity of products that could be processed from soybean. The following conclusions were gathered.

(1) Nigeria is blessed with an abundance of foods (cereals,legumes, tubers, fruits, and vegetables) from which highly nutritious foods can be formulated. It now becomes imperative to disseminate knowledge on food based on local staples. These traditional foods can be fortified with soybean to make them more nutritious.

(2) Soybean is a source of high quality inexpensive protein for human food, particularly for the low income group.

(3) Soybean can be substituted for animal proteins in many homes, and when complemented with cereals, the protein qualities improves.

(4) Various inexpensive recipes can be developed and utilized at the home.

(5) Soybean can fit into the existing food habits in various states of Nigeria.

(6) Soybean can be used to alleviate nutritional problems in Nigeria.

(7) There is a need for the establishment of a small-scale processing center for soybean in each institution.

(8) There is also a need for more training on soybean processing and utilization.

Recommendations

(1) Government and non-governmental organizations should try and establish soybean processing centres in selected states in the Federation with a direct link to collaborating institutions on the IDRC project.

(2) Standards of nutritional quality for soybean products should be established.

(3) More trainings is needed on soybean processing either in Nigeria or outside Nigeria to upgrade knowledge on soybean processing.

(4) More publications on soybeans should be available.

(5) Workshops should be held periodically by each institution to disseminate technologies on soybean.

SECTION 5

National Programs Receive Project Vehicles

On 20 March 1992, IAR&T, NCRI, NAERLS, and UNN sent representatives to IITA to officially receive a Toyota Land cruiser each. The vehicle provided through the IDRC-funded Soybean Utilization Project, would assist the national programs in implementing the project objectives.

In a short ceremony organized to hand over the vehicles, Dr. K. Dashiell signed a Memorandum of Transfer of each vehicle and handed over car keys to respective institutional representatives while Dr S.M. Osho signed as witness. The signing and given out ceremony is shown in pictures 5 and 6.

Dr (Mrs) A.C. Uwaegbute from UNN, on behalf of all the national programs present, thanked IDRC and IITA, and said she was very confident that through this project soybean would become a popular ingredient in traditional foods and thus greatly improve the nutrition of the people.

Dr P.O. Oyekan, President of the Nigerian Soybean Association, thanked IITA, for its continued support of soybean research in Nigeria and specifically thanked IDRC for understanding the importance of providing transportation for the scientists involved in the Soybean Utilization Project.

Picture 7:

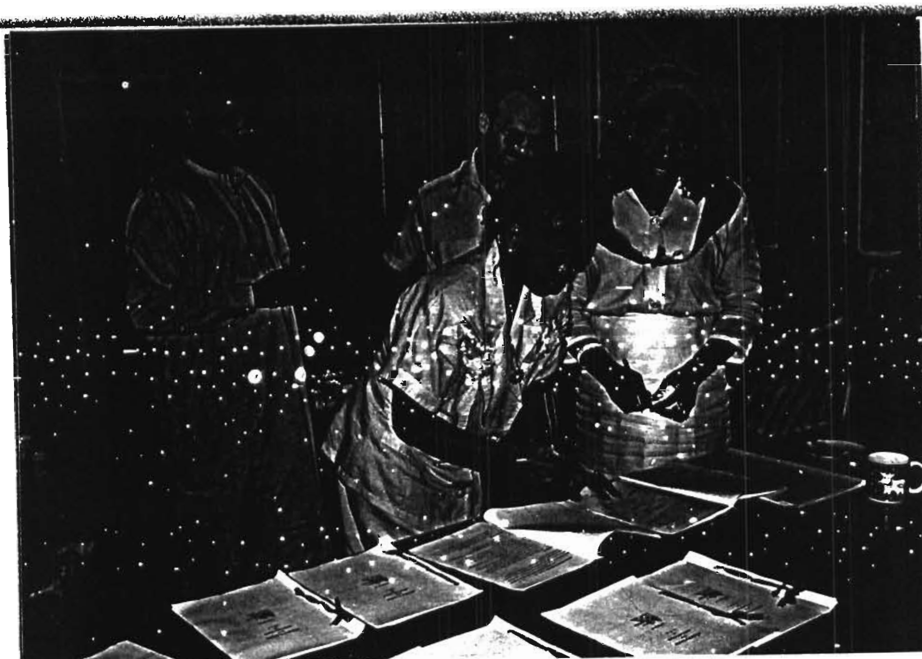
Participants during the project person on soybean processing and utilization training at IAR&T.

Picture 8:

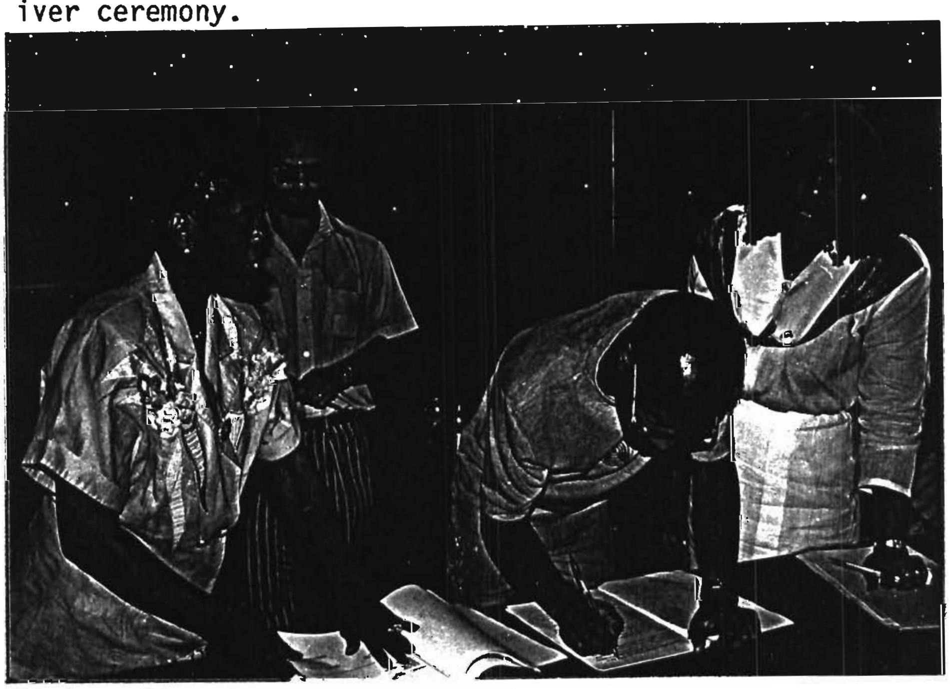
A village demonstration scene watched by project personnels.

Picture 9:

Project food technologists/ home economists working on a recipe development during training at IAR&T.

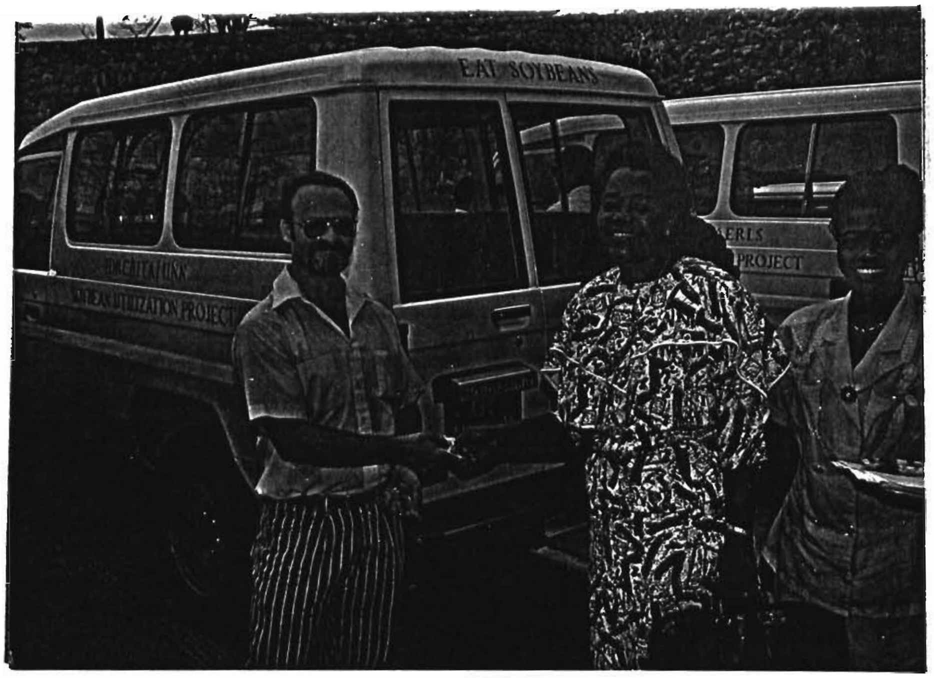


Picture 10: Dr Sidi Osho signing during the vehicles hand iver ceremony.



Picture 11: A representative of NCRI Director signing for the vehicle.

Picture 12: A representative of IAR&T Director signing for the vehicle.



Picture 13:

A representativ
of UNN Vice
Chancellor
receiving the k
to their vehicl
from Dr K. Dash

Picture 14: Project drivers and personnels inspecting the vehicles.

Picture 15: A representative of NAERLS Director receiving the key to their vehicle from Dr K. Dashiell.

SECTION 6

Summary of baseline surveys on status of soybean production and utilization in Nigeria

The major **objective** of the survey was to provide baseline information on the status of soybean production and utilization in the states where the project was to take place. However, the **specific objectives** within the areas of study were to:

1. Provide an up-to-date review on the state of knowledge of soybean production and utilization;

2 Familiarize the project personnel with the project sites where soybean will be introduced to improve nutritional status;

3 Identify the constraints associated with production, processing and utilization of soybeans; and

4 Provide a basis for monitoring the impact of the project on soybean production and utilization.

Survey methodology

The survey was conducted in all the project sites of each institution. These communities were selected on the basis of production sites, non-production sites, and an urban center. IAR&T selected two new additional sites in Lagos state to the existing sites that were inherited from the 1st Phase of the soybean project (1987-1990).

Two important approaches in gathering information were used for the survey. The first was the Rapid Rural Appraisal (RRA) methodology which involves a multidisciplinary team of four scientists and the second was the conventional survey method, i.e use of questionnaires.

The multidisciplinary team in each institution was composed of a home economist/nutritionist, a food technologist, an agronomist, and a socio-economist/agricultural economist.

Results

The summary of the results is reported in sections 5. Each section deals with the result findings in selected areas of participating institutions.

3.5.1 The status of soybean production, processing and utilization in Oyo and Lagos States, Nigeria (a baseline survey)

Case study areas

(i) Ikoyi, Ogbomoso Local Government Area	-	(production site)
(ii) Igangan, Ifelodun Local Government Area	-	(production site)
(iii) Ijaiye, Akinyele Local Government	-	(production site)
(iv) Lagos State	-	(non-production site and urban center)

Composition of survey team - IAR&T

Obatolu, V.A. (Mrs)	:	home-economist
Oyekan, P.O. (Dr)	:	plant pathologist
Lanipekun, A.G. (Mr.)	:	agricultural economist
Adjebeng-Asem, S. (Dr)	:	socio-economist

A. Oyo State

Socioeconomic characteristics of farming households in Oyo state

Some socioeconomic factors that may influence decision making on soybean production and utilization by households in the surveyed area are summarized in Table 3.2. They included economic infrastructure, family size and age distribution, educational level of respondents, households, decision-making in food production and utilization, farm size, and income generation.

The degree of general rural infrastructure development, such as water supply, rural markets, roads, health care delivery, and schools, was poor and inadequate in all the communities. Household sizes and age distribution for the communities were fairly large, averaging 11 for Ijaiye, 11 for Igangan, and 10 for Ikoyi. Moreover, a large proportion of household members (41% for Ijaiye, 32% for Igangan and 41% for Ikoyi) were children aged 10 years and below.

An analysis of the educational attainment of respondents Ijaiye, Ikoyi and Igangan showed that about 60% in Ijaiye 55% in Ikoyi and 50% In Igangan (Table 3.2) had no formal education. Thus, on average, 55% of present and potential soybean growers in these areas are illiterate. The educational attainment of the respondents may influence the rate of adoption, production, and consumption of soybean. Gender roles in food production and utilization differed according to the type of crop and type of operations in the areas. The entire family was involved in soybean production; both men and women planted and harvested the crop (Table 3.2). The larger the family, the greater the involvement of household members.

Husbands take most of the decisions with respect to agricultural production but they consult their wives, especially in Ikoyi and Igangan communities. Women farmers take decisions concerning their own personal farms, especially at Ijaiye.

The average farm size among households studied was 4.17 ha in Ijaiye, 4.45 ha in Ikoyi, and 4.0 ha in Igangan. A small fraction of the farms in Ikoyi were used for soybean cultivation.

The level of general infrastructural development such as water supply, rural markets, roads, health care delivery and schools was poor and inadequate in all the three communities. About 76.7% of the respondents were male while only 23.3% were females. Over 80% of all the respondents were married. Marital status is a vital factor in determining family size, since married respondents have larger families size. The large family sizes may enhance greater consumption of soybean. The married male respondents had an average of 3 wives each and there was an average of about 6 children per household.

All the respondents in Ijaiye, and 35% in Igangan and 55% Ikoyi were full-time farmers. Out of seven respondents who had farming as their main profession in Igangan, six were males while one was a woman. Out of all the full-time farmers in Ikoyi, eight were male and three were females. Considering the three locations together, over 60% of the respondents were full time farmers. The fact that the studied areas were predominantly farming communities may have acted as a catalyst for increased soybean production during the Phase I of the project.

Soybean production

Table 3.3 summarizes the farming activities of the respondents in Ijaiye, Igangan, and Ikoyi in 1990. The most popular practice by the respondents (46%) was sole planting of soybean on heaps. Some respondents intercropped soybean with other crops such as maize, melon, and cassava on ridges or flat land. Sole planting of soybean on flat was the least popular.

Table 3.2 Socioeconomic characteristics of the three communities surveyed (1990)

(a) Ijaiye	(b) Ikoyi	(c) Igangan
1. Economic Infrastructure:		
1. Borehole with four serving points	1. Pipe-borne water in Iluju,	1. Well and stream water for villages
2. A rural market meeting every four days	2. One market	2. One market
3. Primary schools and secondary schools	3. Primary schools and secondary schools	3. Primary schools
4. No electricity	4. No electricity	4. No electricity
5. Graded rural road	5. Graded rural road	5. Graded rural road
6. Cottage industry: cassava to lafun and gari (women food processing center)	6. Cottage industry: cassava to gari	6. Cottage industry: cassava to gari
7. No Town Hall	7. A Town Hall	7. No Town Hall
8. No postal agency	8. A postal agency	8. No postal agency
2. Family size and age distribution:		
Average family size is 11 Average age of respondents is 45 years	Average family size is 10 Average age of respondents is 48 years	Average family size is 11 Average age of respondents is 38 years
3. Educational level of respondents:		
60% of respondents had no formal education	55% of respondents had no formal education	More than 50% had no formal education
4. Household decision-making in food production and utilization:		
Most decisions with respect to farming are undertaken by men	Decision-making is done by men	Most decisions with respect to agriculture are taken by husbands in each household, though wives may influence such decisions
5. Gender roles in food production and utilization:		
Contributions by family member groups are: Adult male - 27% Adult female - 45% Male children - 23% Female children - 5%	Contributions by family member groups are: Adult male - 36% Adult female - 21% Male children - 25% Female children - 18%	Contributions by family member groups are: Adult male - 41% Adult female - 28% Male children - 20% Female children -
6. Farm size:		
Average farm size is 4.17 ha	Average farm size is 4.45 ha	Average farm size is 4 ha.

The reasons given by farmers for undertaking the cultivation of soybean were nutritional benefits (77%), economic gains (10%), and both nutritional and economic considerations (13%). Over 70% of the soybean producers in the survey started soybean production between 1987 and 1989 and this period coincided with project years (Phase I). Moreover, about 73% of these soybean producers claimed that they had learned how to grow soybean during the IITA/IAR&T rural training program. These training programs were an integral part of the project. Other avenues for acquiring the knowledge of soybean cultivation by the respondents were from IITA field trials, spouses, and farmer friends.

With regard to farm sizes, most of the farmers (80%) still had soybean farms less than 1 ha. It was only in Ikoyi that a farmer had over 5 ha of soybean. The soybean farm sizes generally can still be regarded as small, though the increased number of producers may lead to higher production levels. The small farms size is not peculiar to this crop, since most farmers in these areas are peasant farmers. Other factors that can account for this small farm size may be production problems mentioned by the farmers. These include difficulties in having their land prepared on time, as well as lateness in getting viable seeds for planting.

Some of the planting seeds (over 50%) used by farmers at Igangan and Ikoyi were supplied by PZ/IAR&T, while Government supplied about 70% of seeds used by soybean farmers at Ijaiye. Other sources of seed for planting were the market, or farmers' reserves.

While two weedings were common among respondents in Igangan (50%), three weedings were done by 60% of respondents in Ikoyi and 95% in Ijaiye. Hired labour was used by 45% of respondents for weeding and 41% of them used family labour for the same purpose. Almost all the farmers did not apply herbicide, fertilizer, or insecticide on their soybean farms. Harvesting and threshing were done mostly by family labour (80%) manually. The bulk of the threshed grains were stored in fertilizer jute bags by the farmers (over 90%), and over 80% of the respondents stored the grains for a period of 1-3 months before marketing. Major production constraints highlighted by the farmers were pests (mostly rodents and birds) and pod shattering.

Since all the respondents in this survey planted soybean, it can be concluded that the level of awareness of soybean production in the area is high. Consequently, soybean is being gradually integrated into the farming systems of these communities.

Soybean utilization in (Igangan, Ikoyi and Ijaiye) in 1989/90

In various forms, 95% of the respondents in the three communities consumed soybean. This clearly indicated that the level of awareness of soybean utilization was very high because of the project activities during the Phase 1 (1987-1990). Most of the respondents in Igangan (60%) and Ijaiye (75%) started consuming soybean between 1987 and 1988, while majority in Ikoyi (80%) started soybean consumption between 1985 and 1986. Considering the three communities together, about 61% of all the respondents started soybean consumption in their homes between 1987 and 1989. (Table 3.5).

The level of consumption of soybean was highest among the respondents (70%) between October and December and this coincided with the harvesting period in the areas studied. It was observed that at this time, in addition to having plenty of soybean, melon which is a good substitute for soybean would be very scarce. The forms in which soybean was taken by the respondents in order of popularity were soup (47%), ogi, milk, akara, moinmoin and Iru. They claimed they had learnt about the preparation of these soy foods during the training given earlier in the project. About 13% of the respondents said they ate soybean everyday, about 69% claimed they eat it several times a week while 18% do not eat soy foods frequently.

Table 3.3 Farming activities of soybean producers (respondents) in Ijaiye, Igangain, and Ikoyi in 1989

Activities	Igangan	Ikoyi	Ijaiye
1. Sources of seed for planting	IITA - 30% Previous harvest - 50% PZ/IAR&T - 50% Others - 5%	IITA - 15% Previous harvest - 30% PZ/IAR&T - 50% Market - 5%	IITA - 15% Previous harvest - 5% Market - 10% Government - 70%
2. Farm size	<0.25 ha - 75% 0.3 - 0.75 ha - 25%	>0.25 ha - 85% 0.3 - 0.7 ha - 10% Over 5 ha - 5%	>0.25 ha - 90% 0.3 - 0.7 ha - 10%
3. Planting method	Sole flat - 5% Sole heap - 5% Sole ridge - 30% Inercrop flat - 30% Intercrop heap - 15% Intercrop ridge - 15%	Sole flat - 5% Sole heap - 55% Sole ridge - 10% Intercrop heap - 25% Intercrop ridge - 5%	Sole ridge - 10% Sole heap - 80% Intercrop heap - 10%
4. Number of weedings	One weeding - 30% Two weedings - 50% Three weedings - 15% No weeding - 5%	One weeding - 5% Two weedings - 35% Three weedings - 60%	Two weedings - 5% Three weedings - 95%
5. Who weeded	Self - 5% Family labor - 25% Hired labor - 65% Family+hired - 5%	Self - 5% Family labor - 60% Hired labor - 30% Family+hired - 5%	Self - 5% Family labor - 60% Hired labor - 40% Family+hired - 10%

Table 3.3 continued

Activities		Igangan	Ikoyi	Ijaiye
6.	Use of chemicals			
(a)	Herbicide	Used - Nil Not used - 100%	Used - 5% Not used - 95%	Used - Nil Not used - 100%
(b)	Fertilizer	Used - 5% Not used - 95%	Used - Nil Not used - 100%	Used - Nil Not used - 100%
(c)	Insecticide	Used - Nil Not use - 100%	Used - 5% Not used - 100%	Used - Nil Not used - 100%
7.	Labour for harvesting (manual)	Family labor - 80% Hired labor - 20%	Family labor - 85% Hired labor - 15%	Family labor - 75% Hired labor - 20% Self -5%
8.	Threshing (manual) (labor used)	Family labor - 85% Hired labor - 10% Hired and family labor - 5%	Family labor - 85% Hired labor - 10% Self - 5%	Family 85% Hired labor - 10%
9.	Quantity of soybean harvested	1-100 kg - 50% 101-200 kg - 20% 201-300 kg - 5% 301-400 kg - 20% 401-500 kg - 50% Over 500 kg -	1-100 kg - 90% 101-200 kg - 5% 201-300 kg - 301-400 kg - 401-500 kg - Over 500 kg - 5%	1-100 kg - 100% 101-200 kg - 201-300 kg - 301-400 kg - 401-500 kg - Over 500 kg -
10.	Storage of soybean after harvest	Stored in polythene bags - 5% Fertilizer jute bags - 95%	Fertilizer jute bags - 100%	Fertilizer jute bags - 95% Plastic containers - 5%
11.	Period of storage before marketing	1-3 months - 85% 4-5 months - 10% 6-10 months - 5%	1-3 months - 95% 4-5 months - 5%	1-3 months - 70% 4-5 months - 10% 6-10 months - 20%

Table 3.4 The year respondents started growing soybean and the percentage of farmers using different crop mixtures

Communities	Started Planning Soybean in					Cropping Mixtures				
	1985 (%)	1986 (%)	1987 (%)	1988 (%)	1989 (%)	Sole Soybean (%)	Soybean cassava maize (%)	Soybean maize (%)	Soybean cassava maize melon (%)	Soybean cassava (%)
Ikoyi	15	45	20	10	10	-	30	10	35	25
Igangan	-	-	-	20	80	46	20	5	30	35
Ijaiye	5	5	40	40	10	-	100	-	-	-

When comparing taste of soybean products with that of conventional foods, 47% of the respondents were of the opinion that there was no difference, while 21% felt that they tasted differently. Only 32% believed that soybean meals tasted better than the ordinary local meals. With regard to cooking time, the majority of the respondents (78.3%) indicated that both soy-based and the traditional foods have almost the same cooking time. The general opinion (85%) was that it was cheaper to prepare the soy-based foods than their normal meals. Less than 10% of all the respondents had ever used soy oil.

In conclusion, there is a remarkable increase in the level of awareness of soybean utilization locally in Igangan, Ikoyi, and Ijaiye communities between 1987 and 1990. Consequently, the consumption level has increased tremendously over the 3-year period, especially at Igangan where little or nothing was known about soybean at the on-set of this project. The main reasons responsible for this positive change were that, the villagers now realized that soybean is highly nutritious and cheaper than other commonly eaten foods. In addition, the preparation of most soy-based foods does not require additional time.

Soybean marketing survey in Oyo State (1990)

A total of 20 traders in the three project sites were interviewed. Two sets of questionnaires were used; one for soybean sellers and other for buyers. Information was collected on their marketing experiences in soybean, sources of soybean sold, volume of trade, and the period of greatest sales.

About 65% of the traders were female and 35% were male. While 45% were farmers/traders, others were mainly traders. Other minor occupations of some of the traders were teaching and sewing. Most of the traders (60%) were between the ages of 20 and 30 years, and 15% were between 31 and 40 years. The others were between 41 and 50 years. Only about 35% of the respondents had formal education (30% had primary school education and 5% had Grade II Teachers Certificate). The others had had no formal education.

A distance of between 1 and 4 miles is usually covered by about 60% of the traders before getting to the markets, and 30% travelled about 5 to 10 miles. The remaining 10% had a distance of 11 to 20 miles between their homes and the markets. Walking on foot from the villages to the markets is practised by 55% of the traders. Others (45%) conveyed their products to and from the markets in buses and lorries. As much as 40% of the traders said they went to the market every time (almost every day) and 20% go to the market on occasionally. The remaining 40% said they went to the market every 5 to 10 days. The study revealed that about 60% of the traders buy and sell in other markets apart from the markets where the interview was conducted. These other markets include Moniya, Bodija, Itewure, Iluju, Sabo, and Ogbomoso. In addition to soybean, the traders also market other products such as processed cassava in the form of gari and flour (lafun), cowpea, rice, melon, groundnut, pepper and maggi cubes. With regard to trading experience in soybean, only about 35% of them had over 5 years' experience. The rest had less than 4 years' experience.

The main sources of soybean sold by the traders were from personal farms (45%), farm gate (25%), and rural markets (30%). Considering the volume of trade, 45% of the traders purchase less than 50 kongos (1 kongo equals 1.4 kg) at a time, and 15% purchase between 51 and 100 kongos at a time. About 40% usually buy over 100 kongos at once. Leftover soybean are usually kept for future market days by over 70% of the respondents. Such soybean is usually stored in bags. Some traders consumed part of the unsold soybean.

The study showed that soybean sells for ₦3.50 - ₦4 per kongo at harvest time and this price increase to about ₦5 - ₦6 in the off season. The period of greatest sales was between October and December. This period coincides with the harvesting of soybean in the area, and the average price of soybean at this time is usually lowest, compared with other periods of the year. The profit margin of the traders is between 50k to ₦1. About 10% of the traders sell soybean in form of powder. The cost of grinding the grain into powder is ₦1/kongo, and the flour is usually sold at 50k per small tomato tin. Over 80% of the traders had profitability as their main motive for trading in soybean.

Compared with traders, the buyers usually make smaller purchase, less than 1 kongo at a time (35%); between 1 and 5 kongos (60%) only 5% buy over 5 kongos at a time. About 45% of the buyers purchase soybean every time, others buy every market day (25%), bi-weekly (20%), and occasionally (10%). Reasons given for buying soybean are for consumption, selling as grain, processing into milk and vegetable soup, and for nutritional. Some buyers buy soybean because it is cheaper than some other foodstuffs. In fact, while 80% of the buyers purchase soybean solely for consumption, 15% buy it for both consumption and to sell, either as grain or in the processed form.

The buyers consume soybean in the form of soup, milk, moinmoin, and iru. The buyers' knowledge of soybean was acquired during training on soybean utilization they had attended, or through friends and neighbours.

B. Lagos State

The areas surveyed in Lagos state were Badagry, Ikeja, (Idimu), Ikorodu and Epe (Imota). (figure 3.5). These areas were surveyed in order to select two project sites among the areas. About 89% of the people in these chosen areas were surveyed. This included women's group and industries. About 28.1% of the total families were farmers while 7.6% of the total families had ever grown soybean. The farmers' major crops were cassava, maize, and vegetables. Most farmers operated integrated mixed-farming. Land was a major constraint of farmers within the state, especially those in Ikeja. The staple foods of the people surveyed were cassava products, rice, amala (yam-flour pudding) and snacks from coconut. About 68% of the total number surveyed in the areas had heard about soybean before. However, only 28% had consumed soybean products, the greatest number coming from Badagry. The main products were soymilk and soy iru. Soybean was seen in three major market in the surveyed area, at Oja-Nla (Agege), Agbalata (Badagry), and Mile 12 (Ikorodu). On the average, consuming families use 400 g of soybean grain per month and consume it twice a month during its season. It was however, observed that none of the households were processing soybean at the time of the survey.

Within the selected areas there were many food processing businesses (20). Only 1 (Farina) was on full-time soybean processing while 2 others (Betamark and Mitchell) process soybean when available.

Soybean production in Lagos state

Generally the level of soybean production in Lagos state was very low, and almost nonexistent. About a fifth of the sampled farmer population had grown soybean before. Soy production was viewed as woman's work in Epe. The legume was not the farmers' crop in Badagry. The average soybean farm was 0.02 ha. The source of planting material was the Lagos State Agricultural Development Program, commercial section. No significant yield was recorded.

Farmers generally complained about being novices, with regard to soybean agronomic practices. There was however, the eagerness to put an extra small portion of available land to further test crops of soybean if there could be proper guidance and supervision.

Soybean processing and utilization in Lagos State

Despite ready availability of protein (fish) in Lagos state, clinical observations revealed signs of malnutrition in 5 children out of 10 brought to two main hospitals in Ikeja.

For soybean processing, the household requirements of soy grain were purchased from intra-city markets. Though none of the households was seen processing soybean at the time of the survey, available data revealed that, on the average, each family processed 0.4 kg of soybean grain per month. Womens' groups in Idimu, Imota, and Agbelere/Ikorodu also undertook food crop processing. There was no gender distinction in soybean processing. Local pepper mills were used for grinding the soy grain. Soymilk and soy soup were the main products. Consumed at home twice a month in conjunction with any of these foods -gari, tuwo, lafun, fufu, rice, and coconut snacks. Utilization was highest at Ikorodu and lowest at Epe. Minor products were soy night cap, soy weaning food, and soy candy.

Domestically processed soy products were classified into: Products with a high moisture content (>13%) such as soymilk, soy iru and soy soup; and products with a low moisture content (under 13%) such as soy candy, soy night cap (a beverage) and soy weaning food that was traded among fellow cooperators. Storage containers for products were honey jars, tins/cans, wrapping leaves, and paper. Storage treatments were cold temperature, hot air heating, and natural atmospheric conditions.

At the industrial level, soybean processing were concentrated in Ikeja. Enterprises studied were Betamark, Mitchell, and Farina. Those companies relied on markets outside Lagos state for their supply of soy grain.

Betamark	-	made solid and powder soy food products for human consumption, and utilized 0.5 tonnes of soybean grain per month.
Mitchell	-	processed meal from soy cake for livestock consumption, and utilized 150-180 tonnes of soybean cake per month.
Farina	-	processed soy-products (milk and milk flavoured) for human consumption. It utilized 12.5 tonnes soy grain per month. Farina documents that soybean and its products are protein-giving and nourishing foods that possess excellent sources of dietary fiber and have the physiological functions of controlling blood cholesterol; preventing colon cancer; and improving the body's system of glucose tolerance.

Soymilk (chocolate-flavoured) and soy crisps were the best industrial products of soy trade. The fluid products usually contain emulsifiers and stabilizers and were held in 60-200 ml cylindrical polythene packs and distributed for sale in refrigerated vans, mobiles, and containers. Soy crisps were held in 20-50 gm polythene packs and displayed on shelves. Dry industrial products have a short shelf-life of two years.

Marketing and storage of soybean grain and products in Lagos State

Soybean grain was seen in 3 out of 23 markets surveyed. Soy grain traders, mostly non-Yoruba, ranged from 1 to 5 out of over 60 cereal and grain legume sellers in each market. Monthly sales of soy grain was greatest (50 kg) in Mile 12 market and lowest (10-15 kg) at Oja Nla and Agbalata markets. Price ranges were ₦3.3 - ₦3.8 per kg (wholesale) and ₦5 - ₦9 per kg (retail). The prices were highest in June. Despite the relatively low returns, sellers insisted on trading in soybean because the grain was more resistant to weevil infestation than cowpea.

In conclusion, the findings from the baseline survey of the selected sites in Lagos state showed an awareness of soybean but definitely negligible levels of adoption and utilization.

The status of soybean production, processing and utilization in Diko, Mungorota, Bida villages in Niger state of Nigeria (a baseline survey)

Case study of areas:

(i) Diko Village, Suleja Local Government Area (production site)
(ii) Mungorota Village, Gbako Local Government Area (non-production site)
(iii) Bida Urban, Bida Local Government Area (urban center)

Composition of survey/RRA team

Mrs U.I. Ibanga	:	(Food technologist)
Mrs C.F. Ndaeji	:	(Home economist)
Dr V.I.O. Olowe	:	(Agronomist)
Mr D.U. Ikejimba	:	(Agricultural economist)

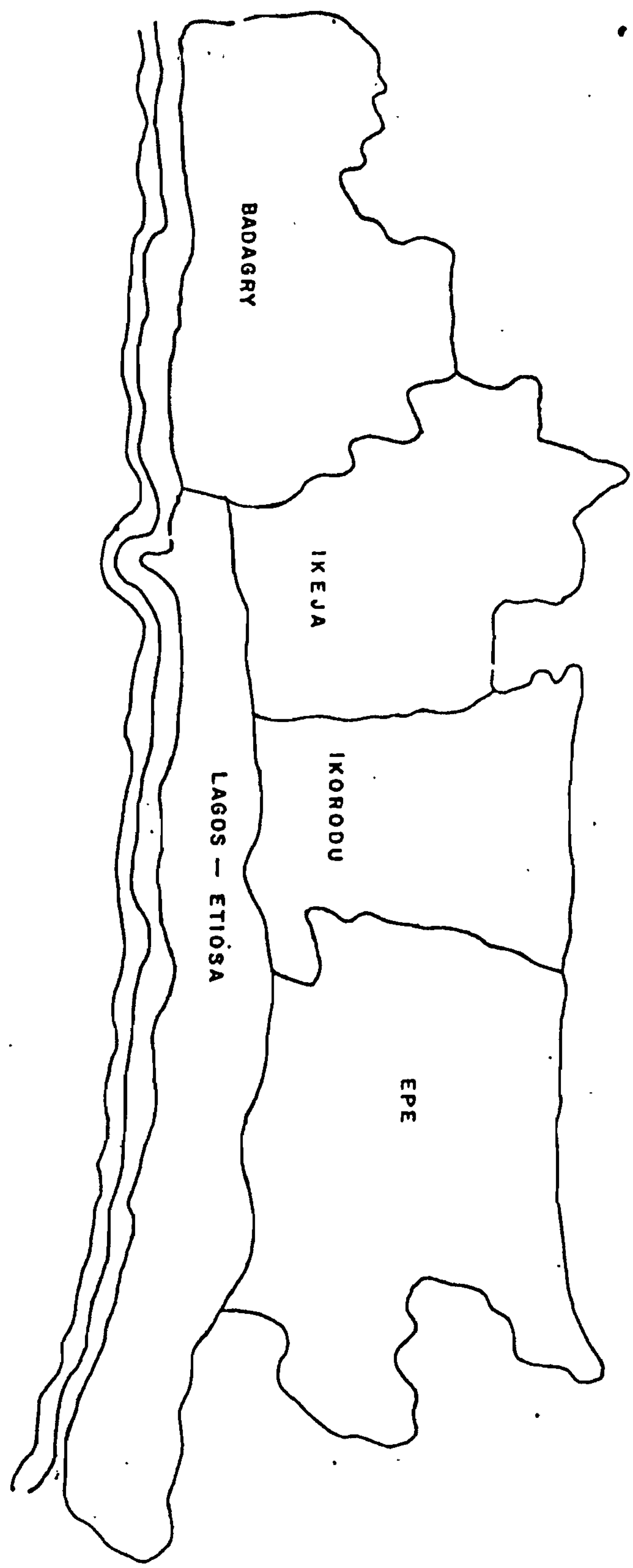
Soybean was first introduced to Diko, Bida and Mungorota in 1930, 1955, 1970 respectively. About 67, 28 and 4% of the respondents claimed that they grow soybean at Diko, Mungorota and Bida respectively. Soybean was utilized by 82% of respondents at Diko, 33% at Mungorota, and 1% at Bida. Soy products identified were soy daddawa, soy akara, soy milk, soy vegetable soup and soy moinmoin.

Soybean grain is sold at local and nearby markets to grain merchants, retailers, and food processors. At Diko, soybean production and processing into soy akara and soy daddawa are profitable ventures (i.e. benefit - cost ratios > 1). The major production and processing constraints identified were the high cost of basic inputs (fertilizer, tractor services, and agrochemicals) and lack of affordable processing equipment and basic knowledge of processing techniques.

Table 3.5 The year respondents started consuming soybean in Igangan, Ikoyi, and Ijaiye

Communities	1985		1986		1987		1988		1989		1990		Total
	No	%	No	%	No	%	No	%	No	%	No	%	
Igangan	-	-	4	20	8	40	4	20	3	15	1	5	20
Ikoyi	7	35	9	45	3	15	1	5	-	-	-	-	20
Ijaiye	1	5	1	5	4	20	11	55	3	15	-	-	20
Total	8	13.31	14	23.3	15	25.0	16	26.7	6	1.7	60		

Fig. 3.5 AGRICULTURAL DIVISIONS OF LAGOS STATE



Socio-economic status of farming households in Diko

About 75% of the respondents were between the ages of 20 and 54 years. About 68% of the farmers interviewed were males and 32% females. In a farming community such as this, the males carry out the strenuous farming operations (such as land preparation and weeding) while the females perform the less strenuous operations (such as the transportation of harvested crops and their processing). Majority of the farmers had more than one wife. The number of wives that a farmer has dictates the level of his social class and responsibilities. It also portrays the strength of the farmer and the land area the farmer cultivates. In this village, it was gathered that about half of the unit heads possessed 5-9 children (53%) while about one quarter (23%) of them had between 1 and 4 children. Only one farmer had between 20 and 24 children. This particular farmer was observed to have three wives and there were some members of the extended families dwelling in the farmer's house. The village is dominated by the Gwari community (about 89% of the respondents are Gwari by tribe), while about. It is pertinent to note that about 5% of the populace are Igbo. It was gathered that the soybean farmers in the village are mainly the Gwaris. There are two multipurpose cooperative societies in the area: Alheri and Harske whose membership strength are 34 and 32, respectively, but mainly Gwari by tribe. They produce soybean as one of their major crops. The few Hausa, Igbo, and Yoruba are mainly meat sellers, provision (beverages and patient medicines) and petty traders, respectively. The Gwaris utilize soybean predominantly as daddawa, soy-milk and soy-kosai. Therefore, there is need to popularize the nutrient potentials of the crop among the minority groups (Hausa, Igbo, Yoruba and Nupe) of the village. Figure 3.6 shows the location of Diko village. Half of the farmers (53%) had had no formal education while about 29, and 13% had post primary education, respectively. The spectrum of the educational level at Diko showed the agricultural base of the people as there were a few artisans and traders. The level of education of a farmer or respondent helps to portray the degree to which he understands and takes in new technologies. It shows the level of an individual's perception of and reaction to change. This factor is also influenced by the extent one is exposed or travelled (environmental influence) and learned. In this village, about 66% are farmers while about 25% are traders. Most of the traders are women and their wares are mainly cereals/grain and vegetables. The vegetable producers are Hausa and a few indigene. The occupation of the respondents plays important role in the style adopted by them and their family members. The respondents were mainly Christian (90%) while about 9% were Moslem. The rest (1.9%) belong to unknown religion or sect. The Moslem religion does not encourage the production, and consumption of pigs in the area.

(i) <u>*Soybean production and utilization in Diko*</u>

The map showing the location of Diko village in Suleja Local Government is shown in Fig 3.6. Diko is noted for its long history of soybean production. The crop constitutes about 30% of the total domestic crop production annually. Yields on farmers' fields are comparatively high, at 700 to 1200 kg/ha. Survey results show that soybean ranks third among the major food crops grown by farmers from the two comparative groups: Alheri: yam, maize, soybean, guinea corn and rice; Harske: maize, guinea corn, soybean, cowpea and rice.

Samsoy is the main variety of soybean grown in Diko. All the people interviewed had been aware of soybean, while only 67% claimed that they grow the crop. About 43% of the farmers grow soybean as sole crop. However, 24% of the farmers intercrop soybean with cereals, particularly guinea corn, while about 6% practise both monocropping and intercropping. The villagers usually grow soybean between July and November. The farmers expressed the desire to expand the level of production, provided they can have access to the basic inputs.

Survey results indicated that about 82% of the respondents utilize soybean. About 77% claimed that soy-daddawa is the commonest and most readily available product in the village. Soymilk is rapidly increasing in importance. Other products known to the villagers are soy akara, soy moinmoin, soy vegetable soup, and soy cheese. Unfortunately, the majority of the villagers cannot prepare these products because they lack practical knowledge of preparation. In 1988, Niger State Agricultural Development Project (NSADP) through its village extension officers and Women in Agriculture Program organized lectures on soybean processing and utilization, but no practical demonstrations were done.

The soy-products when ranked in order of preference were soy-daddawa, soy akara, soy milk, and soy vegetable soup.

Soybean farmers in Diko sell their produce at the cooperative division of Ministry of Agriculture, Suleja, in an open markets at the village and environs. Their main buyers are grain merchants from Kaduna state, retailers, and local food processors. Prices fluctuate in the market depending on the time of the year. A mudu (1.2 kg) of soybean grain costs between ₦3 and ₦4 or ₦300 for 70 kg bag in December (i.e., after the harvest). However, prices increase to ₦10 per mudu (1.2 kg) in June because of the closeness to the planting period (July).

About 39% of the farmers in Diko store their grain in jute bags, 18% in sealed containers and 15% in polythene bags. This grain is later kept in the local silos against the next season.

(II) *Soybeans production and utilization in Mungorota*

Figure 3.7 showed the map of Mungorota village. In the 1970s, soybean was first introduced to Mungorota village through some of the villagers who were members of the staff of the Ministry of Agriculture. The grain obtained from the first planting were thrown away because of poor cooking quality, lack of market channels and knowledge of the crop's nutritional potential and processing techniques. No cultivation was done in the 1980s except by a woman named Hajiya Nnagi Lami who intercropped one mudu (about 1.2 kg) of soybean with cassava and got seven mudus which were utilized as soy moinmoin and soy akara by her family. The same woman also cultivated the crop in 1990.

The major crops grown in the village in order of preference are cassava, guinea corn, sugarcane, maize, groundnut, yam, and rice. About 77% of the respondents were aware of soybean, while about 75% have not grown the crop before. Out of about 18% that grew the crop, 57% claimed to have used monocropping, 25% intercropping, and 5% both systems.

The diets of the villagers are predominantly carbohydrate-based. Hence, the community, especially the children, is malnourished. Gari is the main food commodity of the village. About 62% of the respondents claimed not to be aware of the uses of soybean. However, about 33% of the respondents have heard of soy akara, soy moinmoin and soymilk from extension agents and health officers. Hajiya Nnaji Lami recently prepared soy moinmoin and soy akara from full fat soybean flour and cowpea for home consumption in a ratio of one part of soy flour to two parts of cowpea paste.

(III) *Soybean production and utilization in Bida*

The team surveyed four major areas in Bida town, (Figure 3.8) Kpotun Lochinta Palace; Maternal and Child Health Clinic (MCH); Umaru Sheshi Primary School; Bida Central and Kpebegi Markets.

Soybean was first introduced to Kpotun Lochinta in 1955 by an expatriate who was an agricultural officer. He distributed seeds to out-growers to grow on their farms. Very few of them grew the crop because of lack of ready market and limited knowledge on its nutritional potentials. About 4% of the people interviewed claimed to have grown soybean. In 1989, an home economist from the Multipurpose Centre, Bida, brought samples of soymilk to MCH and created an awareness of the nutritional potentials of the crop in the minds of the nurses and clients.

After the introduction of soymilk to MCH in 1989, a staff nurse of the clinic prepared a small quantity of soymilk at home and brought it to the clinic. Nevertheless, soybean has not been used to intervene malnutrition at the clinic.

At Umaru Sheshi Primary School, soybean is not being used in any form. Snacks sold at the school by food vendors include groundnut, pop corn, bambara-groundnut, and kunu zaki (a local, non-alcoholic cereal-based drink). Some of the inhabitants of Kpotun Lochinta have only heard of soybean utilization from a workshop manual on soybean utilization and processing. Only 1% of the respondents claimed to have utilized the crop.

In Bida urban, the Central and Kpebegi markets were surveyed. A mudu of soybean grain sold for ₦6.50. The few sellers identified, claimed that they bought their grain from distant markets such as Zuru near Sokoto, Katsina, Kateregi, Gwada, and Paiko in Niger state. The main buyers are mainly livestock owners, nursing mothers, civil servants, and students from Federal Polytechnic Institute, Bida.

The status of soybean production, processing and utilization in Kaya, Makera and Kurmin Masara villages in Kaduna state (a baseline survey)

Case study areas:

(i)	Kurmin Masara village	-	(production site)
(ii)	Makera village	-	(low production, non utilization)
(iii)	Kaya village	-	(urban center)

Composition of survey/RRA team

Mr R.I. Giwa	:	(Agricultural economist)
Mrs V.B. Dunmade	:	(Home economist)
Mr J.E. Onyibe	:	(Agronomist)
Mrs H.J. Chindo	:	(Food technologist)

The project sites for NAERLS were Kurmin Masara, production site, Makera, non-production site, and Kaya, urban center site.

Soybean production and utilization is a relatively new phenomenon in Kaduna state. The study conducted in 1991 revealed that the crop had great potential in the state although it did not receive major attention until the late 1970s in Kurmin Masara and 1987 in Kaya. In 1991, 98% of the farmers in Kurmin Masara were aware of soybean and were growing it. In Makera the figures were 15% and 5%; in Kaya 52% and 48%. Also about 50% of the farmers grew soybean sole against 40% that intercropped with maize or sorghum on a small scale level (0.25-4 ha per farmer). The number of households that consumed soybean was 4% in Makera, 6% in Kaya, and 82% in Kurmin Masara. Soybean was locally processed and consumed mainly as a soup condiment (daddawa) and in vegetable soup in Kurmin Masara. Soybean sold for between ₦2-₦3.00 per kg during 1991 at the project sites. The study of cowpea and groundnut showed poor storability of products and inadequate knowledge of processing techniques as critical problems of soybean production and utilization.

Socio economic characteristics of the surveyed people

A total number of 281 people were surveyed in the three sites (Table 3.6). The frequency distribution were 97,100, and 84 for Kurmin Masara, Makera and Kaya respectively. The males were about 42% in Kurmin Masara,76% in Makera, and 80% in Kaya. The females accounted for the remaining figures in all the sites.

The married respondents ranges from 90% in Kurmin Masara and Makera to 96% in Kaya. On the average, about 88% of the respondents were within the ages of 21-59. Between 4 and 7% of the total respondents from the three sites had had no formal education, 19% had received primary education, 8% post-primary education, and 26% adult education.

The major occupation of the respondents at Kurmin Masara was farming (93%), petty trading (46%) at Makera, and farming (83%) at Kaya. The other main occupation was house keeper.

The survey showed that about 61% of the total respondents have the knowledge of soybean (99% in Kurmin Masara, 25% in Makera, and 81% in Kaya). Their main sources of knowledge were extension workers (28%) news media (17%), and colleagues (21%). The survey revealed that soybean had been introduced to the study area from 1 to 4 years before the survey was conducted; to 53% of the respondents at Kurmin Masara, 16% at Makera, and 71% at Kaya. Other respondents had heard about soybean over 5 years before the survey.

Soybean production activities in Kurmin Masara:

Kurmin Masara (figure 3.9) is situated along Samnaka-Kafanchan road which is one of the Zango Kataf District in Zonkwa Local Government Area. The old people in the community said that the crop was first grown around the mid-1950s. Production increased when it was used by women in the community as a substitute for locust bean in processing the soup condiment (daddawa). Its production also increased as a result of the establishment of the Kaduna Agricultural

Development Project in the late 1970s. Currently, the crop is fairly widely grown by nearly every household.

Farm input supplies such as fertilizers and seeds are available to farmers from government sources and local markets. In Kurmin Masara, planting of soybean starts in late May and ends in late October depending on the date of planting. The marketing channel for soybean seems to be simple. The major outlets are the rural markets. Over 75% of the farmers store their soybean for home consumption. Soybean seeds are also reserved for the next planting season.

Processing and utilization of soybean in Kurmin Masara:

For a long time, the crop was only used in the processing of daddawa, a soup condiment, and for animal feed. Of recently, the community have come to know of soybean through the help of agricultural extension agents since the early 1980s and about 82% of the households now consume soybean regularly. It was revealed that most families consumes over 1 kg of soybeans in a week in the form of "Kosi" (field cowpea paste), daddawa, "alele" (steamed cowpea paste) and milk.

Soybean has contributed very of the respondents well because nearly all the households sell soy based products. For example daddawa; 62% indicated from studies that they consume the products daily. A woman can make a sale of ₦200 on any market day and from ₦80 to ₦100 on any other day.

Soybean production in Makera

Makera is one of the 6 districts in Kaduna metropolis. It comprises 10 wards within the 4 important settlements; Merka (2); Barnawa (2); Kakurin Hausa (2) and Kakurn Gwari (4).

The soybean crop is not known to the majority of the farmers in Makera. Only a few (about 15%) of the households interviewed reported to have heard of it and about 5% had seen the grain. No farmers was producing soybean in Makera. However, a number of them expressed their interest in growing the crop if necessary inputs and market outlets are available.

Processing and utilization in Makera

Findings of the RRA reveal that the level of processing and utilization of soybean in Makera is very low. From the households visited, only 15 claimed to know how to process soybean, while in only 9 households, was soybean processed and consumed. The common soybean products used by these households are soy milk and the incorporation of soybean into soup and pap. In about 18 households, we were informed that soybean was unknown.

The low level of soybean utilization in this area was due to lack of information about soybean

Soybean production in Kaya village

Kaya is a relatively rural area situated about 56 km from Zaria, off Zaria-Funtua road. The majority of the people are Hausa.

The history of soybean in Kaya began in 1987. Alhaji Mohammed Sani Adamu, an illustrious son of the village, advised some innovative farmers to start soybean production. Alhaji Adamu introduced these farmers to the Funtua Cotton Seed Crushing Company (FCCC) for the supply of seed and technical advice.

In 1987, 15 farmers started growing soybean successfully in Kaya and neighbouring villages. This motivated other farmers to start producing in subsequent years. Hence, an association called "Haddadiyar Manoman Waken Soya" was formed in 1988.

The average soybean farm size is 2 ha. The smallest farm is about 0.4 ha while the largest farmer has over 10 ha. Most farmers intercrop soybean with other crops such as guinea corn, maize, and cassava. The FCCC gave the farmers the assurance that they would buy all soybean produced in the area. However, farmers are free to sell to any buyer who purchases at a higher

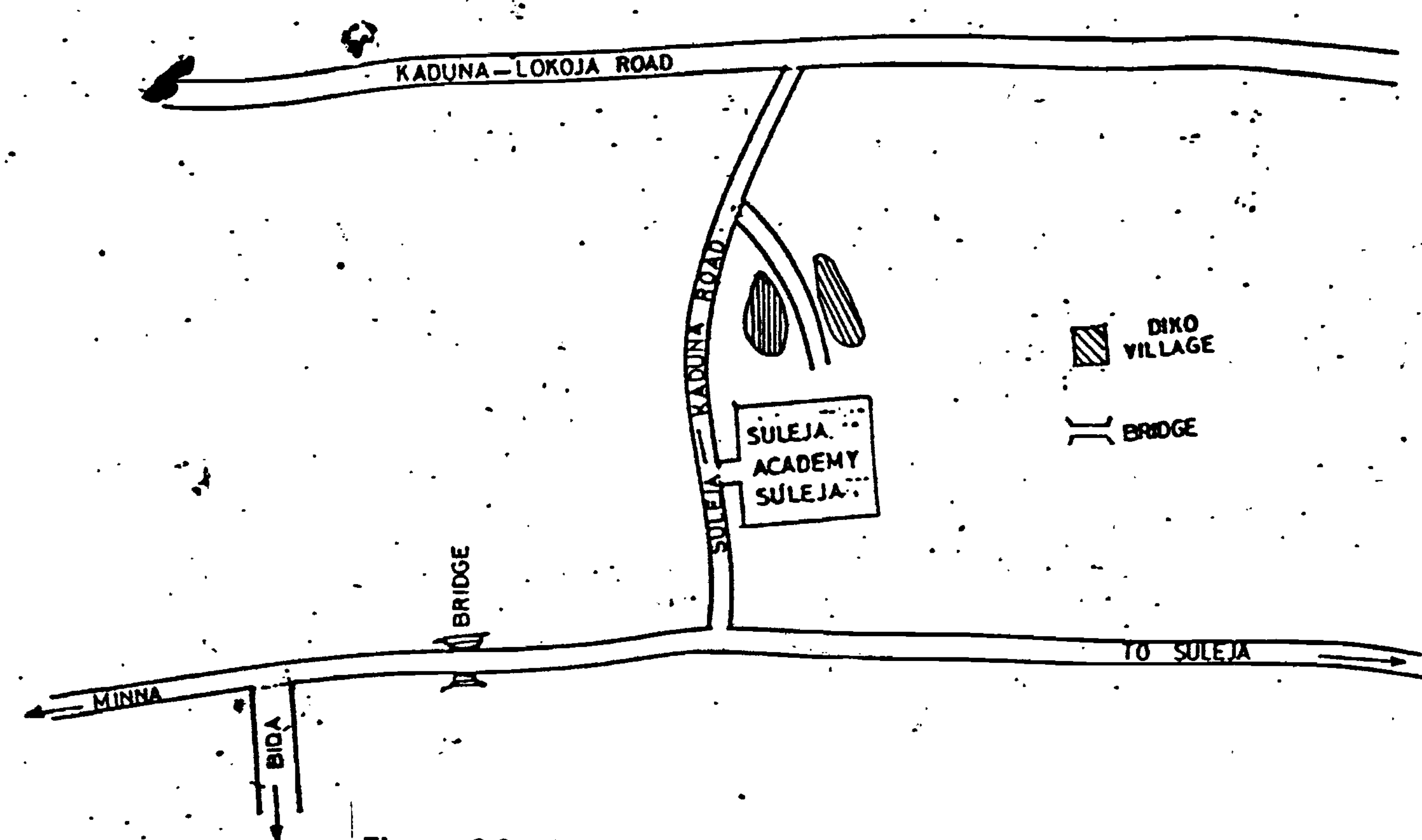


Figure 3.6 Map showing the location of Diko village in Suleja LGA

Figure 3.7 MAP SHOWING LOCATION OF MUNGOROTA VILLAGE IN GBAKO LGA OF NIGER STATE

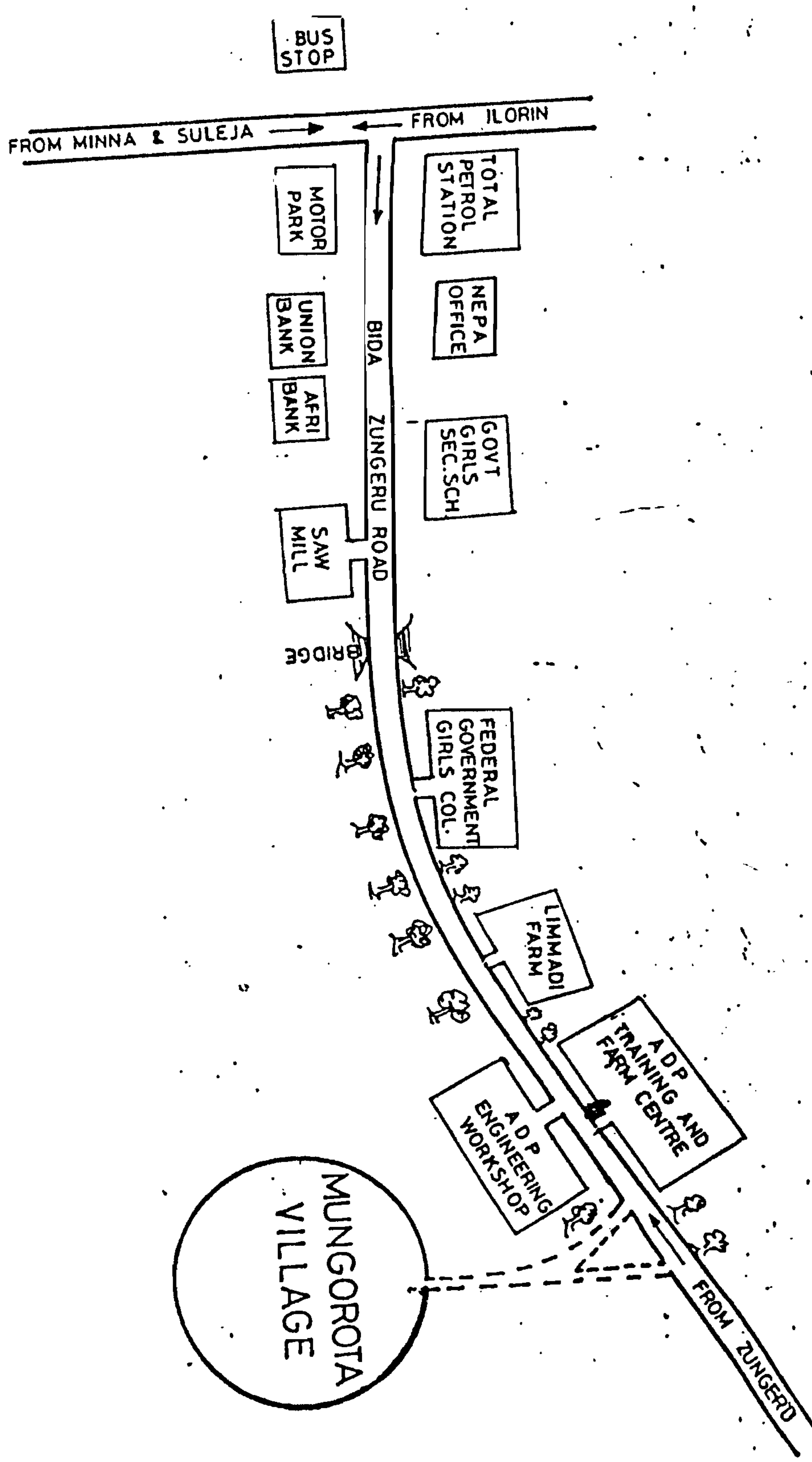


Fig. 3.8: LOCATION MAP OF THE CASE STUDY AREAS OF BIDA URBAN

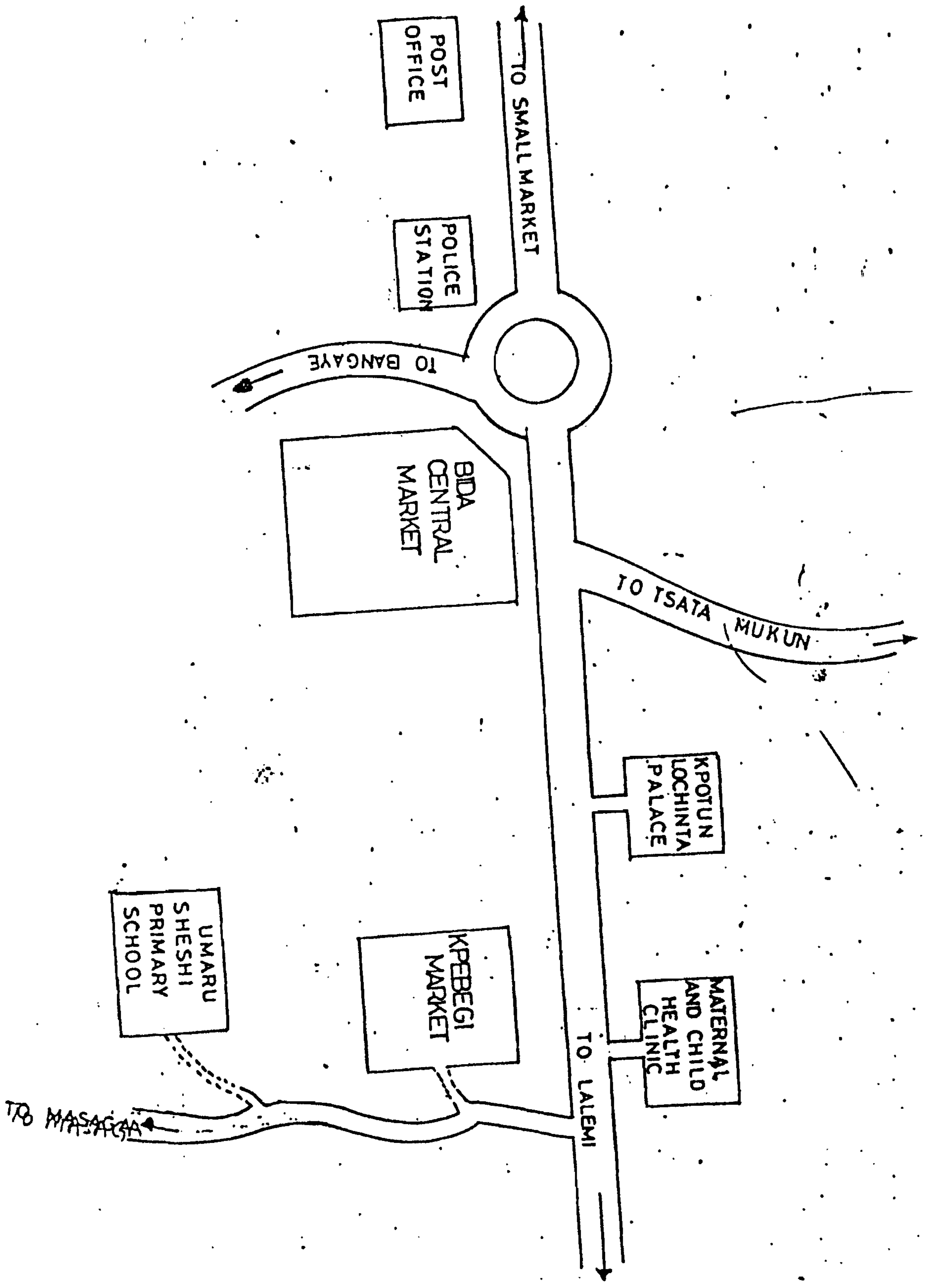
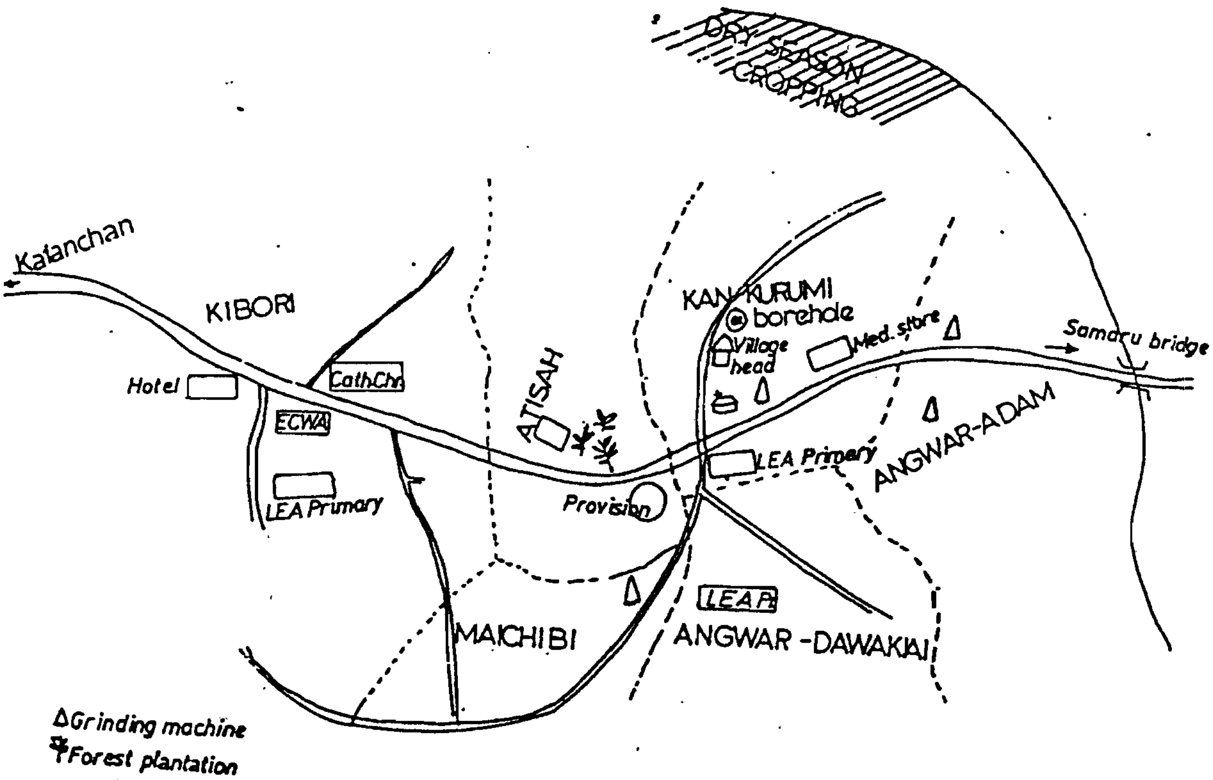


Table 3.6 Socioeconomic characteristics of people in Kurmin Masara, Makera (Kaduna), and Kaya, 1991

Characteristics	Kurmin Masara		Makera (Kaduna)		Kaya		Total	
Sample size:	97		100		84		281	
Sex: Male	41	(42)	76	(76)	68	(80)	185	(66)
Female	56	(58)	24	(24)	16	(20)	96	(34)
Marital status:								
Married 88	(90)	90	(90)	81	(96)	256	(92)	
Single 1	(1)	44	(44)	22	(26)	102	(36)	
Divorced/widowed	8	(9)	9	(9)	2	(3)	19	(7)
Age:								
Below 20 years	3	(3)	7	(7)	3	(4)	13	(5)
21-39 years	36	(37)	44	(44)	22	(26)	102	(36)
40-59 years	55	(57)	433	(43)	49	(58)	147	(52)
Above 60 years	3	(3)	6	(6)	10	(12)	19	(7)
Average	42.4		38.5		41.4		40.7	
Educational background:								
Primary school	27	(29)	19	(19)	8	(10)	54	(19)
Post-primary school	8	(8)	9	(9)	5	(6)	22	(8)
Others (Adult Education)	14	(14)	30	(30)	29	(34)	73	(26)
No formal education	48	(49)	42	(42)	42	(50)	132	(47)
Tribe:								
Hausa 4	(4)	67	67)	80	(95)	151	54)	
Kaje 0	0	(0)	0	(0)	0	(0)	0	(0)
Kataf 92	92	(95)	28	(28)	1	(1)	121	(43)
Others 1	(1)	5	(5)	2	(4)	8	(2)	
Occupations:								
Farmers	90	(93)	21	(21)	70	(83)	181	(64)
Petty traders	0	(0)	46	(46)	5	(6)	51	(18)
House keepers	5	(5)	25	(25)	7	(8)	37	(13)
Others 2	(2)	8	(8)	2	(3)	12	(4)	
Knowledge of soybean (%) (RRA survey):								
Know 98		15		52		55		
Do not know	2		85		48		45	

* Figures in parenthesis are percentage of the sample size.

Figure 3.9 A MAP OF KURMIN MASARA, KADUNA



price than that of the company. For example, in 1990, the FCCC price was only ₦200 per ton, while the open market price of soybean can reach up to ₦300 per ton. Picture 7 shows soybean from different farmers packed, and deposited at FCCC ware house.

The major constraints to production in Kaya include lack of tractors, problem of pest (birds), laborious threshing, and a low market price for soybean grain.

Soybean utilization in Kaya:

Our investigation revealed that soybean is a well known in Kaya (figure 3.10) as a very nutritive food crop. But unfortunately, only a few of the women (6%) here prepare soybean foods. The most common foods prepared by these majority are "Kosai", "daddawa" and roasted soybean for snacks. It is also incorporated into maize or millet dishes. There are some major problems in the areas of production, utilization, and processing. These include the inadequate supply of production inputs such as fertilizers, high labour cost of weeding and threshing; inadequate market outlets; lack of credit facilities to farmers; energy-sapping and time-consuming processing methods, and poor storage of some soy based products.

The status of soybean production, processing and utilization in Okutu, Ozalla and Enugu in Enugu state (a baseline survey)

Case study areas:

(i)	Okutu	-	(production site)
(ii)	Ozalla	-	(non-production site)
(iii)	Enugu	-	(urban center)

Composition of survey/RRA team:

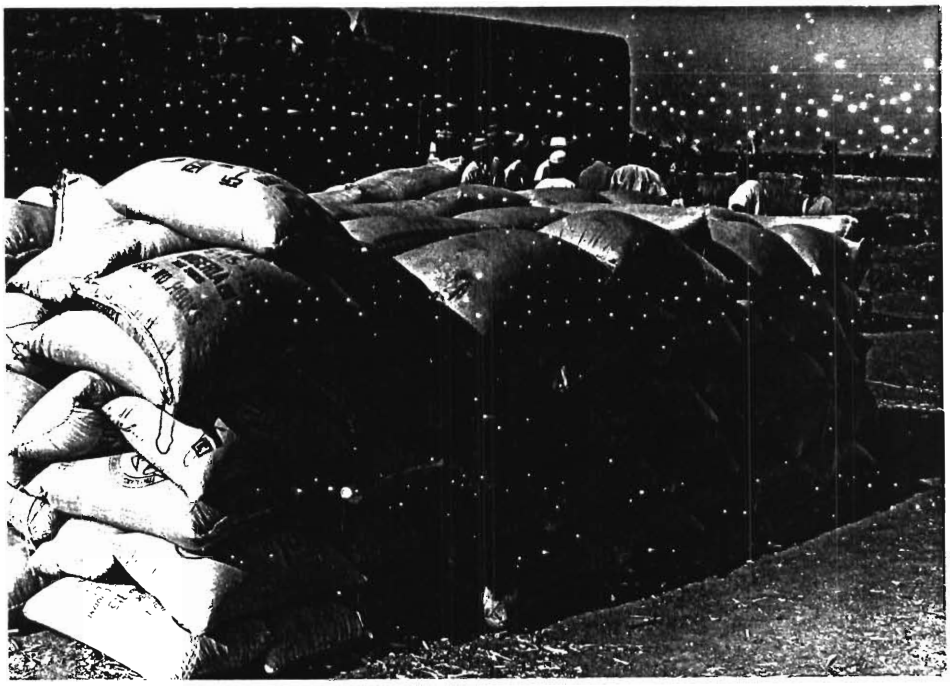
Dr. (Mrs) Uwaegbute	:	(Nutritionist)
Dr. B.N. Mbah	:	(Agronomist)
Mrs. B.N. Onah	:	Socio-economist)
Mrs Mrs. N.J. Enwere	:	(Food technologist)

The status of soybean production, processing and utilization in Okutu (figure 3.11), Ozalla (figure 3.12), and Enugu urban, the three project sites, was investigated by the RRA and conventional survey methods to document the status of soybean production, processing and utilization. Several RRA tools and a structured, validated, and pretested questionnaire were used for data collection. Non-parametric statistical methods were used.

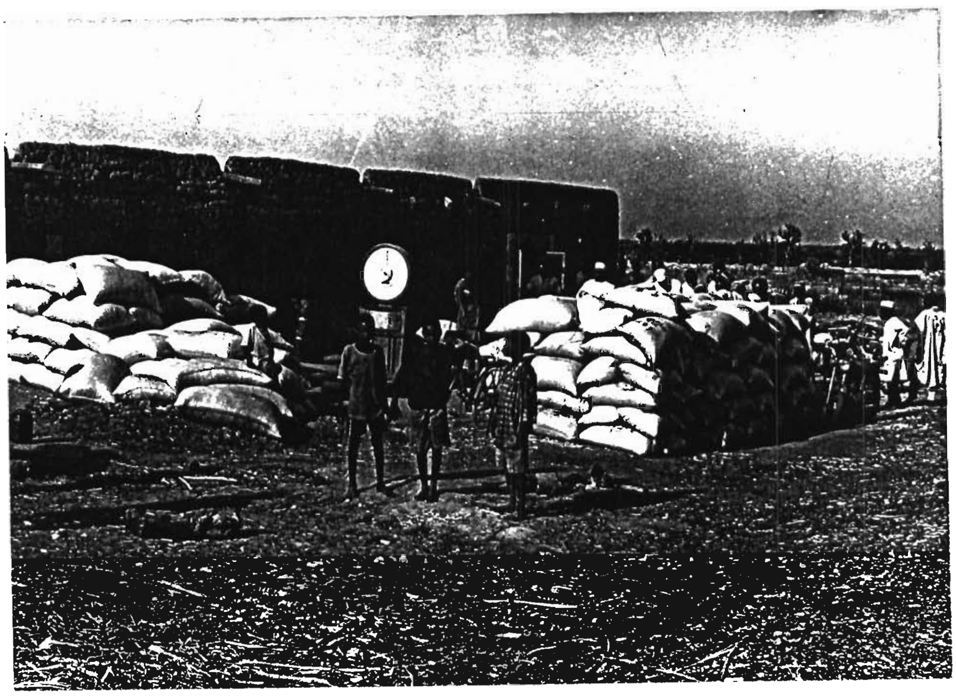
The results showed from analysis that in Okutu, about half of the respondents knew what soybean is. In Ozalla about half had heard of soybean but none knew what it is. Soybean was introduced into the Okutu community by an Agricultural Officer from old Anambra Agricultural Development Projects (ASADEP) but production had not continued because the people did not know how to use soybean. Local persons could not purchase the grain owing to lack of knowledge. Consequently, only one person in Okutu who knew how to use it was planting it at the time of the survey and there was no production in Ozalla. The farmers claim that they have never been exposed to soybean production. Processing and utilization of soybean was found to be very low in Enugu.

Production of soybean in Enugu State

Soybean production in Enugu state is almost nonexistent since production in Okutu which the agricultural officer recommended as a producing area did not really increase after introduction but rather decreased and eventually stopped. The major constraint to production was inability to either utilize what they produced or sell it. Ignorance of how to use soybean may also be said to have contributed to the lack of production in Ozalla because if they knew how to eat it, then they could look for the seed to plant. This observation is confirmed by the fact that in Okutu, the only person who knew how to use soybean continued planting, although he was not selling his products.



Picture 16: Soybeans bags in a government farmers shop.



Picture 17: Farmers awaiting their soybean allocations.

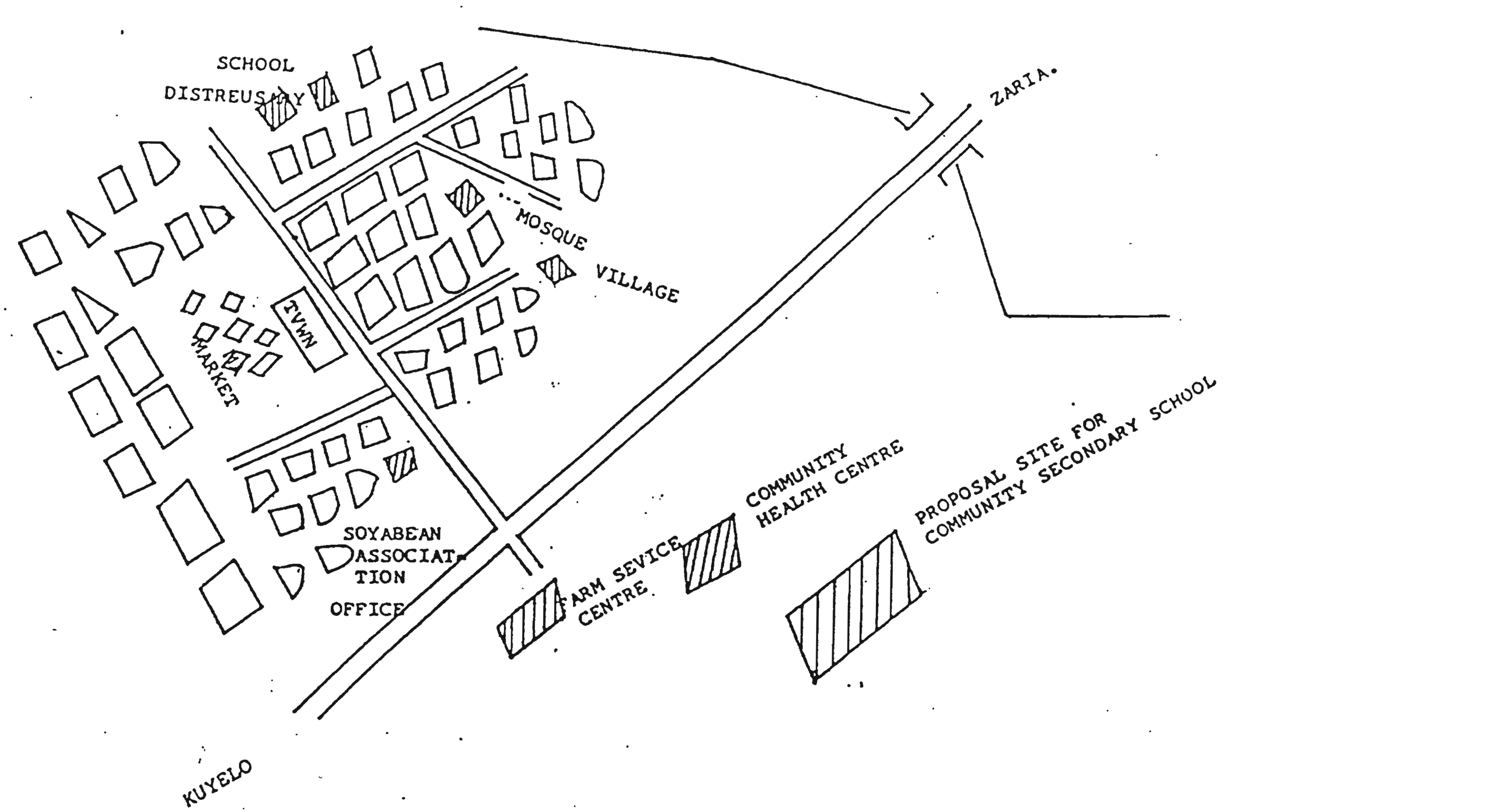


Figure 3.10 A SKETCH MAP OF KAYA VILLAGE

Figure 3.11 TRANSECT OF OKUTU TOWN

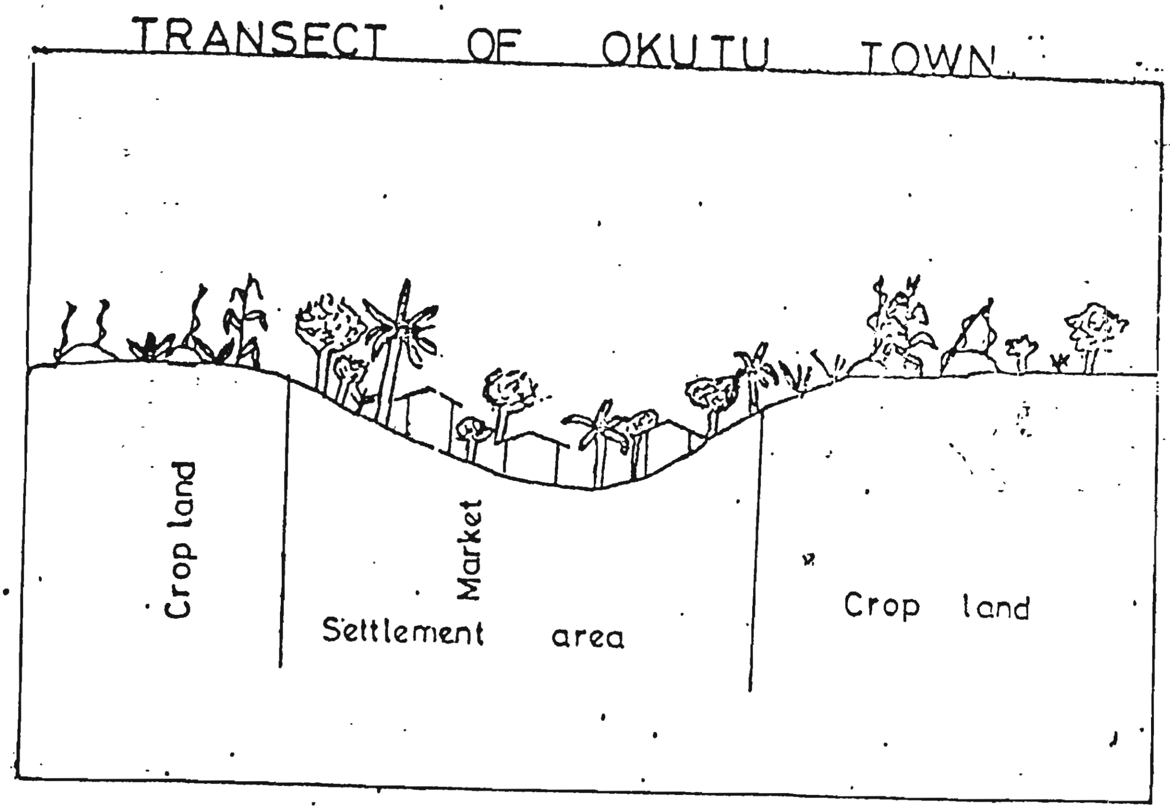
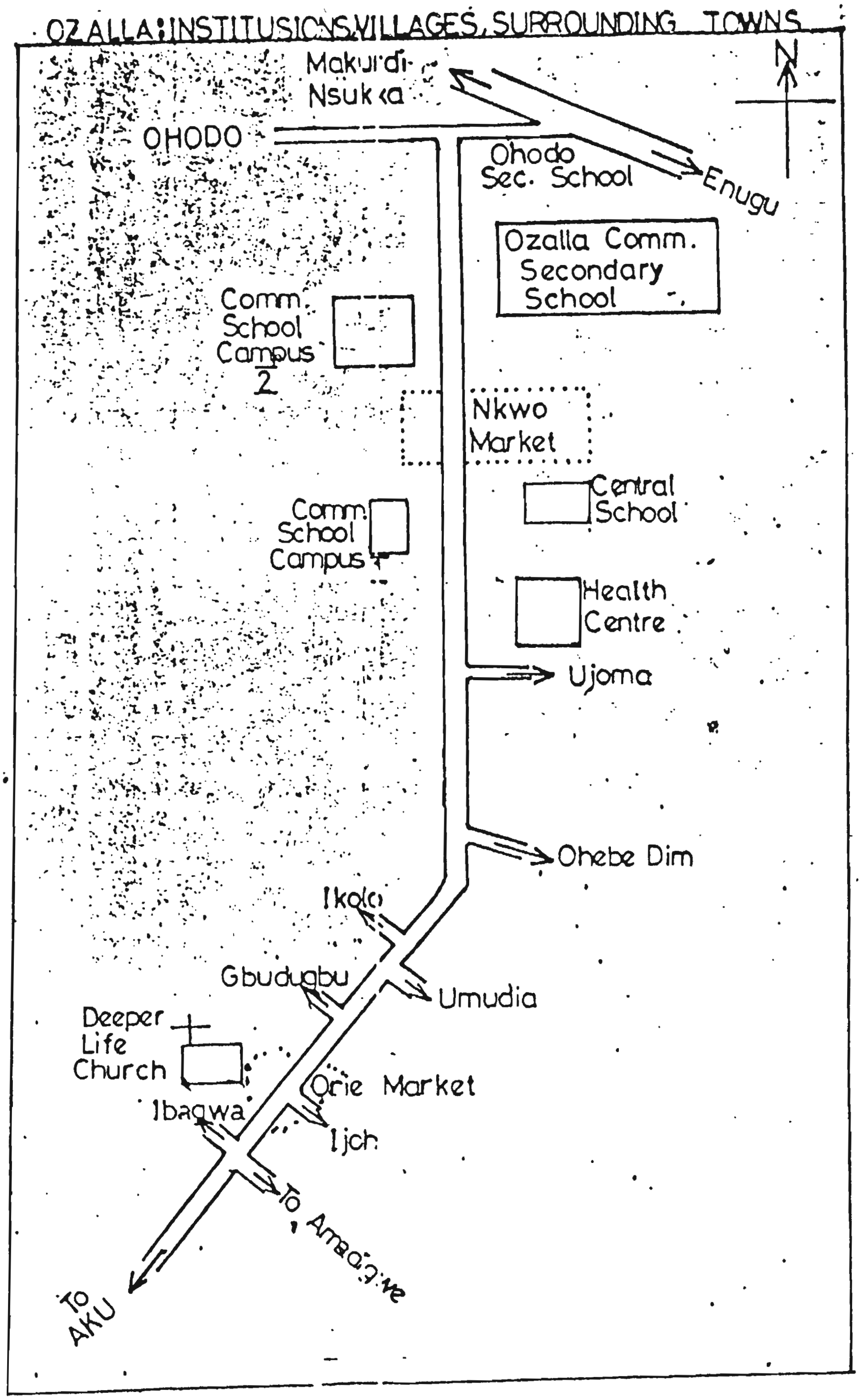


Figure 3.12 OZALLA: INSTITUTIONS, VILLAGES, SURROUNDING TOWNS



All farming activities were done by family members. The large family sizes create a large work force to cultivate large hectarages of land in both villages. This also implies that there is need for soybean production to fortify the predominantly starchy staples since the women and children belong to the nutritionally vulnerable groups. Although ranking which was based on ownership of land, animals, houses, and children in higher institutions of learning ranked some of them as wealthy, the socioeconomic survey (Uwaegbute and Osho, 1992) indicated that all of them are poor and may probably not be able to afford mechanized equipment and hired labour. Production activities must therefore be based on simple, easily affordable practices that the people can readily embrace.

Processing in Enugu State

Soybean processing is also at a very low level, even in the urban areas (Enugu). There were no particular mills used for soybean processing. Because the volume of processing was low, clientele was irregular, the processors were not always willing to mill the small quantities of soybean. However, the processors remarked that soybean processing had increased since January 1991 for reasons they could not explain. They assured the team that they would be most willing to devote some of their machines or create time slots for soybean processing as they have done for cowpea provided there was enough soybean to sustain their business.

SECTION 7

Product Development Research

Results from the baseline survey revealed that soybean was not being used to any significant level by the people of Nigeria. Despite the very high level of malnutrition noticed among the people and the relative low cost of soybean compared to conventional sources of protein like beef, pork, poultry, egg, milk, fish, and even cowpea; some of the reasons given by the people for not using soybeans were:

(a) complete lack of knowledge of the nutritional benefit of the grain.

(b) long cooking time;

(c) development of off flavour during processing;

(d) presence of some antinutritional factors; and

(e) lack of simple processing techniques and soybean recipes.

It, therefore, became clear that new technologies to be introduced will need to:

1. reduce the long cooking time required to tenderize the beans.
2. inactivate the lipoxygenase enzyme present in soybean that causes off flavour and odour.
3. destroy the antinutritional factors like trypsin inhibitor, phytic acid, tannin, flatulence factor, etc.
4. ensure high protein content of the processed soy food.

To achieve these objectives, several studies were undertaken and the results disseminated to different househols and industries.

Household processing and utilization of soybean

Baseline investigations of the chemical composition of some selected Nigerian traditional dishes (with and without soy-fortification) are shown in Table 3.7. The level of antinutritional factors, arising from the use of soybean, which were monitored during processing are shown in Table 3.8. Processing effectively eliminated trypsin inhibitor activity and reduced the levels of phytic acid and tannin. Soy-based products generally had higher protein and mineral levels than the non-soy containing foods. There was no significant difference in the level of acceptance of soybean-based products and the conventional products by panel members. This study demonstrated the nutritional superiority of soy-based foods over the conventional foods and showed that the traditional processing methods effectively eliminated the antinutritional factors of soybean.

Anti-nutritional factors include a number of components such as the trypsin inhibitor, hemagglutinin, phytic acid and other minor factors. Proteinase inhibitors of legumes, such as soybeans, have been studied in great detail because of their importance in animal nutrition (Rackis, 1972). Generally, very little has been done to relate their effect to human nutrition. However, it is generally considered that treatments of soybeans and other products that are suitable for animal nutrition are quite adequate for human nutrition. The trypsin inhibitor can be destroyed in soybean products by adequate heat treatment. It has been well established that the trypsin inhibitor can be eliminated in hydrated soybean tissue more rapidly than in dry tissue. An alkaline medium, such as a sodium bicarbonate blanch, will also destroy the trypsin inhibitor during blanching. In addition, the trypsin inhibitor is considered to be the most heat resistant of the anti-nutritional factors in soybeans.

It is also known that the trypsin inhibitor requires more heating (cooking) to inactivate than the lipoxygenase system. Fortunately, both factors are completely eliminated when beans are cooked or blanched long enough to develop adequate tenderness or texture in the beans. About twenty to thirty minutes is required to destroy/inactive antinutritional factors in soybeans. Adequate time, temperature and treatment to inactivate soybean trypsin inhibitor is specified in Table 3.9.

Table 3.7 The proximate and mineral contents of selected home made soybased products compared with traditional preparation method**

	Ogi*		Milk		Moinmoin		Akara	
	Conv.	Soy	Conv.	Soy	Conv.	Soy	Conv.	Soy
Dry matter	99.1	99.1	97.5	97.5	95.4	95.4	95.4	95.4
Protein (%)	7.2	21.1	21.8	14.20	17.28	24.7	16.1	23.0
Oil (%)	1.4	2.2	1.4	3.30	10.10	22.7	21.7	25.5
Phosphorus (%)	0.21	0.23	0.66	0.41	0.21	0.3	0.2	0.30
Calcium (%)	0.02	0.02	0.32	0.04	0.06	0.08	0.05	0.08
Magnesium (%)	0.04	0.04	0.01	0.01	0.02	0.01	0.01	0.01
Potassium (%)	0.31	0.30	1.40	1.83	1.20	0.90	1.0	0.91
Copper (%)	1.00	0.90	4.00	7.76	4.40	6.0	4.0	4.1
Manganese (ppm)	16.00	15.8	4.00	14.07	53.50	72.0	42.0	54.5
Iron (ppm)	138.00	136.6	20.00	75.00	255.73	271.0	314.0	222.2
Zinc (ppm)	16.00	15.8	43.0	7.76	50.20	43.0	43.0	44.4

* Ogi is maize porridge, moinmoin is steamed cowpea paste, and akara is fried cowpea paste

** Means of 3 readings

*** Samples were either freeze dried (Ogi and milk) or oven dried (moinmoin and akara) before analyses

Table 3.8 Phytic acid, tannin, and trypsin inhibitor levels of raw and processed soybeans*

	Raw soybean	Soy ogi	Soy milk	Soy moinmoin	Soy akara
Phytic acid (%)	2.1	1.3	1.2	1.2	1.1
Tannin (%)	1.9	0.9	1.3	0.6	0.7
Trypsin inhibitor (mg/g)	16	NAD**	NAD	NAD	NAD
Percent soy	100%	50%**	100%	50%	50%

* Means of 3 readings
** NAD = No Activity Detected

Table 3.9 Specification of time, temperature and treatment for the complete inactivation of the soybeans trypsin inhibitor at the household level

Method of heating	Temperature (oC)	Time (minutes)
Puffing in sand (whole soybean)	150	4
Roasting in pan (whole soybean)	85-90	10-12
Soaking and boiling (whole soybean)	100	20
Boiling (whole soybean)	100	30
Pressure cooking (whole soybean)	100/151lbs	15
Soaking and pressure cooking (whole soybean)	100/151lbs	10
Boiling with soda (whole soybean)	100	20
Boiling with Kanun (whole soybean)	100	20
Soybean grits (boiling)	100	15
Dehulled soybean (boiling)	100	10
Soybean flour (boiling)	100	5

The summaries of research activities on product development during the life of the project is given under several subheadings below. Details are reported in IDRC Soybean Utilization Project 2nd and 3rd year technical reports.

1. *The production of yoghurt from soybean milk in the presence and absence of starter culture*

Dairy yoghurt is a fermented milk with a firm consistency generally made with a mixed culture of *lactobacillus bulgaricus* and *streptococus thermophilus.* Several researches have shown that soy yoghurts can be made from other cultures apart from those mentioned above. Soybean yoghurt have been found to be more digestible than soymilk. Soy yoghurt is free of lactose unlike most U.S commercial dairy yoghurt which contain about 5.8% lactose.

Yamnaka et. al. (1970) have developed soymilk yoghurt using acqueous dispersion of soy protein fermented by a mixed culture of *lactobacillus bulgaricus* and *streptococcus thermopilus.*

Two methods were used in the production of soy yoghurt drink as shown in figure 3.13 and 3.14. Method 1 was method of soy yoghurt preparation without starter culture, while method 2 was preparation of soy yoghurt with starter culture. The products were subjected to chemical and sensory evaluation. The rate of acid development was also in the product after 30 days storage.

Figure 3.13 Flow chart processing of soybean yogurt without starter culture Ariyama (1963), modified (Method 1)

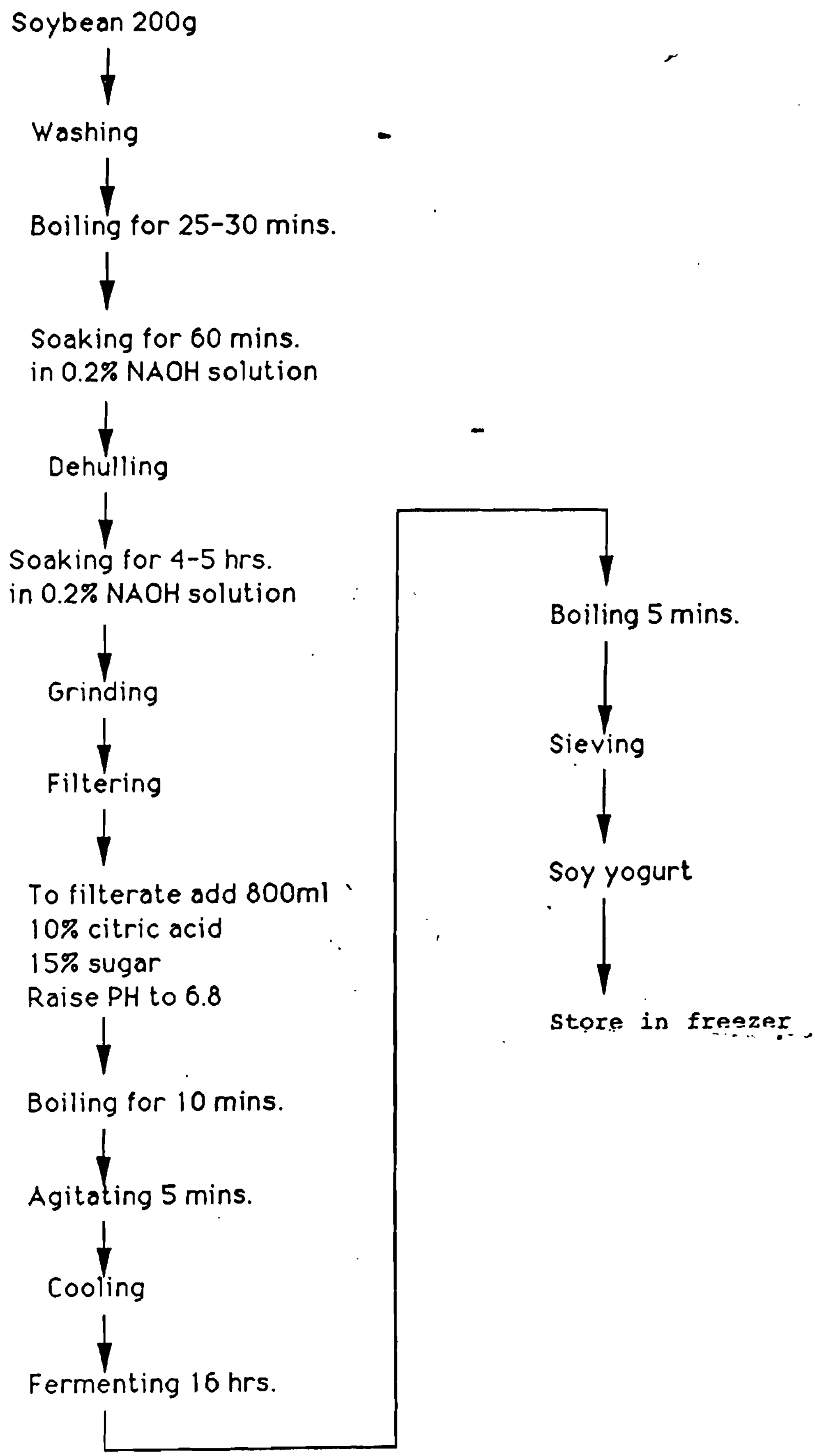


Figure 3.14 Flow chart processing of soybean yogurt with starter culture, (*Lactobacilus bulgaricus and Streptococuss thermophilus)* (Method 2)

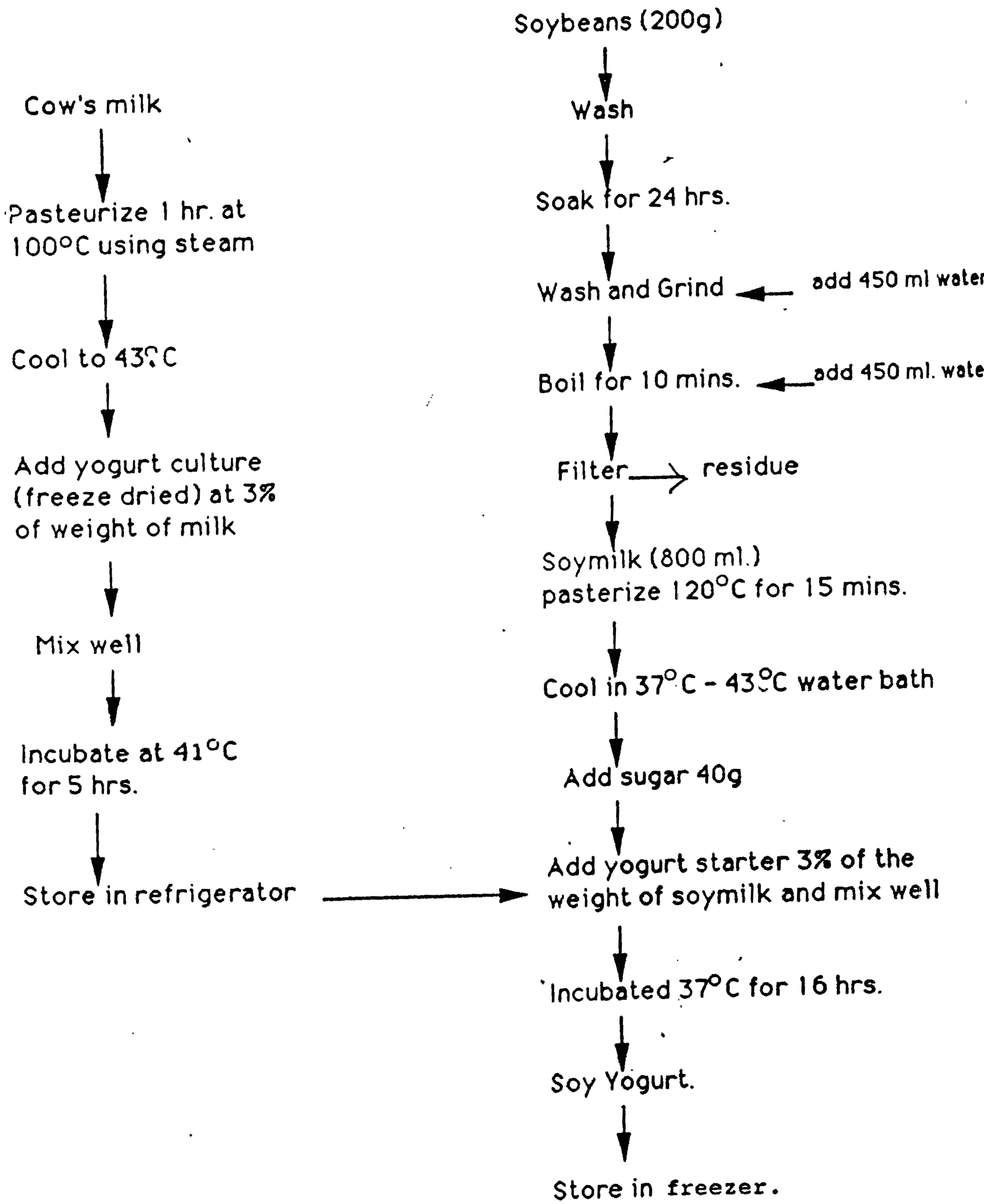


Table 3.10 Proximate analysis of soy milk without starter culture, soy milk with starter cultured yoghurt samples, and commercial soy yoghurt stored under frozen conditions for 30 days

Composition	Day 1			Day 7			Day 14			Day 30		
	A	B	C	A	B	C	A	B	C	A	B	C
Protein %	4.8	4.2	3.6	4.7	4.1	3.5	4.8	4.5	3.6	4.9	4.4	3.4
Fat	1.4	1.5	1.6	1.4	1.3	1.6	1.3	1.5	1.6	1.2	1.2	1.6
Moisture	94.4	94.7	95.4	94.4	94.9	95.4	94.4	94.8	95.6	94.4	94.7	95.6
Ash %	0.7	0.8	0.9	0.7	0.7	0.9	0.7	0.9	0.9	0.7	1.0	1.0
Carbohydrate	93.1	93.5	93.9	93.2	93.9	94.0	93.2	93.1	93.9	93.2	93.7	94.0
Fibre	1.2	1.3	1.5	1.2	1.2	1.5	1.2	1.4	1.7	1.2	1.3	1.5

Sample A - Soy yoghurt without starter culture
Sample B - Soy yoghurt with starter culture
Sample C - Commercial yoghurt sample. Uncle Suyo. Yoghurt frozen drink.
* Means of 3 reaaings

Table 3.11 Sensory evaluation of yoghurt (commercial soy yoghurt, soy milk without starter culture and soy milk starter yoghurt) stored under frozen condition for 30 days.

Samples	Flavour	Colour	Sources	Smoothness	Sweetness	Overall acceptability
			Day 1			
A	7.8	7.2	7.2	7.5	7.5	7.5
B	7.7	7.1	7.1	7.5	7.4	7.5
C	8.2	7.0	8.2	7.5	8.7	8.5
			Day 7			
A	7.5	7.2	5.2	7.5	7.4	7.4
B	7.4	7.1	7.1	7.4	7.3	7.4
C	7.9	7.0	8.1	7.5	8.6	8.4
			Day 14			
A	7.2	7.0	3.2	7.5	6.1	6.5
B	7.2	7.1	6.2	7.4	6.0	6.3
C	7.9	7.0	7.8	7.5	7.2	6.8
			Day 30			
A	5.2	6.8	2.1	6.0	5.1	5.0
B	5.1	6.7	6.0	6.2	5.0	5.1
C	6.1	6.8	7.5	6.3	6.3	6.1

The result of the chemical analysis and sensory evaluation is shown in table 3.10 and 3.11. The protein content were 9.8%, 5.2% and 3.5% for soy yoghurt with starter, without starter and commercial yoghurt respectively. The sensory evaluation showed that the products from the two processing methods were acceptable although they were scored lower than the commercial product. This was attributed to the flavouring added to the commercial soy yoghurt. The pH. of the products also varied. The yoghurt with starter culture had a pH of 4.19 on the first day of production and increased gradually to a pH of 4.30 at 30 days of storage. The yoghurt without a starter had a pH of 4.43 on day 1 and increased gradually to 4.79 by day 30. The use of starter in soybean milk yoghurt production have been found to have an effect on the yield of soy yoghurt but have no significant effect on the acceptability of the product.

2. <u>Consumer acceptability and quality of soy cheese (tofu) and local cheese (Warankashi) in Nigeria</u>

A high protein product which is popular in most homes in some part of the country is called "Warankashi". Warankashi is an indigenous soft cheese made by coagulating fresh cow's milk with an acqueous extract from the leaves of sodom apple (*calotropis Procera Ait*). This product is very similar to product from coagulated soybean (tofu). Tofu is a popular food in East Asia and nearly 42% of the total consumption of soybeans in Japan is in form of curd.

Warankashi is consumed mostly by the poor Nigeria populace and because of the high cost of fresh cow's milk, the product had become very expensive, making it out of reach for the consumers. The study was therefore aimed at finding a cheaper substitute which will be acceptable to consumers for warankashi (local cheese).

The methods used for the preparation of fresh cow's milk cheese (warankashi) and soybean tofu are shown in figures. 3.15 and 3.16. The product were subjected for proximate analysis and sensory evaluation.

The result showed that soybean tofu had virtually no flavour when compared with the local cheese. The sensory evaluation results show that the tofu was bland and had an inconsistent texture. There was no significant difference in the overall acceptability and flavour of both products.

The proximate analysis and the amino acid composition of the product is shown in tables 3.12 and 3.13. The protein content ranges from 8.9% in local cheese to 10.43% in the tofu. The fat content was higher in the local cheese (12.8%) than in the tofu (3.5%). Table 3.14 showed that methionine was higher in local cheese. The amino acid result however, compared favourably well in both products.

Table 3.12 Chemical composition of local cheese (Warankashi) and soybean curd (tofu)

Constituent	Local cheese	Tofu (soybean curd)
Moisture %	70.3	79.80
Protein %	8.9	10.43
Fat %	12.8	3.5
Ash %	0.9	1.28
Carbohydrates %	7.1	2.41
Fibre %	0.00	0.00
Calcium (mg/100 g)	3.21	197.5
pH	5.8	6.01
Yield %	19.8	19.4
Total acidity	0.48	0.42

* Mean of 3 readings

Table 3.13 Sensory evaluation scores of soy cheese (tofu and Warankashi)

Sensory attribute	Warankashi	Soy cheese (tofu)
Texture	7.1 a	5.0 b *
Flavour	6.3 a	4.6 a NS
Colour	8.1 a	4.4 b *
Overall acceptability	6.4 a	5.0 a NS

* = Significant at 5% level;
** = Means for each attribute followed by the same letter are not significantly different at 5% by Duncan. Higher values indicate greater preference;
NS = Not significant at 5% level.

Table 3.14 Amino acid composition of local cheese (Warankashi and soybean curd (tofu)

Amino Acid	*Soybean Curd	Soybean Curd gAA/100 g	Local Wara gAA/100 g
Lysine	6.18	2.1	2.5
Histidine	2.37	1.2	1.2
Arginine	7.25	1.1	0.8
Aspartic Acid	11.63	4.1	2.4
Threonine	3.60	0.9	1.0
Serine	4.65	0.7	0.7
Glutanic Acid	19.53	7.1	7.8
Proline	3.27	0.8	1.2
Glycine	3.92	1.6	0.7
Alanine	4.22	1.6	1.1
1/2 Cystine	2.26	0.2	0.1
Valine	5.31	2.0	2.2
Methonine	0.99	0.02	1.00
Isoleucine	4.95	0.4	1.6
Leucine	8.02	1.7	2.9
Tyrosine	3.60	1.4	1.6
Phenylalanine	5.33	1.9	1.5

* Schroder D.J., and Jackson H. 1972 scores for amino acid composition for soybean curd (based on % total amino acid).

Figure 3.15 The processing of local cheese (warankashi) from cows milk

Heat Cow's milk to 40°C

↓

Add aqueous extract of
Calotropis procera
10g leaves to 4 litres of
milk

↓

mix

↓

Heat to 70-75°C at
1.5-2.0°C /min

↓

Descum

↓

Cook curd at
85°C for 12 min.

↓

Drain

↓

Local Cheese
Warankasi

Figure 3.16 The processing of soybean cheese (tofu) for soybeans.

Soak lkg soybeans in
water at refrigeration temp for 8 hours
1 part of soybean to 5 parts of water

↓

Drain and Rinse

↓

Grind Coasly with
2.5 litres water (speed 3 min. into paste)

↓

Pour paste in a container
inserted into 2 litres boiling water

↓

Boil for 3 minutes

↓

Sieve the paste to remove milk
(milk yeild 3.750 litres)

↓

Cool milk
(Temp. 40-45°C)

↓

Into 3 litres milk
Immerse 3% Calotropis procera leaves - which
is pounded and raped into a cheese cloth for 5 minutes
add 0.5% lime juice (by vol. of milk)
to aid coagulation

↓

Immerse container of milk + calotropic
procera enzyme + lime juice
into boiling water for 30 minutes

↓

Remove curd from the boiling water

↓

Pour curd in cheese hoops

↓

Apply.l psi on hoops to allow whey to drain

↓

Tofu;
cut up into pieces

3. <u>Determining and extending the shelf-life of local cheese and soybean tofu in Nigeria</u>

Soybean tofu have been found to be highly acceptable among the Nigerian populace that consume local cheese (coagulated fresh cow's milk). Tofu contains about 80 - 88% water and it is the subject to microbial spoilage. Under refrigerated conditions, it shelf-life is 1-2 days. In tropical areas like Nigeria, there is the problem of food spoilage. Thus, it is essential to develop a local or home-level preservation method for several products developed. Refrigeration, canning and other sophisticated methods of preservation does not exist at village level in Nigeria. This study was therefore conducted to determine the shelf life of soybean tofu and local cheese (warankashi) under different storage conditions and to develop a home level method of preservation for room temperature.

The products were processed and preserved in various acqueous solutions made from common table salt (Nacl), lemon juice at natural strength and tab water. The solutions were changed on weekly basis while the control was changed on daily basis. The samples were stored at room temperature.

The preserved products were subjected to sensory evaluation and protein content, moisture content and pH analysis.

The highest moisture content were recorded in the treatments 2% Nacl+5% lime juice and 4% Nacl at 5% lime juice. The protein content decreased in all the samples. Observations during days of storage of local wara and soybean curd are stated in table 3.15 while tables 3.16 and 3.17 show the sensory evaluation results of the products. The immersion in tap water which was refrigerated had the highest shelf life of 11 and 14 days respectively for local cheese and soy curd; followed by 7 and 8 days storage life for 4% Nacl plus 10% lime juice aqueous solution. However, it was noticed that soybean curd remains whole-some for 10 to 12 hours under tropical storage conditions.

Table 3.15 Effect of immersion in acqueous solution on keeping quality of local wara and soybean curd at 24°C-28°C

	Treatment	Storage days		Comments
		Local cheese	Soy curd	
1	Tap water only	1	1	Putrid odour appeared on both samples after 1 day storage.
2	2% Nacl + 2% lime juice	2	2	Too wet
3	5% Nacl	3	3	Slightly salty taste Very salty
4	5% lime juice	4	4	Bitter taste
5	2% Nacl + 5% lime juice	5	4	Bitter taste
6	4% Nacl + 10% lime juice	7	8	No odour, salty taste
7	1% Nacl	1	2	Wet
8	1% lime juice	2	1	Acidic taste
9	Tap water Refrigeration	10	14	Fresh smell

* Comments based on subsequent days

Table 3.16 Sensory Evaluation scores after day 1 storage of soybean curd and wara

Treatment		Flavour	Colour	Texture	Overall Acceptability
1	Tap water only				
	A) Wara	4.6	5.1	5.5	4.2
	B) Soy curd	3.2	5.0	3.2	3.5
2	2% Nacl + 2% lime juice				
	A) Wara	6.0	6.5	6.4	6.0
	B) Soy curd	5.0	6.3	5.8	5.0
3	5% Nacl				
	A) Wara	5.0	7.0	6.0	5.0
	B) Soy curd	5.5	6.5	5.0	5.5
4	5% lime				
	A) Wara	5.0	6.8	7.3	7.0
	B) Soy curd	5.0	6.5	7.2	7.0
5	2% Nacl + 5% lime				
	A) Wara	4.3	6.1	7.1	4.8
	B) Soy curd	4.9	6.5	6.8	4.9
6	4% Nacl + 10% lime				
	A) Wara	8.5	7.9	8.2	8.5
	B) Soy curd	7.7	8.0	7.8	7.7
7	1% Nacl				
	A) Wara	7.5	6.3	6.7	7.5
	B) Soy curd	7.0	6.1	6.5	7.0
8	1% Lime juice				
	A) Wara	5.3	5.5	5.5	5.3
	B) Soy curd	5.5	5.2	5.1	5.5
9	Tap water refrigeration				
	A) Wara	8.5	8.6	8.5	8.6
	B) Soy curd	8.9	8.9	8.8	8.8

* 1 - 1
9 -
Hedonic scale scores

Table 3.17 Sensory Evaluation after 5 days of storage of soybean curd and wara, under selected treatments

Treatment		Flavour	Colour	Texture	Overall Acceptability
1	2% Nacl 5% lime juice				
	A) Wara	2.1	2.3	1.3	2.2
	B) Soy curd	1.3	2.4	1.0	1.4
2	4% Nacl 10% lime juice				
	A) Wara	5.3	5.1	4.7	5.6
	B) Soy curd	4.7	6.0	4.5	4.9
3	Tap water refrigeration				
	A) Wara	6.4	7.1	6.5	7.8
	B) Soy curd	7.6	7.2	6.9	7.8

4. *Soybean based foods developed at household level (soy scotch egg, soy Ogbono and soy tortilla)*

Soybean based foods were developed to prove the versatility of soybean. Soybean incorporated in these new products will not only improve the nutrients of the food but reduce the cost. Among the new products developed are soy ogbono, soy scotch egg and soy tortilla.

Ogbono is a local seed which is normally ground up into flour and made into draw soup. It is usually used as soup for "eba", "pounded yam" or any other root or tubber pudding. Scotch egg is a snack which had become so expensive because of the animal products (egg and sausage meat) used as raw material in the preparation. Tortilla is a new product processed from maize.

The three products were fortified with soybean and subjected to organoleptic and chemical test.

The result of the organoleptic test show that there was no significant different between soybean fortified scotch egg and sausage scotch egg. The result of ogbono samples show that ogbono fortified with soybean was higher in protein and fat than ogbono fortified with cray fish. Results of the organoleptic test show that the sugar sweetened tortilla was more acceptable while unsweetened was not acceptable. These results are shown in tables 3.18, 3.19 and 3.20.

Table 3.18 Proximate analysis of Ogbono fortified with cray fish and soybean

Nutrients	Unfortified Ogbono	Ogbono with cray fish	Ogbono with soybean
Moisture %	13.2	11.50	9.65
Protein %	7.3	13.4	19.3
Fat %	38.2	38.6	50.2
Carbohydrate %	27.7	19.6	10.6
Ash %	3.5	8.1	4.4

Table 3.19 Sensory evaluation of ogbono soups

Parameters	Unfortified Ogbono	Ogbono with cray fish	Ogbono with soybean
Colour	4.2	5.8	5.7
Flavour	4.3	5.5	5.8
Drawness	5.8	5.6	5.4
Taste	4.4	5.6	5.4
Overall acceptability	4.8	5.7	5.5

Table 3.20 Sensory evaluation of tortilla products (baked)

	Unsweetened	Sugar Sweetened	Salted
Taste	2.6	4.9	3.5
Flavour	3.0	4.7	2.9
Appearance	2.7	3.8	3.2
Texture	2.8	3.9	3.3
Colour	2.6	3.4	3.5
Overall acceptability	2.5	4.4	3.2

5. *Nutritional evaluation of staple foods in Lagos State*

The nutritional quality of most Nigerian staple food is poor. They are especially low in protein. The staple food in the choosen area of Lagos state are gari, lafun, fufu, tuwo and rice. These foods were usually taken with stew or soup.

The method of preparation of the products was done according to the consumer's methodology. The samples were fortified with soybeans. The samples (unfortified and fortified) were analysed for protein, fat, carbohydrate, moisture and ash content. Sensory evaluation was also done to test the level of acceptance.

The result of the chemical composition of gari, lafun, fufu, tuwo and rice before and after soybean fortification of the food samples are shown in table 3.21. The inclusion of soybean at a ratio of 3:1 increased both the protein and ash content of the food samples.

The sensory evaluation result (table 3.22) also shows that there were no significant difference in the level of acceptability for the fortified staple food and the unfortified for samples.

6. *Fortification of composite flours with soybean*

Composite flour technology has been used as a means for extending scarce supplies of wheat used in the preparation of baked products. Due to the high cost of wheat flour, confectioneries or snacks made from wheat flour had become very expensive, thus making it unaffordable for the poor populace. The inclusion of soybean into composite flours have been found not only to reduce the cost of the end products, but also help to improve the nutrient composition of the product.

The composite flours were developed as shown in table 3.23. These composite flours were used in the preparation of some snacks and compared with snacks from whole wheat flour. The snacks prepared were cake, bread and sausage roll.

Table 3.24 showed the proximate analysis of each of the composite flour while table 3.25 showed the nutrient composition of each product from the composite flour. The result indicated that product with soybean have higher level of protein and fat. The sensory evaluation in table 3.26 shows that wheat flour fortified with soybean flour compared favourably well with whole wheat flour.

Table 3.21 Nutrient composition of non-fortified and fortified staple food in project sites

Nutrient*	Gari A	Gari B	Lafun A	Lafun B	Fufu A	Fufu B	Tuwo A	Tuwo B	Rice A	Rice B
Moisture %	10.4	11.3	12.4	11.0	10.8	11.2	18.1	15.2	45.0	40.0
Protein %	1.2	7.6	0.9	11.2	0.7	13.2	2.1	12.0	2.3	14.5
Fat %	0.2	0.81	0.4	1.8	0.5	2.1	0.1	3.0	1.2	2.8
Carbohydrate %	79	65.6	69.5	60.4	78.06	1.1	69.9	56.3	43.5	35.0
Ash %	1.2	1.7	0.8	2.0	0.8	1.8	1.0	1.9	2.1	2.0

* These are means of 3 readings

Table 3.22 Sensory evaluation of fortified and unfortified staple foods of project sites

Samples	F.F	NFF	Difference between two means	LSD	Remarks 5%
Gari	7.2	7.0	1.2	0.7	NS
Lafun	6.9	7.0	0.1	0.6	NS
Fufu	8.0	7.3	0.7	1.5	NS
Tuwo	6.1	5.8	0.3	0.9	NS
Rice	6.4	6.7	0.3	0.9	NS

F.F - Fortified foods
NFF - Non-fortified foods
NS - No significant difference at 5% level

Table 3.23 Percentage of raw materials that makes up flour

Materials	Percentage of materials			
	AB	BB	BC	AD
Wheat	100	-	-	60
Sorghum	-	70	-	-
Maize	-	-	70	-
Soybean	-	30	30	40
Total	100	100	100	100

AB - Whole wheat flour BC - Maize/soybean
BB - Sorghum/soybean AD - Wheat/soybean
AB. BB, and BC were used for processing cakes and bread while AB and AD were used for cake ,sausage rolls and bread.

Table 3.24 Proximate analysis of composite flours

Flours	Moisture %	Protein %	Fat %	Ash %
Wheat	12.1	7.50	1.2	1.2
Sorghum/soybean	15.1	12.85	11.2	3.0
Maize/soybean	11.2	12.64	13.2	2.7
Soybean/wheat	12.0	15.14	8.8	3.4

Table 3.25 Nutrient composition of products from each composite flour

	AB			BB		BC		AD		
Nutrients	Cake	Bread	Sausage roll	Cake	Bread	Cake	Bread	Cake	Bread	Sausage roll
Moisture	15.2	22.0	24.1	20.0	24.0	21.1	24.5	18.4	20.3	21.9
Protein %	10.2	8.55	9.35	8.1	10.4	7.5	10.6	9.87	12.3	14.2
Fat %	33.2	9.1	19.3	40.4	18.6	43.2	13.2	40.2	11.1	22.4
Carbohydrate	41.0	55.8	42.4	27.6	45.8	25.4	51.3	27.8	55.1	36.0
Ash %	2.6	1.5	5.0	3.45	1.0	3.2	1.0	4.1	1.8	3.2

Table 3.26 Mean of sensory evaluation of products from composite flours

	AB			BB			BC		AD	
Nutrients	Cake	Bread	Sausage roll	Cake	Bread	Cake	Bread	Cake	Bread	Sausage roll
Colour	7.8	7.0	7.6	6.4	4.4	7.2	6.2	7.6	6.8	7.5
Flavour	6.5	7.4	7.2	6.0	6.2	6.5	7.0	6.8	7.2	7.4
Taste	7.5	7.6	6.4	7.0	2.6	6.6	4.1	7.6	6.5	7.0
Overall acceptability	6.9	7.2	7.0	6.6	4.2	7.0	5.6	7.4	7.0	6.8

7. *Development of soy fortified local weaning food for Niger State*

Most weaning foods in Niger state of Nigeria are nutritionally poor. Akamu (porridge from cereal) is the most common infant weaning food in Nigeria. The nutritional quality is very low and cannot meet the nutritional requirement of a weaning infant.

The objective of the study was to use soybean to fortify some weaning foods. Three main cereals (millet, guinea corn and maize) were used in processing of akamu. Soybean was use to fortify the cereals at ratios of 3:1; 3:2 and 1:1. The method of processing is shown in figure 3.17. The products were subjected to sensory evaluation and chemical analysis.

The result of the sensory evaluation is shown in Tables 3.28, 3.29 and 3.30. The maize based weaning foods were preferred to those from millet and sorghum. The chemical analysis also proved that soybean improved the protein content of the products, (Table 3.27). As shown in table 3.27, soy guinea corn weaning food of ratio 2:3 had the highest protein level (19.39%) followed by soy guinea corn of 1:1 and soy maize weaning food of ratio 1:1 which contained 18.49 and 18.0% respectively. Fat level was also improved significantly by soybean inclusion, ranging from 6.0 to 13.7% while the unfortified weaning foods had no trace of fat. Same trend was exhibited in minerals composition.

8. *Improvement of the nutritional quality of kunu zaki using soybeans*

kunu zaki is a local non-alcoholic beverage widely consumed in the middle belt and Northern parts of Nigeria. It is prepared from cereals flavoured with Kayaji (a combination of local spices) and sweetened with sugar.

The study was aimed at improving the nutritional quality of kunu zaki using soybean. The fortified soy-kunu was a modification of the basic method of kunu zaki preparation and it is shown in figures 3.18 and 3.19. The products developed were subjected to sensory evaluation and chemical analysis.

Table 3.31 shows the sensory evaluation result of unfortified and fortified kunu zaki. The result shows that there were no difference in the appearance of the samples but were significantly different in flavour, odour, consistency and overall acceptability. The products from soybean-millet blend were preferred by the judges. The addition of soybean whether soymilk or paste, improved the chemical composition of the kunu zaki considerably. The total protein in soybean-millet kunu (1:1) was the highest of all the samples. 1.3% protein was recorded for it while the commercial kunu contained the least - 0.02% protein.

9. *Comparative nutritional evaluation of tuwo with and without soybean*

Local foods like "tuwo" are consumed in Kaduna state households. Tuwo is cereal based food. Cereals such as maize, sorghum and millet are used in processing Tuwo.

The cereals (Rice, sorghum, millet and maize) were fortified with soybean at 25%, 30%, 40% and 75% levels. These were then subjected to sensory evaluation. The method of preparation is shown in figure 3.20.

Sorghum tuwo fortified with soybean at 25% was highly acceptable. There was no significant difference between sorghum Tuwo fortified and the control (whole sorghum) in terms of colour and overall acceptability (Table 3.32). Proximate analysis of sorghum, millet, rice and maize tuwo showed that they are low in protein content (Table 3.33). The protein content increased when fortified with soybean at 25% level.

10. *Comparison of daddawa from soybean and locust beans*

In the Northern part of the country, fermented dried locust beans are referred to as "daddawa" while in the Southern part they are called "Iru". daddawa is a soup condiment. The production of daddawa have been reduced because of lack of enough seed yield by the African locust bean (*Parkia filicoidea Weln*) seed. Thus the need for soybean as raw material in the production of daddawa. Processing of soybean into daddawa is a good way of incorporating soybean protein into the traditional foods.

The method of processing locust bean and soybean daddawa is shown in Figures 3.21 and 3.22 respectivey. These products were tested for their chemical qualities after preparation.

The result shows a shorter time in the preparation of soybean daddawa. An indication of reduction in energy and fuel used. The chemical analysis as shown in table 3.33 shows that both samples were good sources of protein.

11. *Development of "Soy-Hatsi" (soybean-cereal mixtures)*

Weaning foods play an important role in the growth of children. Most foods usually used for preparing weaning foods are from cereals like sorghum. As a cereal, the protein content of sorghum is low apart from being deficient in some amino acid needed for growth.

Three different methods were used in the preparation of soy-hatshi. Soybean was combined with cereal (sorghum) to process "tom brown". The cereal was combined with soybean in form of paste and roasted flour. It was called "Tom Brown". These soybean based products were subjected to chemical analysis.

The chemical analysis of the combinations with soybean gave the highest protein content and fat as shown in table 3.35.

Figure 3.17 Processing of soy fortified weaning foods (soy-akamu)

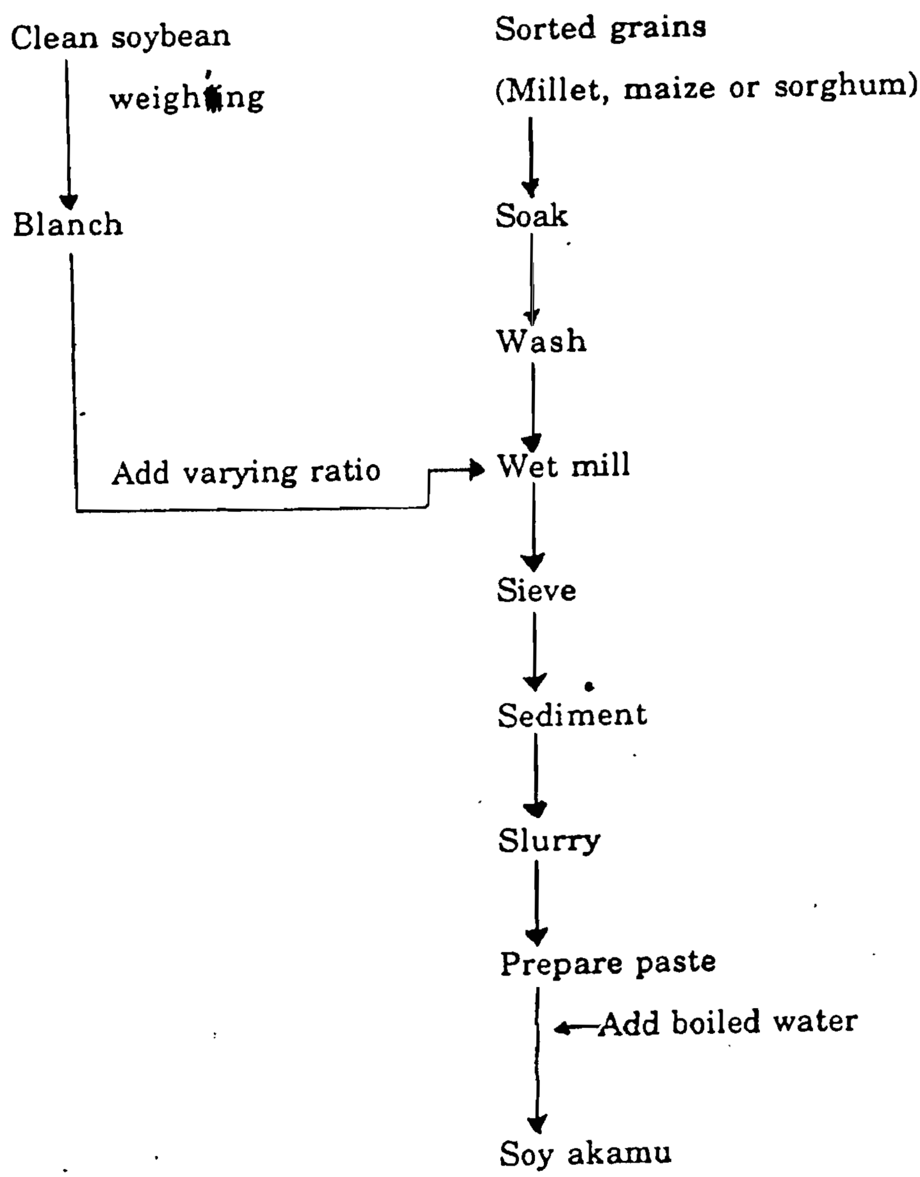


Table3.27 Proximate composition of the cereals, local and soy fortified weaning foods

Product	Moisture %	Protein %	K* %	Ca* %	Mg* %	Fe* ppm	ppm* Mn	ppm* Zn	ppm* Cu	Fat* %	P %
AM	7.87	7.5	0.1	0.05	0.11	0.8	89	62	Trace	-	-
AG	6.17	5.7	0.1	0.83	0.16	0.6	109	40	Trace	-	-
AMM	7.00	5.1	0.1	0.05	0.14	0.9	84	58	Trace	-	-
AOB	50.26	0.9	0.02	Trace	0.01	0.9	184	2	26	2.7	0.090
AFC	46.50	0.8	0.01	Trace	Trace	676	188	102	20	2.2	0.07
AJC	47.8	0.8	0.02	0.03	0.02	476	196	70	28	1.0	0.10
DDC	50.50	17.5	0.04	0.02	0.01	34	176	36	36	12.0	0.26
LLC	51.65	16.6	0.04	Trace	0.01	584	176	12	20	13.0	0.24
OOB	49.95	10.2	0.03	Trace	Trace	608	180	Trace	14	8.3	0.20
DCM	45.30	18.0	0.04	0.13	0.015	248	194	146	24	9.0	0.23
BCD	50.15	14.5	0.03	0.11	0.003	34	180	74	26	13.6	0.19
OBL	50.50	11.0	0.03	Trace	0.003	345	180	22	24	6.0	0.115
BCM	51.00	18.4	0.04	0.090	0.008	Trace	172	46	24	6.3	0.280
ABC	50.05	15.4	0.03	0.11	0.002	Trace	192	44	28	6.6	0.185
BCC	53.25	19.3	0.03	0.10	0.004	616	194	30	16	8.00	0.240

Key

AM - 100% millet
AG - 100% sorghum
AMM - 100% maize
AOB - 100% processed millet

DDC (1:1) Soy - sorghum
LLC (2:3) Soy - sorghum
OOB (1:3) Soy - sorghum
AFC 100% processed maize
AJC 100% processed sorghum

DCM (1:1) Soy maize
BCD (2:3) Soy maize
OBL (1:3) Soy maize
BCM (1:1) Soy millet
ABC (1:3) Soy millet
BCC (2:3) Soy millet

Table 3.28 Sensory evaluation of soy millet weaning foods

Products	Quality attributes						
	Apperance	Color	Flavor	Odour	Taste	Consistency	Overall Acceptability
OBL	7^a	7^a	6^a	6^a	6^a	6^a	7^a
BCD	5^b	5^a	5^a	5^b	5^b	5^b	5^b
DCM	7^a	7^a	6^a	7^a	7^a	7^a	7^a
AOB	7^a	7^a	7^a	7^a	7^a	6^a	7^a
LSD (0.05)	1.04	NS	NS	1.4	1.3	1.14	1.21

OBL (1.3); BCD(2.3); DCM (1.1); and AOB as control; NS Nct significant

Table 3.29 Sensory evaluation of soy maize weaning foods

Products	Quality attributes						
	Apperance	Color	Flavor	Odour	Taste	Consistency	Overall Acceptability
ABC	7^a	7^a	7^a	7^a	8^a	7^a	8^a
BCC	7^a	7^a	7^a	7^a	8^a	7^a	7^b
BCM	7^a	8^a	7^a	7^a	8^a	7^a	8^a
AFC	8^a	8^a	6^a	6^a	7^a	6^a	7^b
LSD (0.05)	NS	NS	NS	NS	NS	NS	0.84

ABC (1.3); BCC(2.3); BCM (1.1); and AFC as control; NS Not significant

Table 3.30 Sensory evaluation of soy sorghum weaning foods

Products	Quality attributes						
	Apperance	Color	Flavor	Odour	Taste	Consistency	Overall Acceptability
OOB	7^{a}	7^{a}	7^{a}	6^{a}	6^{a}	6^{ab}	7^{a}
LLC	5^{b}	6^{b}	5^{c}	5^{a}	4^{b}	5^{b}	5^{b}
DDC	5^{b}	6^{b}	5^{c}	4^{a}	4^{b}	4^{bc}	5^{b}
AJC	8^{a}	7^{a}	6^{b}	6^{a}	6^{a}	7^{a}	5^{b}
LSD (0.05)	1.31	0.98	0.92	NS	1.22	1.55	1.37

OOB (1.3); LLC (1.1); DDC (1.1); AJC as control (100% sorghum); NS Not significant

Table 3.31 Sensory evaluation of Kunu and soy-fortified Kunu

Products	Quality attributes						
	Apperance	Color	Flavor	Odour	Taste	Consistency	Overall Acceptability
SAM	6^{a}	6^{b}	5^{b}	5^{b}	5^{b}	6^{a}	6^{a}
SBM	6^{a}	6^{b}	6^{b}	5^{b}	7^{b}	6^{a}	6^{ab}
SCM	6^{a}	7^{a}	6^{a}	6^{a}	7^{a}	7^{a}	7^{a}
SDM	6^{a}	7^{a}	6^{a}	6^{a}	6^{a}	6^{a}	7^{a}
SEM	6^{a}	6^{b}	5^{b}	5^{b}	5^{b}	6^{a}	6^{ab}
SAS	5^{a}	5^{c}	5^{b}	5^{b}	5^{b}	4^{b}	5^{b}
LSD (0.05)	NS	0.4	1.0	1.0	1.4	1.4	1.3

SAM - Laboratory Kunu (millet)
SBM - 4:1 millet soy milk kunu
SCM - 1:1 millet soy milk kunu
NS - Not significant
SDM - 4:1 millet-soybean kunu
SEM - 1:1 millet soybean kunu
SAS - Kunu from USP-school

* Values with the same letters are not significantly different at the 5% level of Duncan multiple range test

Figure 3.18 Processing of kunu zaki fortified with soybeans

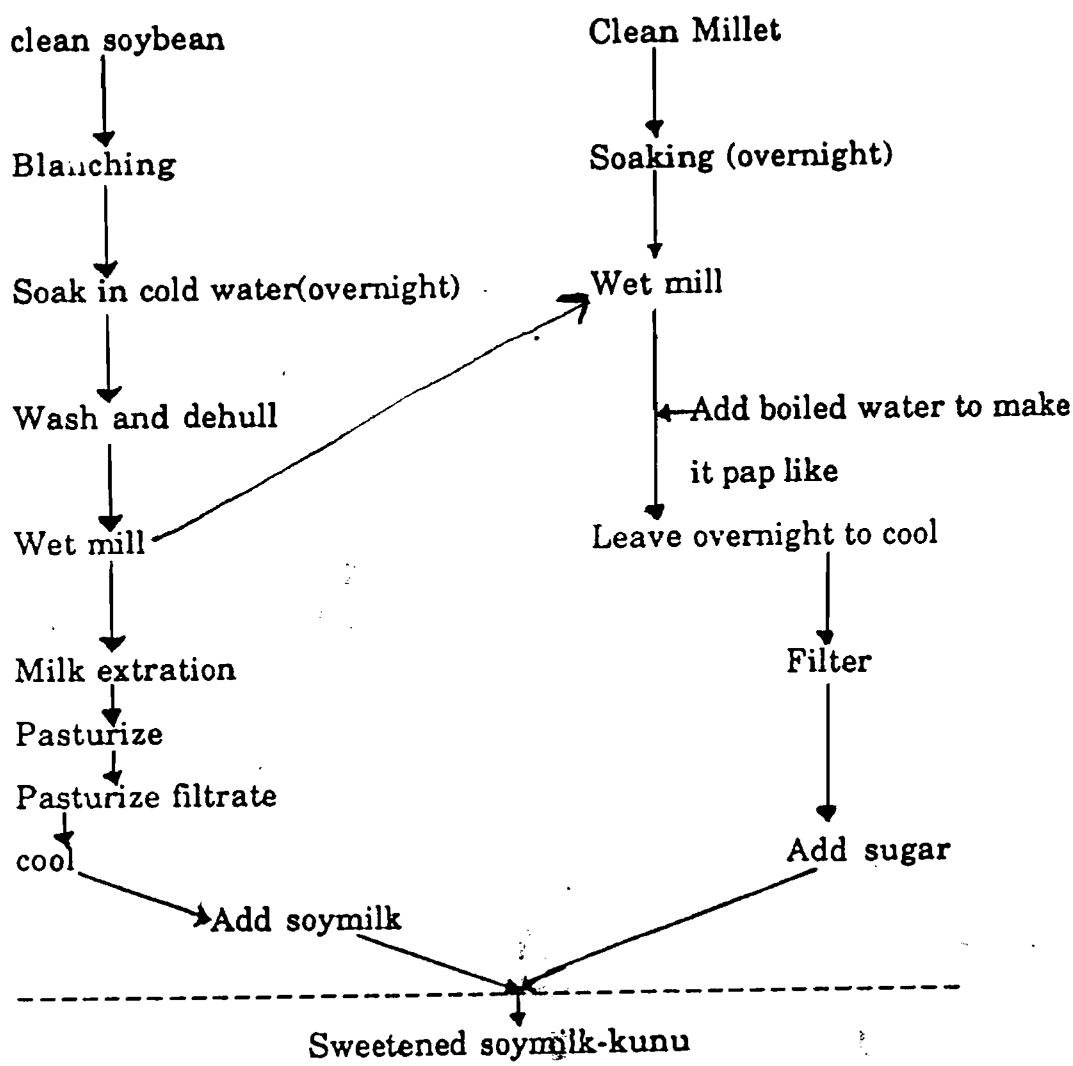


Figure 3.19 Preparation of soybean-kunu zaki

Clean Millet
↓
Soaking (overnight)
↓
Washing
↓ ←Add Kayaji
Wet mill ← (Blanched soybeans → Wash dehull & Decant)
↓ ←Add boiled water to make pap like (lightly viscous)
Leave overnight to cool
↓
Filter anbd collect filterate
↓ ←Add sugar
Sweetened soybean kunu

Figure 3.20 Preparation of fortified tuwo

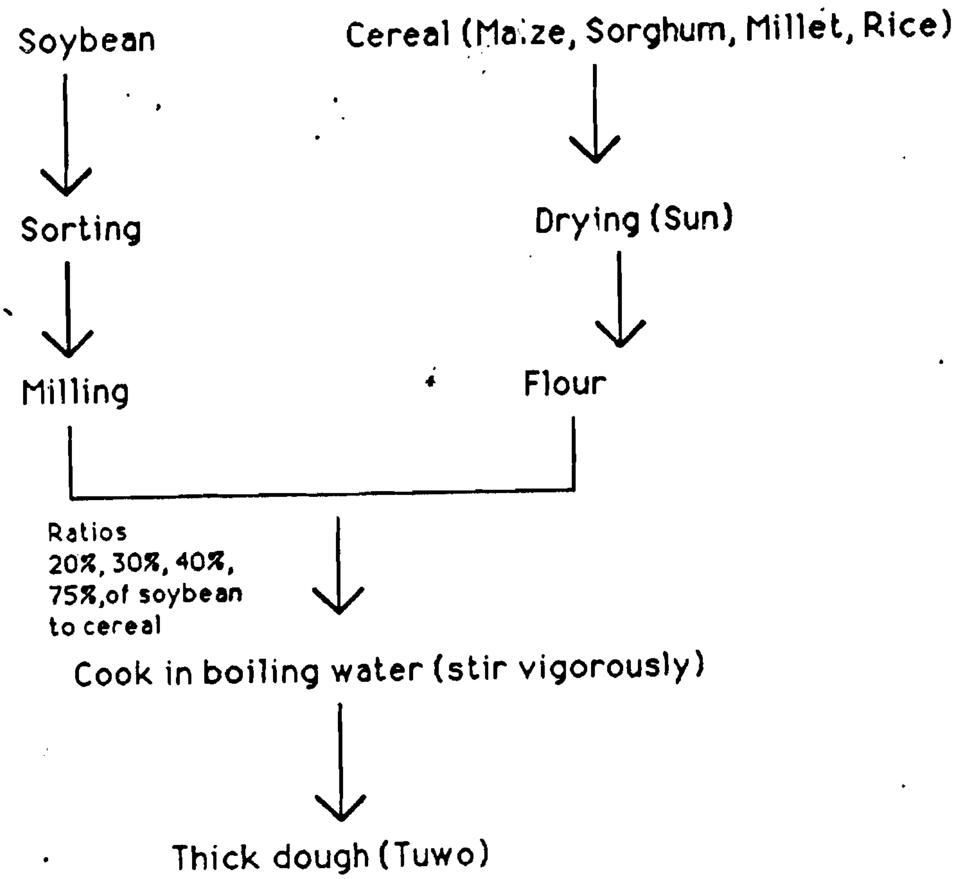


Table 3.32 Sensory evaluation scores of sorghum tuwo fortified with soybean at different percentage levels

Tuwo samples	Attributes				
	Color	Texture	Flavor	Odour	Overall Acceptability
(Control) whole sorghum	3.8^{a}	2.8^{b}	2.6^{c}	3.2^{b}	3.7^{a}
25% fortification	3.4^{a}	2.4^{a}	3.6^{a}	3.0^{a}	3.6^{a}
30% fortification	3.4^{a}	2.4^{a}	3.6^{a}	3.0^{a}	3.6^{a}
40% fortification	2.8^{b}	1.8^{c}	3.0^{b}	2.4^{c}	2.7^{b}
75% fortification	2.4^{c}	1.6^{c}	2.4^{c}	1.0^{d}	2.2^{c}

* Values in the same row with similar supercripts are not significantly different

Table 3.33 Chemical analysis of tuwo and soy fortified tuwo

	Moisture content %	Protein %	Fat %	Ash %	Carbohydrate %
Sorghum 100%	70.9	1.4	0.3	0.35	27.05
Sorghum + Soybean (ratio 3-1)	75.2	3.91	0.89	0.45	19.55
Rice 100%	77.4	1.2	0.2	0.09	21.11
Rice + Soybean(ratio 3-1)	71.8	3.33	0.8	0.45	23.62
Maize 100%	83.9	0.6	0.6	0.2	14.7
Maize + Soybean (ratio 3-1)	77.6	4.1	1.08	0.5	16.72
Millet 100%	81.1	0.25	0.4	0.2	18.05
Millet + Soybean (ratio 3-1)	73.5	4.82	1.4	0.5	19.78

* Result calculated on wet basis

12. <u>Enrichment of traditional foods in Enugu state: 'Okpa', plantain and "ora" soup</u>

Soybean because of its high protein content can be used to fortify less proteinous foods. For such fortification to be meaningful, such foods must be those commonly consumed in families in the areas where such fortification is envisaged.

Bambara groundnuts ("Okpa") though described as a minor legume is the most popular legume in Enugu State. The most common form in which it is consumed is as a pudding that is wrapped and steamed as moinmoin. This is popularly used as breakfast, lunch, dinner and snack foods. Bambara groundnuts are becoming very expensive because of their popularity and high demand by people of all socio-economic groups. Fortification of this food with soybean which has higher protein value and lower cost will reduce the cost of the pudding and increase its nutritional value.

Another major food crops in Enugu State is plantain. When in season, the plantains are not easily used up and many get over-ripen. This over-ripe plantains are either thrown away or made into plantain balls which supply very little protein and a lot of energy. Fortification of this food with soybean will improve the protein value which is very important since these balls are often eaten with pap. The soybean protein will complement the protein in the plantain.

Sauces or stews of all types are used for eating cassava fufu and "eba" in Enugu State. One of the most popular sources is "Ora" (vegetable stew) which is a vegetable used for making a sauce which is thickened with cocoyams and other thickners such as "ofo" and "achi". The socio-economic status of the family, (ability to afford meat, fish cray fish) determines the nutritional value of the sauce. Since the population of our target villages and parts of our urban town are very poor, it is not likely that they will be able to afford these extra sauce and ingredients in order to improve the nutritional value of their predominantly cassava fufu/alibo diets, therefore, the sauces can be enriched with soybean which is more easily affordable. This aspect of the project was therefore designed to enrich "Okpa: soup with soybean paste.

The product was subjected to sensory and chemical evaluation. The results are shown in Tables 3.36 and 3.37, and 3.38.

Table 3.34 Chemical composition of locust bean and soybean daddawa exposed to different cooking method

Samples	Mositure %	Fat %	Protein %	Ash %	Crude fibre %	Carbohydrate %	T.I* mg/g	Tanin mg/g
Locust bean	65.4	12.0	14.5	0.9	3.3	7.2	9.1	4.2
Roasted and dehulled samsoy 2	56.6	8.5	16.8	2.4	13.8	15.6	5.2	4.8
Soaked and dehulled samsoy 2	57.6	10.5	12.7	1.8	0.1	17.5	3.2	7.0
Whole grain samsoy 2	62.1	11.5	8.6	1.4	2.6	16.5	2.8	5.3

* T.I. - Trysin Inhibitor

Figure 3.21 Flow chart for processing of locust bean

Whole Locust Beans

↓

Pre-Cleaning (Wash in water)

↓

Cook (7 hours)

↓

Dehulling (remove with hands)

↓

Cooking (7 hours)

↓

Drain

↓

Fermentating (2-3 days) in a line basket with leaves

↓

airing (1 hr)

↓

Pounding (wooden mortar)

↓

Moulding (in flat shapes)

↓

Sun-Drying (2-3 days)

↓

Packaging.

Figure 3.22 Flow chart for roasting and dehulling soybean before cooking into daddawa

Whole Soyabean

↓

Pre Cleaning (in twice vol. of water)

↓

Roast (10-20 minutes low heat)

↓

Dehulling (cracking)

↓

Winnowing

↓

Soaking (6 hrs)

↓

Rinsing in water

↓

Cooking (3-4 hrs)

↓

Fermentation (2-3 days)

↓

Airing

↓

Pounding

↓

Moulding

↓

Drying - (2-3 days)

↓

Packaging

13. *Nutritional and acceptability of soy fufu*

Fufu is a fermented cassava starch cake traditionally prepared from cassava, by peeling the tubers, washing, cutting into pieces and steeping in water to ferment for 3-4 days. The fermented mash is washed over a fine sieve to remove fibre, and the starchy extract is de-watered by pressing in a cotton bag to produce fufu (Fig. 3.23).

Nutritional value of cassava based products are known to be poor and as such are fortified with other food products rich in other nutrients especially protein. Soybean was used in the fortification of fufu in order to improve the nutritional values. The results of the chemical evaluation (Table 3.39) shows an increase in the protein and fat content when fufu was fortified with soybean. Fufu fortified with soybean at a ratio of 2:1 and 3:1 was most acceptable.

14. *Acceptability and nutrient content of milk substitute processed from two cultivars of cowpea and two cultivars of soybeans*

One of the most accepted soybean based food is in Nigeria soymilk or soybean beverage. Soybean milk can be extracted from soybean by soaking, grinding with water, filtering and then heating the extract.

Cowpea *(vigna unguiculata)* are widely grown in Nigeria. Cowpeas has been used to process food products like akara, (fried cowpea product) and moinmoin, (a steamed cowpea product) porridge, etc.

The proximate analysis of the beverages processed from cowpea and soybean are shown in Table 3.40. The protein content of the beverages varied from 3.9-4.2% and 4.0-4.7% respectively. The residual trypsin inhibitor was higher in the cowpea beverage having 2.3-4.2 mg/g than that of soybean beverage 0.84-0.86 mg/g. The sensory evaluation shows that soybean beverage was preferred to that of cowpea.

15. *The nutritive evaluation and the preparation of akara based food from soybean shaft*

Soybean consists of the seed coat, (hull), the cotyledon and the hypocotylv which is attached to the pad by means of the hillium. The hull is usually removed from the seed and referred to as shaft which is either thrown away or used as animal feed. The hulls have been found to have high protein content. The study was carried out to establish the use of soybean hulls (shaft) for human food in order to improve the nutrient content of some Nigerian foods.

Soybean hulls were dehulled using dry and wet method of dehulling. The ground seed hulls were added to cowpea paste at ratios of 3:1, (cowpea: soybean), 3:1 (soybean: cowpea) and 1:1. The samples were subjected to chemical analysis and sensory evaluation.

The proximate analysis as shown in Tables 3.41 and 3.42 revealed a protein content of 11.3% and 8.6% in seed coats obtained from dry and wet dehulling respectively. The result also shows that soybean hulls are a good based of crude-fibre having an average of 33.0% as opposed to 5.5% in the cotyledon. This shows that soybean hull could serve as a dietary fibre for human consumption when added to human foods in various ways. The level of anti-nutritional factors (T.I. and Tannin) were also low. Table 3.43 show the nutritional values of akara processed from cowpea and soybean shaft.

Table 3.35 Chemical analysis of weaning foods (soybean-cereal mixtures)

	Mositure content %	Fat %	Protein %	Ash %	Fibre %	Carbohydrate %	TI mg/g	Tanin mg/g
Maize ogi	58.3	1.3	2.3	0.9	8.8	37.2	0.2	0.02
Guinea corn (sorghum)	55.3	0.6	3.0	0.5	5.0	40.6	1.0	3.8
Soy maize	4.7	13.2	12.7	3.0	2.1	66.4	0.5	2.2
Ogi tom brown	4.5	13.6	12.8	2.7	2.2	66.4	0.3	2.3
Soy sorghum (Hatsi)	3.76	9.20	19.9	2.6	4.5	64.54	2.6	0.9
Pap tom brown	3.90	9.25	19.9	2.6	4.0	64.35	2.7	1.1
Whole roasted soybean	2.44	15.92	45.3	6.0	3.5	30.34	6.0	1.5
	2.53	15.70	45.1	6.1	3.2	30.57	8.0	1.2
Raw soyflour	6.63	18.50	44.17	5.4	5.9	25.30	17.0	1.8
	6.76	18.52	44.23	5.7	5.8	24.79	15.0	2.0

Table 3.36 Sensory evaluation scores of "Okpa" fortified with soybean

	*Ratios					
Okpa	Soybean	Colour	Texture		Flavor	Overal acceptability
XVS	7 cups	1 cup	6.64 ± 1.8	7.58 ± 3^{a}	7.0 ± 1.3^{ab}	7.0 ± 2.1^{a}
TTV	Whole Okpa	6.64.±1.9	7.83 ± 1.0^{a}	7.83 ± 1.0^{a}	7.8 ± 0.9	$7.67^{a}\pm1.3^{a}$
ART	1 cup	1 cup	6.36 ± 1.7	5.5 ± 1.8^{b}	4.53 ± 1.8^{c}	3.25 ± 1.8^{c}
EYO	3 cups	1 cup	6.45 ± 1.7	5.75 ± 2.2^{b}	6.4 ± 1.7^{abc}	5.5 ± 1.8^{b}
DON	3 cups	2 cups	6.8 ± 1.9	5.75 ± 2.3^{b}	6.53 ± 1.7^{abc}	5.5 ± 2.0^{b}

a-c values in the same column with similar superscripts are not significantly different

* Ratio of Okpa flour to soybean paste

Panel of 110 people

Table 3.37 Proximate composition of Okpa fortified with soybean

Codes	Okpa	Soybean	Mositure %	Fat %	Protein %	Ash %	Carbohydrate %	Tanin mg/g
TTV	Whole	-	56.38	21.4	4.4	4.6	69.4	0.42
XVS	7 cups	1 cup	45.0	29.96	15.6	4.4	50.04	0.42
ART	1 cup	1 cup	54.4	18.9	25.9	5.0	50.20	4.33
EYO	3 cups	1 cup	66.5	0.94	16.0	2.4	80.60	1.19
DON	3 cups	2 cups	58.6	18.6	18.8	4.8	57.80	2.39

Table 3.38 Organoleptic evaluation of "Okpa" soups prepared with soybean and other thickeners

Product	Color	Texture	Flavour	Overall Acceptability
SDA (0 + thickner & 2 cups soybean)	7.17±1.1	7.0±1.5	7.5±1.2	7.06±1.8
ACE (0 + 6 spoons of "ukpo")	7.11±1.6	7.4±1.3	6.39±1.9	6.61±1.8
ADE (0 + 9 tablespoons of achi)	7.44±1.9	7.4±1.1	7.5±1.4	7.28±1.7
SAC (0 + 2 cups soybean)	6.50±1.2	6.22±1.3	6.44±1.3	6.72±1.8
CUD (0 + cocoyam)	6.44±1.5	6.33±1.6	6.11±1.1	6.72±1.6

* O - Ora.

Table 3.39 Nutrients composition of fortified soyfufu and traditional fufu

	1.1A	1.1B	2.1A	2.1B	3.1A	3.1B	100% Cassva fufu
Protein %	5.53	5.33	3.95	4.58	3.47	3.78	0.45
Fat %	1.33	1.42	1.06	1.20	0.53	0.78	0.13
Moisture %	57.80	56.75	57.00	57.60	57.30	56.30	52.96
Carbohydrate %	34.50	35.70	37.39	35.97	38.12	38.64	45.04
Total solids %	42.20	43.25	43.00	42.20	42.07	43.70	47.04
Ash %	0.75	0.8	0.6	0.65	0.58	0.5	1.42
T.I mg/g	0.26	0.96	1.30	1.56	2.04	2.26	0.52

Key

1.1. A - 50% : 50% cassava and soybean slurry.
1.1. B - 50% : 50% cassava and soybean slurry from soybean flour
2.1. A - 66.6% : 33.4% cassava and soybean slurry
2.1. B - 66.6% : 33.4% cassava and soybean slurry from soybean flour
3.1. A - 75% : 25% cassava and soybean slurry
3.1. B - 75% : 25% cassava and soybean slurry from soybean flour
Control - 100% cassava
LSD - Least significant difference

Table 3.40 Chemical analysis of cowpea milk and soybean milk

	Cowpea				Soybean	
	87B-661		87D-55-6		TGx 1660-19F	TGx 536-02D
	Method A	Method B	Method A	Method B	Method C	Method C
Moisture %	91.4	91.4	90.3	90.3	91.8	89.6
Protein %	4.2	3.9	3.6	3.4	4.07	4.0
Fat %	1.54	1.42	1.65	1.50	2.32	2.9
Ash %	0.17	0.18	0.23	0.19	0.41	0.5
Total solids %	8.6	8.6	9.8	9.7	8.2	10.4
CHO %	2.69	3.1	4.02	4.61	1.4	3.0
T.I mg/g	2.30	3.0	3.73	4.20	0.86	0.84
Magnesium (mg) %	0.17	0.14	0.19	0.15	0.43	0.47
Iron (mg)	0.42	0.008	0.26	0.12	0.20	1.2
Copper (mg)	0.03	0.02	0.38	0.23	0.22	0.25
Zinc (mg)	0.44	0.34	0.42	0.38	0.56	0.59
Manganese (mg)	0.16	0.12	0.056	0.029	0.72	0.7751
Yield 200g/ 600ml water	670ml	670ml	660ml	660ml	655ml	650ml
Description of beans	shape white seeded		Red smooth seeded		Cream seeded	

The sensory evaluation result of the product is shown in table 3.44. The product with 3 parts of cowpea to 1 part of soybean shaft was not significantly different from the conventional product.

16. Formulation, evaluation and optimization of tortilla containing soybean flour

Tortilla is a maize based products that is prepared by cooking corn in an alkaline condition like calcium hydroxide. The protein content of the maize tortilla is low and the acceptability of the product have been tested among Nigerian populace. The study evaluated the soybean fortified tortilla and unfortified tortilla.

Maize was fortified with 15% of soybean in the preparation of tortilla and was subjected to chemical and sensory evaluation. The method of soy tortilla preparation is as shown in Fig. 3.24.

The result in table 3.45 shows that the protein content of tortilla fortified with soybean range between 13.8 and 15.8% while the unfortified tortilla had 10.5%. The product with whole soybean had the highest fat content of 4.4%. The soy flour tortilla had the highest T.I. and Tannins.

The organoleptic assessment of the products showed that soy flour tortilla was unacceptable while the whole soybean tortilla compared favourably well with the control. It was concluded that the fortification of maize with 15% whole soybean in the preparation of tortilla would improve the nutritional value of the product without any significant alteration to its sensory qualities.

Figure 3.23 Flow charts of soy fufu production

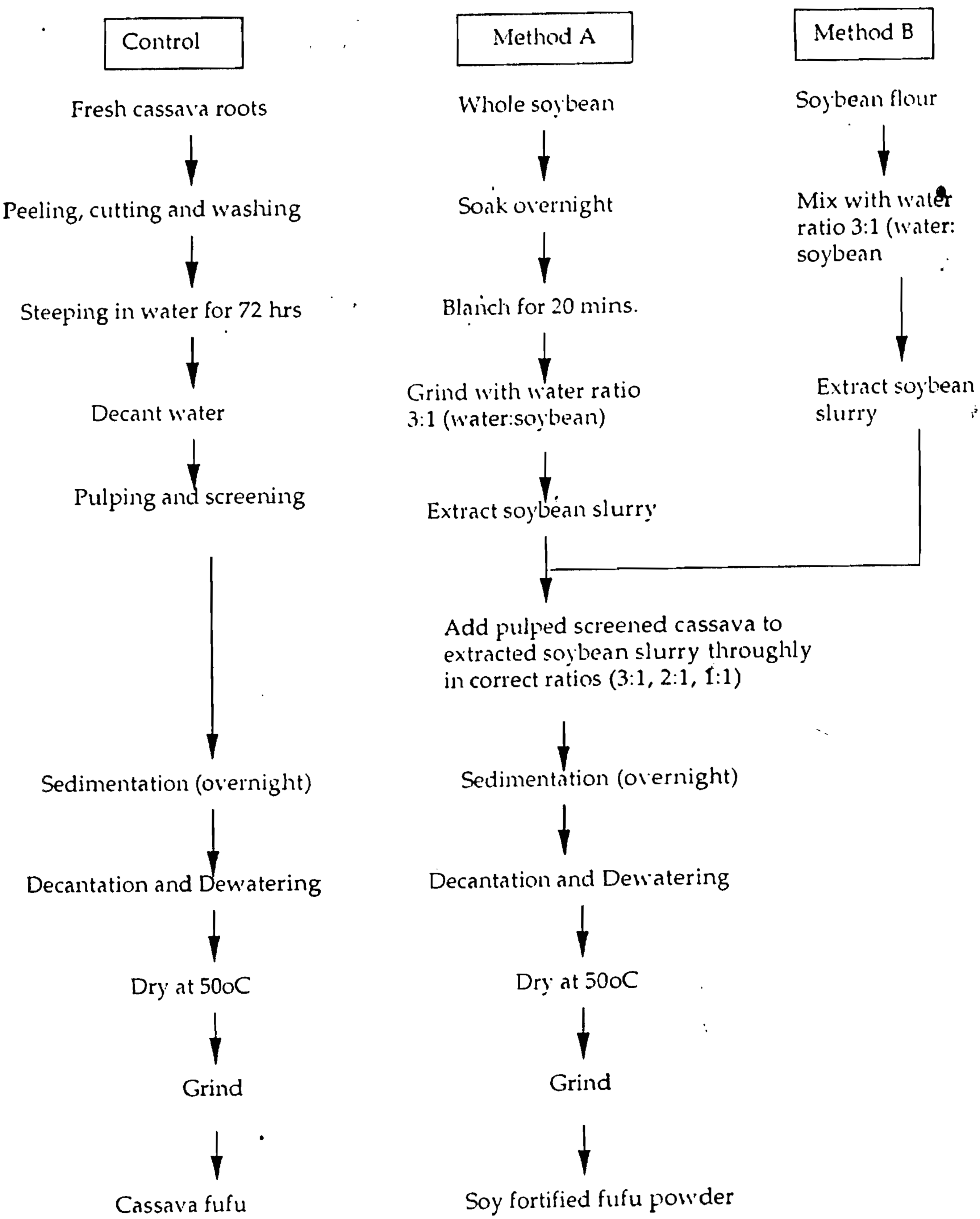


Table 3.41 Chemical composition of shaft obtained by dry dehulling method

Nutrient composition	Soybean shaft	Soybean without seed coat (cotyledons)
% Moisture	8.4	7.5%
% Protein	11.3	31.2%
% Fat	1.8	15.1%
% Ash	5.0	3.2%
% Crude fibre	33.3	5.6%
% Carbohydrate	73.5	43.0%
Tannin mg/g	0.1	0.4
Trypsin mg/g	2.3	11.3

Table 3.42 Chemical composition of shaft obtained by the wet dehulling method

Nutrient composition	Soybean shaft (Hull)	Soybean without seed coat (cotyledons)
% Moisture	9.0	7.6
% Protein	8.6	32.2
% Fat	1.7	14.7
% Ash	4.8	3.1
% Crude fibre	33.5	5.4
% Carbohydrate	75.9	42.4
Tannin mg/g	0.1	0.4
Trypsin mg/g	2.6	11.5

17. <u>*Chemical and organoleptic evaluation of soymilk from different processors in Ibadan*</u>

In Nigeria, soymilk have been fully accepted, adopted and marketed. Processors process and package their products in different ways and this have been found to have a great effect on the end quality of the product, especially the taste and nutritional quality.

About six soybean milk processors were identified in Ibadan. Their products were collected and compared with IAR&T soybean milk. The milk samples were subjected to sensory and chemical analysis.

Table 3.46 shows the sensory evaluation scores from the seven processors, while table 3.47 shows the result of the proximate analysis. As seen in table 3.46, some of the marketed soybean milk compared favourably well in overall acceptability with the control which was processed using the standard method for soybean milk processing. The proximate analysis result (table 3.47) indicated that there were differences in the nutritional qualities of the milk samples. The total solid ranges from 8.23% to 10.6% with a protein values varying from 3.01% to 5.99%. The pH of the samples reduced as the number of days of storage increases.

18. <u>*Effect of storage on the preservation of fermented soybean and locust bean*</u>

Fermented locust bean which is referred to locally as iru has been a soup condiment for a long period of time. Locust bean *Parkia Hlicoidea Welw)* is rich in fat, protein and lysine. The use of this fermented food product is gaining wide acceptability in the country thus making the raw material (locust bean) to be scarce.

A flow diagram of Iru preparation from both locust bean and soybean is shown in figure 3 .25. The product was subjected to sensory evaluation and the pH was monitored during storage.

The result of the pH of products stored under room temperature and in the refrigerator are shown in table 3.48 and 3.49.

Although the products were all acceptable, the fresh locust bean Iru was more acceptable, there was no significant difference in the acceptability of the processed Iru except for fresh Iru.

19. <u>*Effect of addition of soybeans on the shelf-life of kunu zaki*</u>

Kunu is a local non-alcoholic beverage widely consumed in the middle Belt and other parts of Northern Nigeria. It can be prepared from any of the cereals, (maize, millet or sorghum) flavoured with Kayaji (a combination of local spices), and sweetened to taste (Ibanga, et al 1991). Since the basic ingredients of kunu zaki are of low protein content, whole soybean were used to improve its nutritional quality.

kunu zaki and sov-kunu zaki were prepared according to method of Ibanga et al (1991) as shown in Figure 3.26.

Chemical analysis as well as the Titratable acidity (TA), Free Fatty Acids (FFA) and PH of the samples were determined and results shown in tables 3.50-3.53. The samples were tested organoleptically everyday.

The result protein content of the samples increased with storage, while there were no apparent changes in fat content. P^H and TA of the samples at ambient temperature changed significantly during storage, while FFA did not significantly increase. The samples spoiled within two days at ambient temperature while those in the refrigerator lasted for more than 14 days.

20. <u>*Development of local soybean-based food (Waina, Paten masara, Paten acha, Talia)*</u>

During the baseline survey, several local recipes were collected for soybean fortification in order to improve the nutritional value of the end products. Most of the staple foods of the selected project sites in Kaduna state are cereals.

Waina is prepared from rice or maize. Paten is porridge from masara (maize) or acha while Talia is a local recipe inform of spaghetti.

The products were subjected to sensory and chemical evaluation.

The results obtained on analysis demonstrated the importance of fortifying our recipes using soybeans, comparing the control to fortified samples which has higher protein content. Organoleptically, the fortified and unfortified samples were acceptable to consumers.

21. <u>*Development of soy dakuwa*</u>

Dakuwa is a snack taken in-between meals for ceremonial occasions by most households in Northern Nigeria. Dakuwa recipe was obtained from the rural women in Kaya and Kaduna. The traditional method of preparing the snack was followed strictly, soybean was added to the product during processing to improve the nutritional content of the snack. The method used in processing dakuwa is shown in Figure 3.29.

Table 3.54 compares the sensory scores of unfortified and fortified dakuwa while table 3.55 shows the chemical analysis of fortified dakuwa.

Table 3.43 Chemical composition of akara made from cowpea and soy shaft blends

Nutrient composition	Conventional Akara 100%	Soy-shaft-Akara (1:3)	Soy-shaft-Akara (1:1)	Soy-shaft-Akara (3:1)
% Moisture	53.3	55.5	62.2	63.7
% Protein	4.2	4.1	3.1	1.9
% Fat	17.8	19.1	18.0	28.0
% Ash	0.9	1.1	0.8	0.7
% Carbohydrate	23.8	20.2	15.9	5.7
Mg/g Tannin	0.8	1.2	1.8	1.9
Mg/g Trypsin	0.3	1.6	3.4	4.4

Table 3.44 Sensory evaluation of akara made from cowpea and soy-shaft blends

Parameter	A	B	C	D	LSD
Appearance	7.5a	7.5a	6.6a	5.0b	0.90
Flavor	8.2a	7.4ab	6.8b	4.6c	0.78
Mouthfeel	7.2a	7.5a	6.2b	4.3c	0.94
Taste	7.4a	7.5a	4.5b	3.4c	0.93
Overall acceptability	8.1a	7.6a	6.4b	4.6c	0.86

NB:- Figures not followed by the same alphabet are different at 5% level of significance
A - Conventional akara (100% cowpea)
B - Soy-shaft-akara (1:3)
C - Soy-shaft-akara (1:1)
D - Soy-shaft-akara (3:1)

Table 3.45 Chemical composition of soybean-fortified and unfortified tortilla

Sample	Mositure %	Protein %	Fat %	Ash %	Crude Fibre %	Carbohydrate %	Tanin	TI mg/g
Tortilla plain	44.9	10.3	3.1	1.6	2.2	40.1	0.21	3.18
Tortilla salted	44.9	10.4	3.1	1.5	2.0	40.4	0.26	3.0
Tortilla sugared	42.2	10.5	3.1	1.3	2.0	42.7	0.28	3.0
Whole soybean Tortilla plain	36.3	14.6	4.4	3.8	5.4	40.9	0.30	3.21
Whole soybean Tortilla salted	39.5	14.7	3.9	3.7	5.2	38.2	0.35	3.04
Soy four Tortilla sugared	37.1	13.8	4.4	3.9	5.2	40.8	0.35	3.04
Whole Soybean Tortilla Plain	40.8	15.8	2.9	1.8	2.1	38.7	0.37	7.13
Soyflour tortilla Sugar	38.2	14.7	3.3	2.0	2.4	41.8	0.53	6.48
Soyflour tortilla Salted	38.0	15.6	3.5	3.5	2.5	39.4	0.41	6.53

Ratio 85% to 15%
Maize - 85%
Soybean - 15%

Figure 3.24 Flow chart of the alkaline cooking process of soy fortified tortilla (using whole soybean seed)

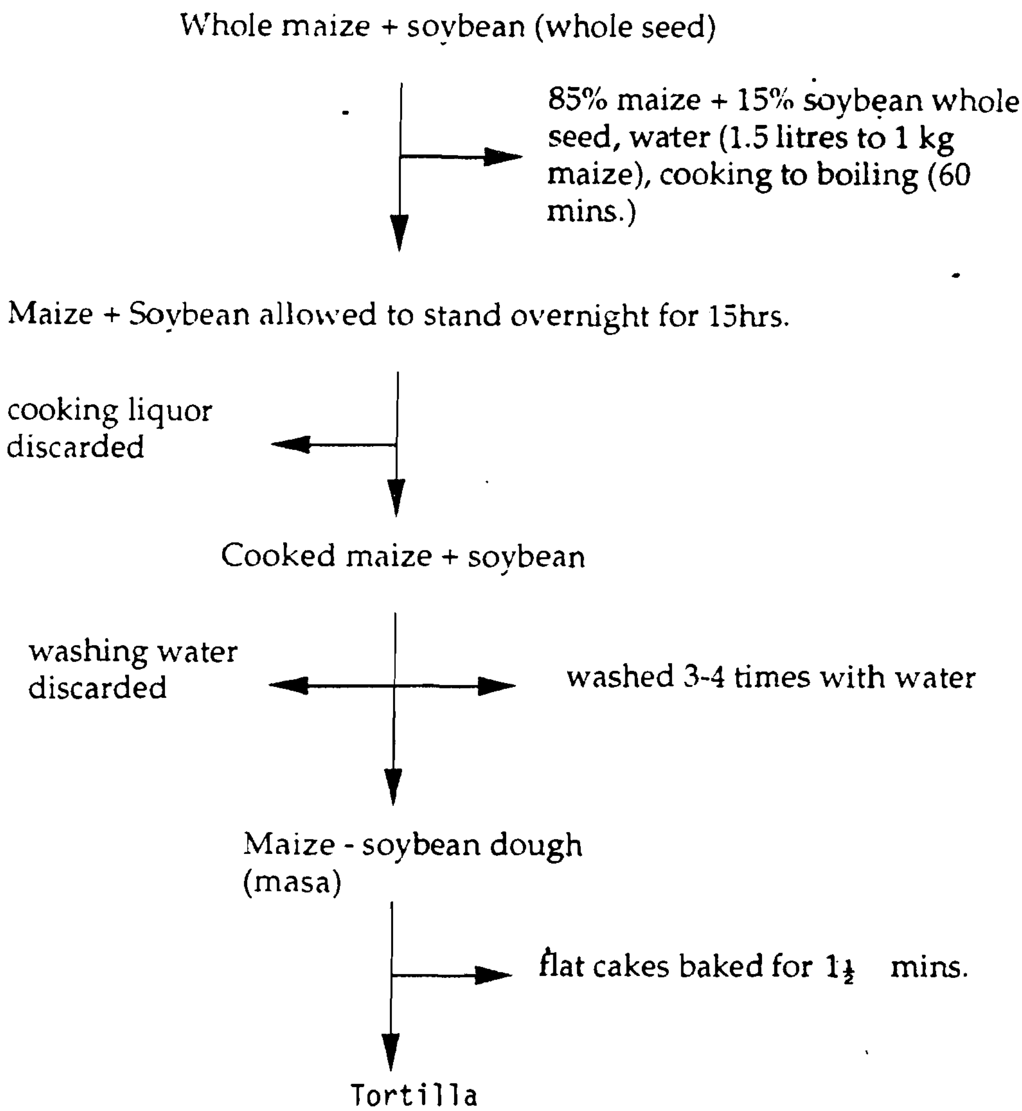


Table 3.46 Sensory evaluation of soymilk from six soymilk processors

Sources	Colour	Flavour	Taste	Mouthfeel	Overall acceptability
Standard method	6.22	5.50a	5.78a	5.58a	6.06a
Challenge	5.72	5.46a	5.72a	5.30ab	5.70a
Apata	5.14	3.56c	4.88b	4.74b	4.90
Odo Ona	4.28a	4.14b	4.30c	4.04c	4.34b
Iwo road	4.00a	6.14	5.28ab	5.12ab	5.76a
Fatimo	3.84ab	3.66bc	3.76c	3.82c	4.00b
Adeoyo	3.46b	2.92	2.32	2.50	3.02

* Values in the same column with the same letter are not significantly different at the 5% level of Ducnan Multiple Range Test

22. The fortification of yam based foods with soybean

White yam and soybean flour or paste were used to develop new recipes. Soybean flour or paste was also used to fortify staple foods eaten in many parts of the country, particularly, Enugu state. The method of preparing each developed recipe is shown in the project third year technical report. Appropriate statistical methods were used to evaluate the relationship between the new recipes and related standard recipe and also the fortified foods. Recipes developed included soy yam flour, soy scones, soy biscuits, soy yam, ring cakes and the traditional foods fortified were "amala", pounded yam, yam pottage. The experiments identified the level of fortification as well as the recipes that were either organoleptically accepted as the control standard recipe or better accepted.

In all cases, fortification substantially improved the protein value at organoleptically accepted levels. The most significant finding was that of fortification of pounded yam with soybean paste resulted in a product that remain resilient even after hours of storage. It was concluded that soybean/yam dishes can help alleviate the problem of protein-energy malnutrition since yam is a very popular food in all parts of the country.

23. Technologies for the processing of soybean seeds into flours, paste, high fibre residue and soymilk

Soybean seeds can be processed into flour using different methods depending on the end-use of the flours. Techniques used in processing may involve some of the following: clearing, decortication, soaking, steaming, wet milling and/or dry milling, drying and toasting. Products obtained from these methods include raw steamed and dried, toasted or untoasted, decorticated or undecorticated (whole) soybean flours as shown in figures 3.30 and 3.31. Some food preparation, which will require further heat treatments especially cooking the soybean flour is used. The heat will destroy the antinutritional factors such as trypsin inhibitors and hemaglutinin. In the formulation of breakfast cereal, soybean is processed to reduce the flavour by soaking in either 1% aqueous citric acid or 0.5% aqueous sodium bicarbonate solutions which are discarded after soaking. The processed soybean is processed into flour, paste, milk and high fibre soybean mash after steaming and milling. For flours, the soybean is dried while the production of the soybean mash and paste does not involve drying. Steaming dried soybean flours and steamed soybean paste or mash may be mixed with steamed dried maize flour or steamed maize paste in the production of breakfast cereal in the ratio of 2:3.

Raw and pre-gelatinized cassava starch and soy flour and cassava pulp were processed and also used in the processing of breakfast cereals.

The proximate composition of different soybean flours is shown in table 3.56.

Table 3.47 Chemical composition of soymilk from six soymilk processors

Sources	Total solids %	Protein %	Fat %	Ash %	Phytic acid %	Tannin %	T.I mg/g
Standard method	10.02	4.56	1.42	5.00	1.1	0.9	NAD
Challenge	10.43	4.76	1.45	5.01	1.0	0.8	NAD
Apata	9.53	3.30	1.92	5.42	1.1	1.1	NAD
Odo Ona	9.82	3.39	1.24	5.44	1.3	1.0	NAD
Iwo Road	8.23	3.01	1.03	5.29	1.2	0.8	NAD
Fatimo	9.49	3.81	1.43	5.81	1.3	1.0	NAD
Adeoyo	10.69	5.99	1.09	5.09	1.3	1.0	NAD
Std Dev.							
CV %							

Table 3.48 Change in p^H during storage at room temperature

	DAYS							
	1	2	3	4	5	7	14	21
Locust bean:								
Fresh	7.3	6.8	6.3	5.5	4.5	5.8	8.4	10.1
Oven-dried	5.8	5.0	5.1	5.2	5.2	5.4	5.5	6.2
Sun-dried	5.7	5.2	5.4	5.0	5.2	5.4	5.5	6.4
Soybean:								
Fresh	7.1	6.5	6.1	5.2	5.6	5.4	7.4	10.4
Oven-dried	5.8	5.2	5.4	5.4	5.2	5.4	5.7	6.1
Sun-dried	5.7	5.0	5.2	5.2	5.7	5.6	5.7	6.2

Table 3.49 Change in p^H during storage in refrigerator

	DAYS							
	1	2	3	4	5	7	14	21
Locust bean:								
Fresh	7.3	5.6	5.5	5.6	5.4	5.4	5.4	5.4
Oven-dried	5.5	5.2	5.2	5.2	5.2	5.2	5.2	5.2
Sun-dried	5.6	5.6	5.6	5.6	5.4	5.4	5.6	5.4
Soybean:								
Fresh	7.3	5.2	5.4	5.4	5.4	5.4	4.2	4.0
Oven-dried	5.3	5.6	5.7	5.7	5.7	5.7	5.6	5.6
Sun-dried	5.7	5.6	5.4	5.4	5.4	5.6	5.4	5.6

Table 3.50 Sample SKA chemical changes in p^H, TA, FFA protein and fat contents in storage

Storage days	p^H	TA	FFA %	Protein %	Fat %	Remark
0	6.71	8.0	0.66	0.97	0.11	Fresh sample
1	3.87	10.60	1.20	-	-	-
2	3.87	12.55	1.35	1.66	0.11	Onset of spoilage
5	3.55	12.70	1.43	1.66	0.11	Complete spoilage

Table 3.51 Sample KA: chemical changes in P^H, TTA, FFA protein and fat contents in storage

Storage days	P^H	TTA	FFA	Protein %	Fat %	Remark
0	6.89	5.60	0.60	0.27	0.05	Fresh sample
1	3.87	8.10				
2	3.87	8.30	1.11	0.33	0.05	Onset of spoilage
5	3.61	8.60	1.27	0.33	0.05	Complete spoilage

Table 3.52 Sample SKF: Chemical changes in P^H, TTA, FFA protein and fat contents in storage

Storage days	P^H	TTA	FFA	Protein %	Fat %	Remark
0	6.71	8.00	0.66	0.97	0.11	Fresh sample
1	6.71	8.00	0.68			
2	6.71	8.00	0.70	1.66	0.11	
5	6.54	8.07	0.71	1.66	0.11	

Table 3.53 Sample KF: Chemical changes in P^H, TTA, FFA protein and fat contents in storage

Storage days	P^H	TTA	FFA	Protein %	Fat %	Remark
0	6.89	5.60	0.60	0.27	0.05	
1	6.88	5.60	0.68			
2	6.87	5.60	0.68	0.33	0.05	
5	6.80	6.30	0.68	0.33	0.05	

SkA - Soy kunu zaki under atmospheric condition; KA - unfortified kunu zaki under atomospheric condition; SKF - soy kunu zaki under refrigeration; KF - unfortified kunu zaki under refrigeration

Table 3.54 Sensory scores of fortified and unfortified dakuwa

Parameters	Unfortified	Fortified
Beany flavour	-	81
Colour	88	86
Taste	84	81
Smoothness	82	78
Mouthfeel	80	77
Sweetness	78	78
Overall acceptability	81	80

f = 10

Table 3.55 Nutrient content of analyzed dakuwa

A. Control	No result yet				
B. Soy-fortified	Moisture content %	Fat %	Protein %	Ash %	Carbohydrate %
1. Guinea corn Soy dakuwa	1.8	13.6	13.8	1.7	69.1
2. Maize soy dakuwa	2.1	19.6	16.5	2.1	60.1
3. Millet soy dakuwa	2.3	19.2	16.8	2.1	56.9

Table 3.56 Proximate composition of different soybean flours

Sample	Moisture (%)	Crude protein (%)	Crude fat (%)	Crude fibre (%)	Ash (%)	CHO
Whole soybean flour (raw)	10.24	39.65	20.1		4.8	
Undecorticated (whole soybean flour (steamed and dried)	7.69	42.70	17.48	4.55	3.77	
Decorticated soybean flour (steamed and dried)	7.71	44.45	22.34	3.50	2.23	

Figure 3.25 A flow chart of iru preparation from both locust beans and soybean

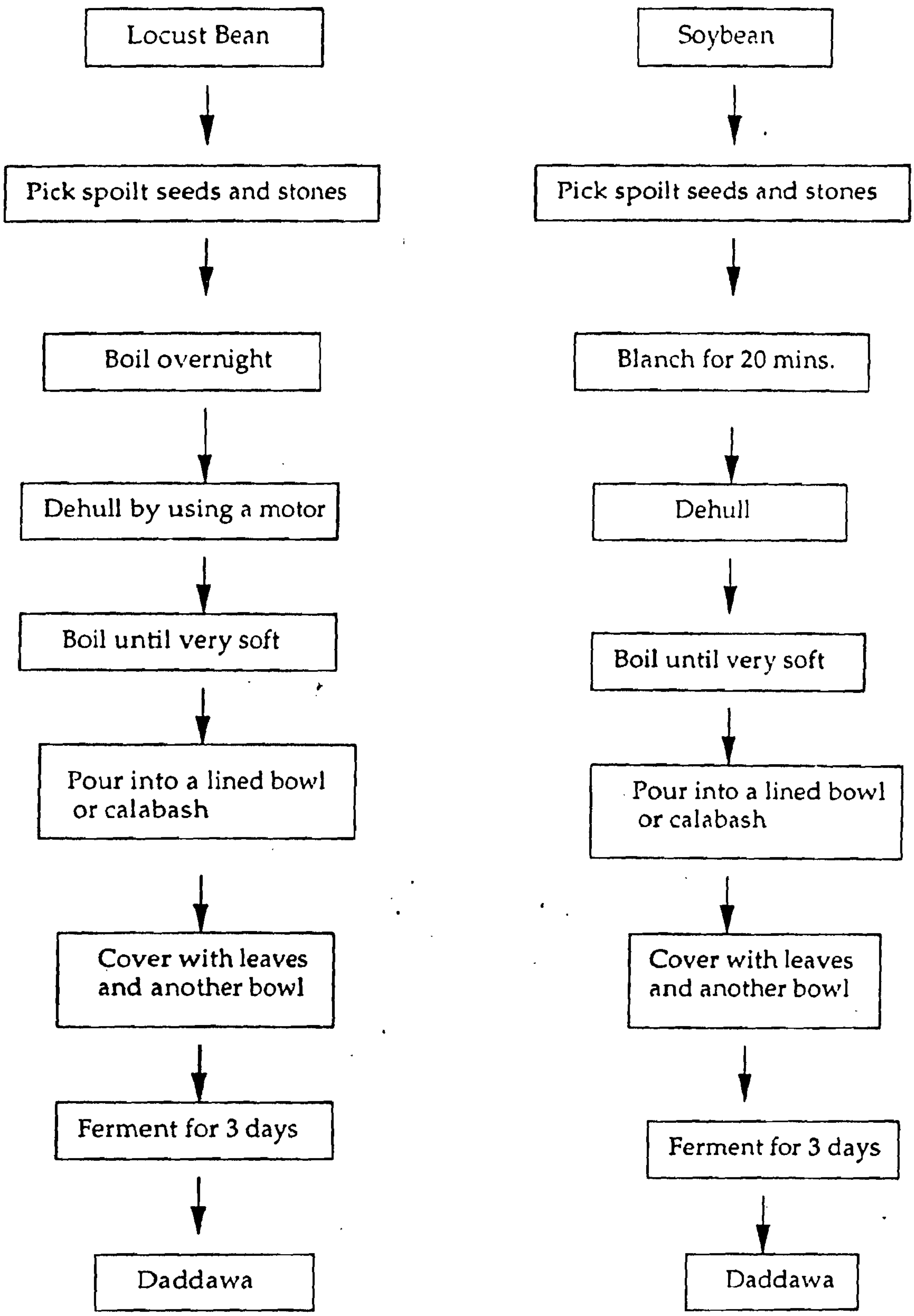


Figure 3.26 Flow chart of soy kunu zaki and kunu zaki production

Soybeans
↓
Sorting
↓
(about 30 mins) - Blanching
↓
Soaking
(Optional) - Dehulling & washing
↓
Kayaji
↓
Kayaji - Milling (ratio 1:1)
↓
Cooking (addition of hot water)
↓
Cooling
↓
Sieving
↓
Soy-Kunuzaki

Millet
↓
Soaking
↓
Washing
↓
Milling
↓
Cooking (addition of hot water)
↓
Cooling
↓
Sieving
↓
Kunuzaki

Figure 3.27 Flow chart for the processing of cereal and groundnut in preparing dakuwa

Cereal (any selected	Soybeans	Groundnut
↓	↓	↓
Clean	Clean	Clean
↓	↓	↓
Roast (light brown)	Roast (light brown)	Roast (light brown)
↓	↓	↓
Cool	Crack	Crack
↓	↓	↓
3 cups roasted cereal	Winnow (to remove husks) 1 cup roasted soybean	3 cups groundnut

↓

Combine the two together

↓

Mill, sieve

↓

Combine the two, add sugar, salt

↓

Pound in a motar until in binds well

↓

Mould and serve

SECTION 8

Nutritional studies

Nutritional status is the state of health of the individual as affected by the nutrients he consumes. Protein-energy malnutrition is a major problem in Nigeria especially among infants, pregnant and lactating women. The problem had become compounded by the present economic crunch in the country. Imported sources of proteins are no longer available and the inflationary trend in the country makes it impossible for many families to afford meat, fish or other animal protein sources. Vegetable proteins therefore becomes the best alternative. Amongst the plant proteins, soybean protein has been considered the best alternative to animal proteins because of its high level of protein and the amino acids composition. This has stimulated the interest in the use of soybean by the project for nutrition intervention in the project sites. The nutrition intervention also enable the project to monitor its impact within the project sites. Pictures 8 and 9 show some of the project beneficiaries.

A. Assessing the contribution of soybean utilization on the nutritional status of children from Idimu, Imota and Badagry in Lagos state

Before the project embarked on soybean promotion activities in Lagos state, a baseline data on the nutritional status of the people were established. The result of the survey showed that families eat a variety of foods but mainly starchy foods (cassava, yam, rice etc.) were used as their staple foods.

In Lagos state, soybean was hardly seen in the families' menu. The household surveyed in Badagry consumed more fish in their diet than those from Idimu and Imota who live mainly on green leafy vegetables apart from their starchy staple foods. Table 3.57 gave the number of households, sample size, age and sex distribution of surveyed children during the baseline data collection and after soybean introduction in the project sites within Lagos state. The result on the prevalence of mal-nutrition during the baseline nutritional survey showed that majority of the children sampled in Lagos state were moderately mal-nourished even though their height were within the acceptable percentage of standard. The results collected on weight and heights (Tables 3.58 and 3.59) of the children showed that only 2 of the children in all the selected area were within 90-99% of the standard weight for their age while majority were under 60% (Table 3.60). According to Waterlow (1973) PEM classification, measurements above 80% of standard are seldom associated with malnutrition, between 60 and 89% is described as mild or moderate PEM while below 60% indicate severe PEM. Therefore, majority of the children during the baseline data collection can be said to be mal-nourished.

Table 3.58 shows the sample size, age and sex after soybean was introduced into their diet while tables 3.61 and 3.62 shows the percentage distribution of surveyed children by weight for age and by height for age centile bracket after introduction of soybean in their diet. The survey revealed that the nutritional status of children from the project sites was improved with the introduction of soybean in their diet.

In conclusion, the introduction of soybean in the diet of the Idimu and Imota families has been effective in improving their nutritional status especially that of the children.

B. Nutritional status and contribution of soybean to nutrient intake of selected population in Enugu State

The food intake patterns, nutritional status and contribution of soybean to nutrient intakes of people of Okutu, Ozalla and Enugu in Enugu state using questionnaires, dietary survey and anthropometric measurements was done.

Soybean utilization in all three locations showed an increase throughout the life span of the project. However, the factor limiting the use of soybean in the rural area is the tedium involved in processing particularly milling. Soybean was utilized extensively for infant feeding. Nutrient and energy intake for all groups during the baseline survey was lower than the FAO/WHO/UN recommendations. Fig 3.30 shows the age at which various solid foods were introduced to the children. In Enugu soybean contributed 65% of protein intake of infants and 34% of that of pre-school children. In Okutu, the contribution was 16% for infants and in Ozalla, 6%. Apart from fortifying the weaning foods, the infants were fed with family food fortified with soybean.

When soybean intake was compared with the baseline data there was a substantial increase in the number of people being introduced to soybean foods especially for children. This was attributed to the promotional activities on soybean utilization. This activities came at a time when cost of commercially prepared weaning foods and infant milk formula was very high.

C. Comparison of the growth and development of selected children in Mungorota (a project site) and Ndakama (a non-project site) in Niger State

A study was carried out by the NCRI team to assess the impact of the soybean utilization project on the nutritional status of pre-school children. The study was carried out in Mungorota and Ndakama in Niger State. Dietary intake data and anthropometric measurements were collected from the selected children in both villages.

Result shows that the diets of the surveyed groups were predominantly composed of starchy foods with limited protein consumed occasionally during festivals.

Table 3.63 shows the comparison of the anthropometric measurement of selected children from the two villages. This result shows a better nutritional status for the children in Mungorota when compared with those in Ndakama. The clinical observations also revealed a greater nutritional disorder in selected children from Ndakama. The lower incidence of mal-nutrition among selected children in Mungorota was attributed to the soybean promotion activities and high level of soybean utilization adoption in the village. The mothers at Mungorota also show a great appreciation for the contribution of soybean products to their children's health and soybean milk had became a major weaning food in the village.

From the data collected from both villages, the IDRC soybean promotional activities has had some impact on the nutritional status of children in Niger state especially those within the project sites.

Table 3.57 Number of households, sample size, age and sex distribution with in sample size during baseline survey

	No. of sample	0-12	12-24		1-48		1-72		Total	
Project site	Households	Size	M	F	M	F	M	F	M	F
Idimu (1)	16	25	6	9	5	3	1	1	12	13
Imota (2)	5	20	4	5	3	3	2	3	9	11
Badagry (3)	5	10	1	2	3	1	1	2	5	5
Total	16	55	11	16	11	7	4	6	26	29

M - Male
F - Female

Table 3.58 Number of households, sample size and age and sex distribution of sample size, after introduction of soybean into their diet

Sites	No of house-holds	Sample size	12 - 24 M	12 - 24 F	24.1 - 48 M	24.1 - 48 F	48.1 - 72 M	48.1 - 72 F	Total M	Total F
Idimu	23	43	4	6	10	14	5	4	19	24
Imota	24	58	10	9	8	19	5	7	23	35
Badagry	13	22	1	4	7	8	2	-	10	12
Total	60	123	15	19	25	44	12	8	52	71

Table 3.59 Percentage distribution in relation to standard body weight for age during baseline survey

Age Months	Sample size	Standard or over	90-99%	80-89%	70-79%	60-69%	Under 60%
12 - 24	27	-	2	8	12	5	-
24.1 - 48	18	-	-	2	10	2	2
48.1 - 72	10	-	-	4	3	2	-
Total	55	-	2	14	25	12	2

Table 3.60 Percentage distribution in relation to standard length for age during baseline survey

Age Months	Sample size	Standard or over	90-99%	80-89%	70-79%	60-69%	Under 60%
12 - 24	24	-	10	52	5	-	-
24.1 - 48	18	-	3	10	5	-	-
48.1 - 72	10	-	-	6	2	-	-
Total	55	-	13	28	12	2	-

Picture 18:

Pictures of children seen in most Nigerian villages.

Picture 19: A project personnel explaining the importances of soybean to rural housewives.

Picture 20: A trainee demonstrating a step in soybean processing to the National Coordinator and project personnels.

Picture 21: A village demonstration scene.

Picture 22: Mothers given their children soymilk after a village demonstration.

Picture 23: Project personnels, hospital staff and mothers during a demonstration at the hospital.

Figure 3.28 Flow diagram for the processing of soybean seeds into raw full fat soybean flour

Raw soybean seeds

↓

Clean (by removing dust, pebbles, pod fragments etc)

↓

Decorticate (dehull) ⟶ discard hulls

↓

Mill (in attrition, hammer and other mills or grinding stone or mortar)

↓

Sieve and remill

↓

Raw soybean flour

Figure 3.29 Flow diagram for the processing of soybean seeds into full fat steamed dried soybean flour with reduced beany flavour

Raw soybean seeds

↓

Clean

↓

Wash in cold water

↓

Soak in 1% aqueous citric acid or 0.5%
sodium bicarbonate solution for 12 hours
changing solution every 3 hours

↓

Decorticate wet

↓

Wash 3 times with clean tap water and drain

↓

Wet-mill in attrition mill

↓

Soybean paste

↓

Steam for 30 minutes to 11/2 hours

↓

Dry at 55-60oC for 8 hours to a moisture

↓

Dry mill

↓

Steamed dried full fat soybean flour with beamy flavour

↓

Package

Table 3.61 Percentage distribution of surveyed children by weight for age centile bracket, after introduction of soybean

Centile brackets	3rd		5th		10th		20th		30th	
	M	F	M	F	M	F	M	F	M	F
				%						
Idimu	5.26 (1)*	20.83 (5)	47.37 (9)	41.67 (10)	31.58 (6)	29.17 (7)	10.53 (2)	8.33 (2)	5.26 (1)	-
Imota	17.39 (2)	14.28 (5)	47.83 (11)	22.86 (8)	30.43 (7)	45.71 (16)	4.35 (1)	11.43 (4)	-	5.71 (2)
Badagry	30 (5)	41.67 (5)	50 (5)	33.33 (4)	10 (1)	16.67 (2)	10 (1)	-	-	-
Total	8	15	25	22	14	35	4	6	1	2
Percentage	15.38	21.13	48.08	30.99	26.92	49.30	7.69	8.45	1.92	1.35

M - Male F - Female

* Figures in parenthesis are number of samples within the given sex of the respondent

D. The evaluation of nutritional status of selected groups in Kaya, Makera and Kurmin Masara of Kaduna state

A study was conducted in order to assess the contribution of soybeans to the diet of people from soybean utilization project sites in Kaduna state of Nigeria.

Food composition table was used in calculating the nutrient content of cooked food consumed by the surveyed groups. The contribution of soybean to their protein intakes was calculated as percent of protein for soybean in relation to total protein intake.

Results showing the nutritional status of all the age group when compared with NCHS (1976) was summarized in table 3.64. Using all indices, mal-nutrition was identified in all cases. Some adult male and females showed signs of moderate malnutrition while the male adult has the best nutritional status of all age groups. This can easily be accounted for by the cultural practice in the communities. Most adult females are in pudah while their male counterparts go out to eat suya, nono, etc. and the children receive the lowest food served at home.

In the three locations, soybeans was greatly utilized in infant feeding basically in fortification of pap and other weaning foods. About 68.7%, 63.2% and 72.1% respectively in Kaya Makera and Kurmin Masara utilizes soybeans in infant feeding respectively. Contribution of soybean to protein in infant is about 26.7%, while that of adult was about 13.8%.

Table 3.62 Percentage distribution of surveyed children by height for age centile bracket, after introduction soybean

Centile brackets	3rd		5th		10th		20th		30th	
	M	F	M	F	M	F	M	F	M	F
	%									
Idimu	-	57.89 (11)	58.33 (14)	41.67 (10)	42.10 (8)	29.17 (7)	-	4.17 (1)	-	-
Imota	13.04 (2)	8.57 (3)	34.78 (8)	48.57 (17)	26.09 (6)	25.71 (9)	21.74 (5)	17.14 (4)	8.70 (2)	-
Badagry	30.0 (3)	50.0 (6)	40.0 (4)	33.33 (4)	30.0 (3)	8.33 (1)	- (1)	8.33	-	-
Total	5	11	23	35	17	17	5	8	2	-
Percentage %	9.62	15.49	44.23	42.30	32.69	23.94	9.62	11.27	3.85	-

SECTION 9

Development of small/medium scale technologies from soybean

1. Development of various formulae for soybean ice-cream

Dairy ice-cream is a very popular dessert in Nigeria. Surveys conducted recently showed that the price of dairy conventional ice-cream is high because the imported milk solids used for its production is expensive. Current ice-cream standard permit solids other than milk to be used in the formulation of ice-cream but minimum of 2.7% protein must be obtained in the resultant product.

This study was designed to develop soy milk enriched ice-cream of which protein content will not be lower than the minimum standard. The materials used in the production of the different types of ice-cream and the schematic diagram of the processing is shown in figure 3.31.

The result of chemical analysis conducted of the ice-cream sample showed that the protein content was in the range of 3.20-4.01%. The fat content was in the between 26.68 and 34.29% in the soy milk based ice-cream while conventional ice-cream (100 dairy) had just 12.96%. The exceptional high fat level in these samples must have been caused by the added hydrolysed vegetable shortenings and soy milk. Total solids is another parameter that exhibited a close variation among the samples. Samples B had the highest of (39.29%) while sample D had the least (36.43%). Total solid determines the moisture content hence, the higher it is, the lower the consistency of the ice-cream.

The result of the percentage over-run analysis showed that sample E had the highest over-run of 54.5% followed by sample B which had 50.7% while sample D had the least (24.4%). Earlier reports claim that high fat content reduced the percentage over-run of ice-cream, this was not confirmed by in this experiment. There appeared to be no correlation between the fat level and percentage over-run of the sample.

Sensory appraisal of the products, table 3.65, showed that all the soy-fortified samples had similar flavour but different significantly from the conventional dairy ice-cream. Comparison of their colour revealed that sample A, C and D were similar while on over-all acceptability rating, samples A, B and D compete favourably with conventional dairy ice-cream.

2. *The utilization of soybean in the production of a beverage*

Research has led to development of various conventional foods. Among such foods are soybean beverages (Soy milk, Soy-ice-cream, Soy-yoghurt) soy iru etc.

Tea and coffee drinks are popular beverages world-wide.

The study was therefore conducted to determine the feasibility of processing a soybean beverage which is nutritious and acceptable. The protein content of the products ranged between 32.39 and 39.35%, fat was between 14.12 and 20.50%, moisture content also ranged between 3.55 and 5.60% while ash was between 3.61 and 4.99%.

The sensory evaluation results, showed that there was no significant differences between the formulas of beverage developed in terms of flavour, taste, mouthfeel and appearance, however, sample with 59% roasted soy flour, 40% sugar and 1% lecithin was the most preferred when consumed in liquid form.

3. *Prospect of substituting skimmed-milk powder (SMP) with soybean meal in the Industrial processing of chocolate in Nigeria*

Chocolate bar is a confectionery that is rich in fat, essential mineral and vitamin but low in protein. It is a popular confectionery of high repute in many Nigerian households and is especially liked by children. The price of chocolate bar is fairly high in Nigeria, since some of the raw material input such as skimmed milk powder are imported. In a recent survey, it was found that milk powder accounted for more that 50% of the cost of a standard milk chocolate bar excluding packaging.

In order to make chocolate still affordable to people, there is need to explore alternative means for the expensive component of the material input. Research into soybean in the last decade has shown that this crop ranks favourably to skimmed milk powder. Besides, it has a relatively high biological value.

This experiment was carried out in collaboration with Cocoa Industries Limited, Lagos, Nigeria which is a well know industry for various cocoa-based beverages and foods.

Figure 3.32 shows the schematic diagram of chocolate production and constituents and their proportions in the different chocolate formulation. Proximate analysis and sensory evaluation were conducted to assess nutritive value and acceptability.

The analysis of variance results for the sample show that at 5% significant level there was no significant differences in terms of flavour, colour, and taste when compared with the 100% chocolate. There was little significant differences in terms of mouthfeel and throatfeel but in terms of overall acceptability; 100% chocolate was preferred.

Defatted extruded soybean was preferred in the processing of to soy-chocolate in terms of flavour, colour, mouthfeel, throat-feel, taste, and overall acceptability.

Cocoa butter used in the manufacture of the chocolate, has a peculiar characteristic of not being compatible with other oil when added in the manufacture of chocolate. After a month when organoleptic assessment was conducted, the oil present in soybean has separated from that of cocoa butter and this brought out a significant differences in both the mouthfeel and throatfeel of the soy-chocolate samples.

The results of the chemical analysis in Table 3.66 showed a protein content of 15.60% for soy fortified chocolate in the defatted extruded form of soybean, and 12.20% protein for defatted soy chocolate. Fat increase in the soybean chocolate (32.2%)

Shelf life study, showed deterioration in quality of the chocolate after a month and the oil contents were able to separate. Also the soybean beany flavour was more pronounced when only defatted soybeans flour was used. In case of the chocolate that contain defatted extruded soybean, the beany flavour of soybean was not noticed.

4. *Characterization of crude and refined soybean oil and quality variation tendency to shelf-life*

Soybeans are typical legume seeds which have various food uses both at home and in the industry. The oil derived from the seed, otherwise called soybean oil is the predominant vegetable oil in the world. Its composition is similar to other vegetable oils such as sunflower and ground-nut. It is highly digestible, high in poly-unsaturated fatty acids and contains no cholesterol.

It has been established that the use of poly-unsaturated fats in the diets reduces the level of cholesterol in the blood and thus, the minimization of susceptibility to cardio-vascular diseases.

Currently, soybean oils are produced industrially by either screw-pressing or by solvent extraction. Screw-press method was used to extract crude oil which was then refined under laboratory conditions. Figure 3.33 showed the production and refining steps.

Physical, chemical and sensory assessment of the crude, partially and fully refined oil stored at refrigerated and ambient temperatures were carried out. The phycio-chemical properties of crude, partially and fully refined soybean oil are presented in table 3.67. The moisture content was highest (0.1%) in the crude and degummed oil samples while the fully-refined oil had the least (0.04%). This trend may be attributed to the drying to which the refined oil was subjected after deodouringing. The specific gravity of all the oil samples was constant (0.91). Showing the stability of the oils physical state.

Table 3.68 showed the percent changes in free fatty acid (FFA) of the crude, degummed, alkali-refined, bleached and deodorized oils over the storage period of 4 weeks. The samples FFA value exhibited an irregular variation. Throughout the storage period, FFA value for crude and partially refined oil ranged from 0.2 -0.8% while refined oil was in the range of 0.15 - 0.6%. The refined oil had the highest acid values in weeks 3 and 4 (0.55 and 0.60% respectively).

Table 3.69 showed the mean sensory evaluation scores of all the oil samples including a commercially obtained soybean oil - Golden Soya (Taraku). The bleached oil sample was most preferred by the panelists.

Figure 3.30 Age at which various solid foods were introduced

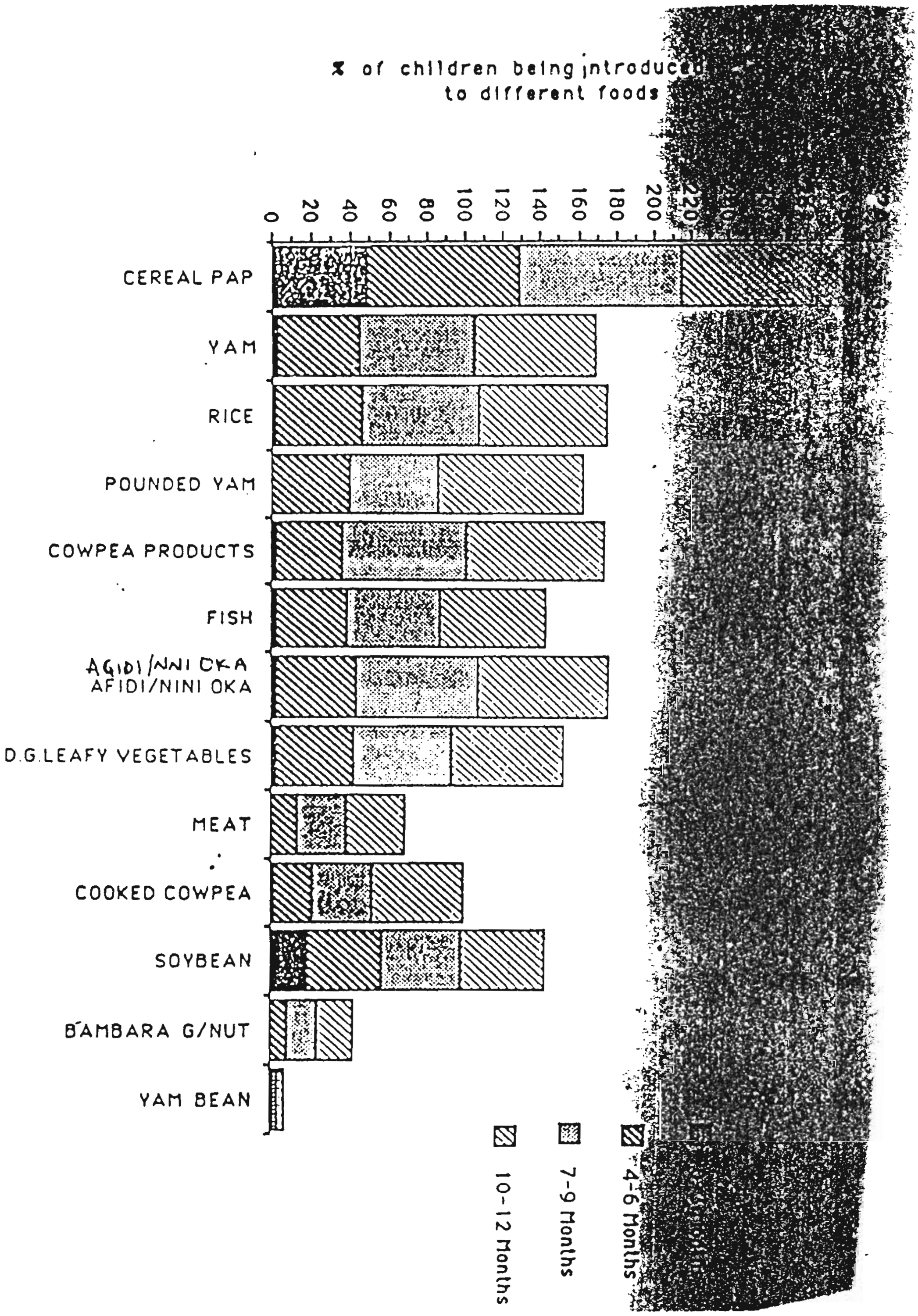


Table 3.63 Comparison of the anthropometric measurements of selected children in Mungorota and Ndakama villages of Niger state, Nigeria

Growth index	Growth chart centiles									
	Above 97th		80th - 97th		60th - 70th		40th - 50th		30th and below	
	Mung-orora	Ndak-ama	Mung-orora	Ndak-ama	Mung-orora	Ndak-ama	Mung-orora	Ndak-ama	Mung-orora	Ndak-ama
Weight for height	5(38.5%)	2(15.4%)	3(23%)	3(23%)	1(7.7%)	5(38.5%)	2(15.4%)	0%	2(15.4%)	3(23%)
Height for age	0	0	3(23%)	0	2(15.4%)	1(7.7%)	4(30.8%)	0%	4(30.8%)	12(92.3%)
Weight for age	0	0	8(61.5%)	0	0	1(7.7%)	2(15.4%)	2(15.4%)	3(23)	10(76.92%)

N.B. The 40th - 50th centile is the range at which growth is considered normal. Values recorded above and below this range indicate over and under-nourishment, respectively

Table 3.64 Nutritional status of respondent compared with NCHS (1975) and Metropolitan Life Insurance Tables (1975)

Parameter		Pre-school age (1 - 5 years)			School age (6 - 15 years)			Adult male*			Adult female*		
		1	2	3	1	2	3	1	2	3	1	2	3
Weight/ Height	Nutritional normal	27.5	22.6	24.6	34.6	24.4	21.7	46.2	50.7	47.9	37.1	42.5	44.9
	Mode rate Malnourished	66.7	68.2	53.9	54.7	55.2	54.6	50.0	42.5	46.7	55.4	44.8	38.0
	Severely Malnourished	5.8	8.2	16.5	10.7	20.4	23.7	3.8	6.8	5.4	7.5	12.7	16.1
Weight/ age	Nutritional normal	20.7	25.1	13.9	55.7	40.9	52.6						
	Mode rate Malnourished	67.4	61.3	62.7	35.1	45.5	38.7						
	Severely Malnourished	11.9	12.6	17.4	9.2	4.6	8.7						
Height/ age	Nutritional normal	17.7	26.2	18.2	27.4	32.7	24.9						
	Mode rate Malnourished	72.3	66.7	70.1	60.5	54.7	56.9						
	Severely Malnourished	10.0	7.1	10.7	12.1	12.6	18.2						

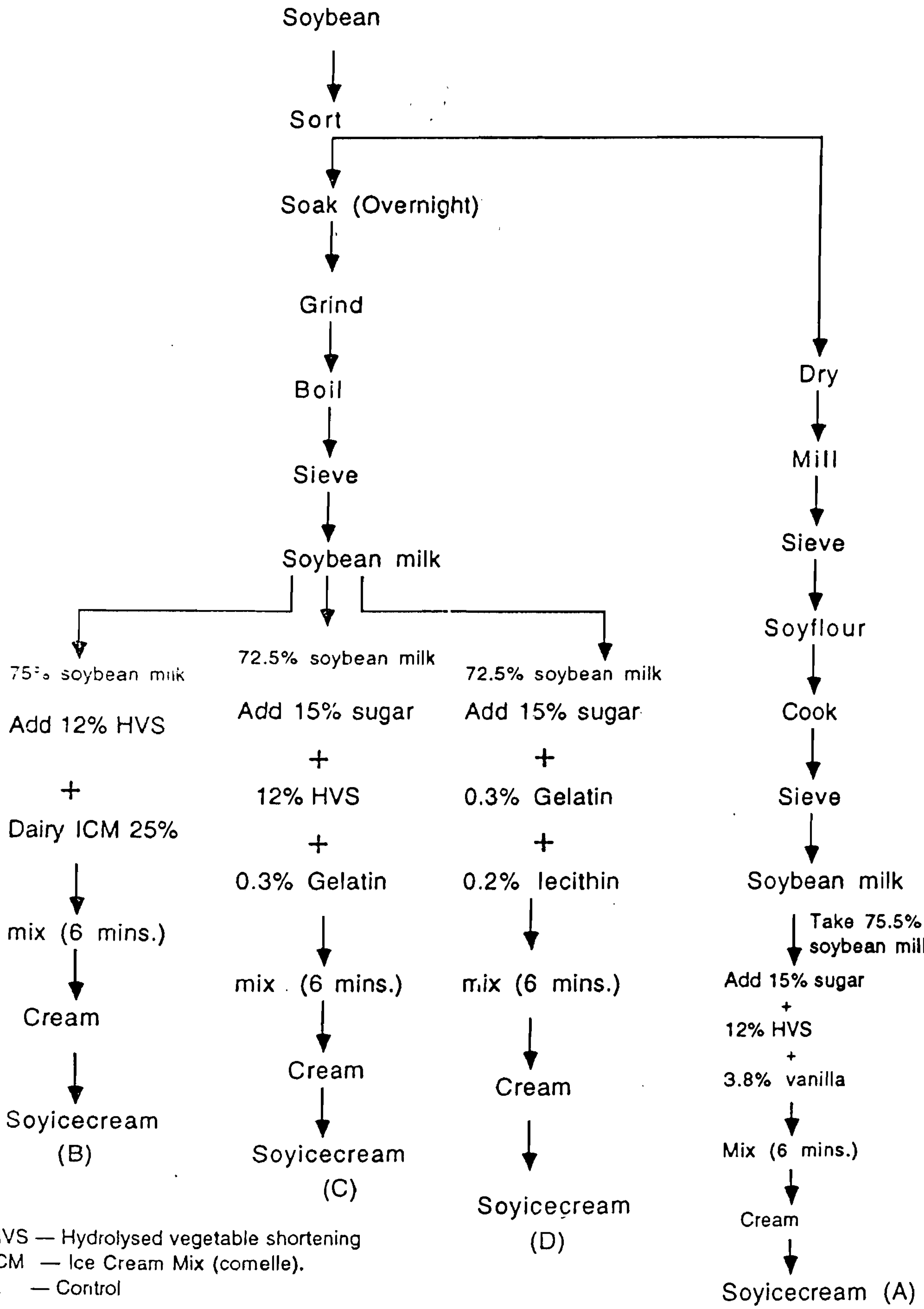
1 - Kay
2 - Makera
3 - Kurmin Masara
* Data for weight for age and height for age were not collected for adult because majority of the adult do not know their age.

Table 3.65 Sensory evaluation of soy ice-cream and the dairy cream

Attributes	A	B	C	D	E
Flavour	6.1000a	7.9000a	6.3000a	7.9000a	8.9000
Creaminess/mouthfeel	7.4000ab	7.6000ab	7.9000a	7.3000bc	8.8000c
Sweetness	7.6000a	7.6000a	7.7000a	7.6000a	7.6000a
Colour	7.9000b	7.000c	7.000c	6.8000a	6.1000b
Overall acceptability	7.3000b	7.5000b	7.2000a	7.6000ab	7.1000b

HVS - Hydrolyzed vegetable shortening
ICM - Ice cream mix (Comelle)
Samples A - Soyflour ice cream
B - 75% soymilk + 25% ice cream mix
C - soaking method without lecithin
D - soaking method with lecithin
* E - 100% dairy ice-cream - control.

Figure 3.31 Flow chart for the processing of soy-ice cream and dairy ice-cream



HVS — Hydrolysed vegetable shortening
ICM — Ice Cream Mix (cornelle).
E — Control

Figure 3.32 The manufacture of plain chocolate, defatted extruded soybean chocolate and defatted soybean chocolate bars

Cocoa Liquor	26.6%	Cocoa Liquor	6.6%	Cocoa Liquor	26.6%
Skimmed milk	24.8%	Skimmed milk	10.0%	Defatted Soybean	14.8%
Sugar	31.1%	Defatted Soybean cake	14.8%	Skimmed milk	10.0%
Cocoa butter	16.5%	Sugar	31.1%	Sugar	31.1%
Lecithin	0.5%	Cocoa butter 1	6.5%	Cocoa butter	16.5%
Vanillin	0.5%	Lecithin	0.50%	Lecithin	0.50%
		Vanillin	0.5%	Vanillin	0.5%

Plain Chocolate → Mixing and Kneading

Defatted extruded Soybean Chocolate → Mixing and Kneading

Defatted soybean Chocolate → Mixing and Kneading

Mixing and Kneading
↓
Refining Twice
↓
Conching 60°C for 24 Hours
↓
Tempering
↓
Moulding
↓
Packaging
↓
Chocolate bars

Table 3.66 Proximate composition of plain and soy fortified chocolate

Samples	Moisture %	Protein%	Fat %	Ash%	crude fibre %	Carbonhydrate %
Chocolate	1.9	11.97	31.9	3.2	1.2	51.03
	2.1	11.80	31.5	3.1	1.3	51.50
Soy Chocolate Fortified with deffated extruded soy bean flour	1.62	15.60	32.1	2.7	1.5	48.0
	1.7	15.60	32.2	2.7	1.6	50.97
Soy Chocolate fortified with deffated soyflour	2.4	12.20	31.59	2.9	1.4	50.97
	2.4	12.40	31.83	3.1	1.3	50.18

* Means of 3 readings

Table 3.67 Physico-chemical characteristics of crude, partially and fully refined soybean oil

	FACTOR	A	B	C	D	E
1.	Moisture (%)	0.1	0.11	0.09	0.06	0.04
2.	Specific gravity (25^{O}C)	0.91	0.91	0.91	0.91	0.91
3.	Sediment/foreign matter	Present	Slightly	Slightly	None	None
4.	Clear/Brillant at ambient temp.	Yes	Yes	Slightly	Yes	Yes cloudy
5.	Clear/Brillant at refrigerated temp.	Yes	Yes	Slightly	Yes	Yes cloudy
6.	Odour	Beany	Beany soapy	Slightly bland	Almost bland	Almost
7.	Colour	Deep Golden yellow	Deep Golden yellow	Golden yellow	Light Golden	Light Golden
8.	Smoke point (^{O}C)	200-220	200-220	220-240	220-240	220-240
9.	Colour at smoke point	improved	improved	improved	improved	improved

Where:
A = Crude Soyoil
B = Degummed oil
C = Alkali Refined oil
D = Bleached oil
E = Deodourized oil
F = Commercially refined soy oil (GOLDEN SOYA)

Table 3.68 Free fatty acid (%oleic acid) of soybean oil samples stored at refrigerated and ambient temperatures

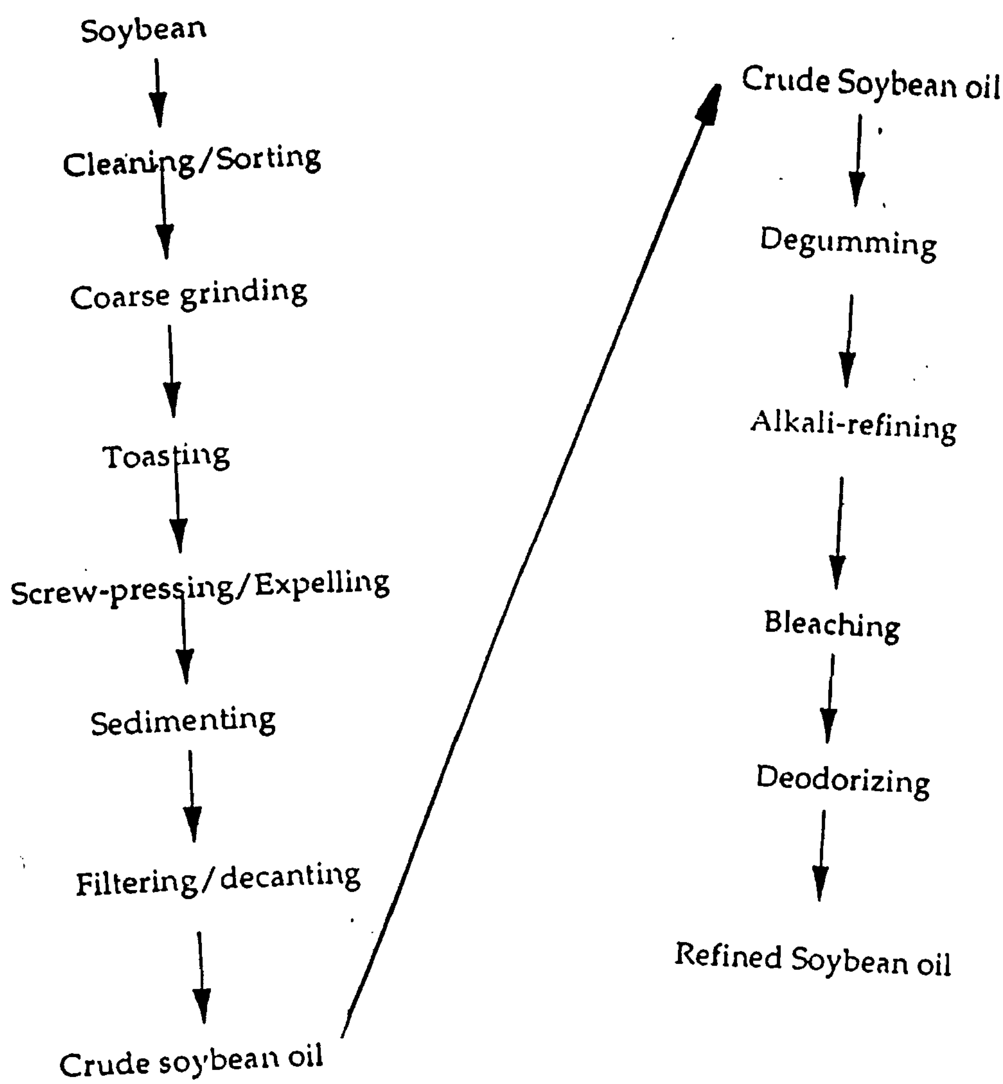
	Week 1 (°C)		Week 2 (°C)		Week 3 (°C)		Week 4 (°C)	
SAMPLE	5	25-30	5	25-30	5	25-30	5	25-30
CRUDE OIL	0.8	0.6	0.5	0.55	0.55	0.6	0.55	0.80
DEGUMMED OIL	0.5	0.4	0.4	0.4	0.7	0.6	0.24	0.35
ALKALI REFINED OIL	0.3	0.3	0.2	0.2	0.3	0.26	0.3	0.26
BLEACHED OIL	0.2	0.2	0.2	0.15	0.24	0.35	0.7	0.6
DEODORIZED OIL	0.2	0.3	0.2	0.15	0.25	0.2	0.55	0.6

Table 3.69 Sensory evaluation of oil sample result

SAMPLE	COLOUR	ODOUR	OVERALL ACCPET
CRUDE	5.9ab	5.1b	5.2b
DEGUMMED	5.7ab	5.0b	5.5ab
ALKALI REFINED	6.5ab	6.7ab	6.8ab
BLEACHED	7.1a	7.1a	7.3a
DEODOURIZED	6.5ab	6.7ab	6.8ab
COMMERCIAL	4.9b	5.1b	5.2b

NB: Figures not followed by the same alphabet are significantly at the 5% level of significance.

Figure 3.33 Steps in production and refining of crude soybean oil



5. *Storage characteristics of porridge breakfast cereal soy flour and maize flours parked in different packaging materials*

Breakfast cereals cover a wide variety of products that are usually processed to improve their texture, flavour and digestibility and which are eaten mainly at breakfast time but may be eaten at any other time of the day. These product are often made form cereals grains, grits and flour and may be toasted, flaked, shredded, extruded milled, puffed, and baked sometimes to some level of crispness. During the processing of breakfast cereals the protein are denatured, thus making them more available to human digestive enzymes.

The processing of breakfast cereals is designed to produce different types such as ready to-eat, easy-to-prepare, infant cereal, porridge-type, flaked, shredded, granular, sugar coated and sugared products.

Since breakfast cereals are usually produced from mainly cereals, they may be limiting in lysine and sometimes trytophan limiting amino acid. However they will be rich in methionine and cystine. A combination of cereals with soybean (which is rich of these amino acids though poor in methionine and cystine) during breakfast cereal production will help to compliment the amino acid profile of the product.

Therefore the objectives of this study were to process some breakfast cereals, maize flour and, soybean flour with and without ascorbic acid as antioxidant, store them in a room under ambient condition and determine the shelf life of the products.

Cooked dried soybean flour was produced as shown in figure 3.36. Figure 3.37 showed the processing flow-chart for cooked dried maize flour while figure 3.38 presented processing flow-chart for pre-gelatinized form cassava roots.

Proximate and thiobabituric acid analyses were conducted on the the products. Physical and biological assessment of defects in the products was done. The proximate composition of the porridge type breakfast cereal, soybean flour and maize flour are given in table 3.70.

Table 3.70

Sample	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Carbohydrate (%)
Breakfast cereal	3.179	17.523	7.154	1.853	42.462
Maize	2.815	8.754	2.841	2.552	83.038
Soybean flour	2.817	42.318	2.501	2.501	31.130

The breakfast cereal products has high protein content of 17.5% which is between the high values for soybean flour and the low value for maize flour. It has intermediate value for fat. Soybean flour is high in fat while the maize flour is low in fat. But both products contain fats/oil with high unsaturated fatty acids so are proned to oxidation. All the products have low moisture content between 2.81 to 3.18.

Storage studies show that breakfast cereal, soybean flour and maize flour during storage. Products packaged in heat sensitive transparent polythene bags absorbed more moisture than all the other samples showing that this package offered least protection against moisture uptake by the products. Also product packaged in plastic container sensitive polythene bag only had good protection property throughout the period of storage while products packaged in sealed polythene bags and placed in plastic containers with snap-on plastic cover were best protected from moisture absorption. Moisture content of all the products increased thus showing that non

Figure 3.34 Flow diagram for the processing of soybean seeds into cooked dried flour

Soybean seeds

↓

Wash with clean tap water

↓

Soak for 12 hours in 1% aqueous citric acid solution at ambient conditions, changing soaking solution every 3 hours.

↓

Wet decorticate (dehull) by rasping the seeds between the palms and removing seed coat by floatation in water

↓

Wash with clean water

↓

Wet - mill in attrition mill with the addition of more water

↓

Soybean paste

↓

Steam for 11/2 hours at 100°C

↓

Dry at 55-60°C in a convection air oven to a moisture content of 2 - 4%

↓

Dry mill

↓

Cooked dried soybean flour

↓

Cool and package

Figure 3.35 Flow diagram for processing of maize grains into cooked dried flour

Maize grains

↓

Clean to remove stones, chaff, other seeds, dust etc.

↓

Wash with clean tap water

↓

Condition by raising moisture content to 20-22%

↓

Degerm and dehull

↓

Soak in tap water for 12 hours at ambient conditions

↓

Wash with water

↓

Wet-mill in attrition mill with addition
of more water to a fine consistency

↓

Maize paste

↓

Stream for 30 minutes at 100°C

↓

Dry at 55 - 60°C in a convection air
oven to a moisture content of 2 - 4%

↓

Dry mill

↓

Cooked-dried maize flour

↓

Cook and package

Figure 3.36 Flow diagram for processing of cassava roots into pre-gelatinized starch

Cassava root

↓

Peel

↓

Wash

↓

Grate

↓

Slurry in 10 times its weight of water

↓

Discard residue ← Sieve through a No 100 American standard testing sieve

↓

Filterate containing raw starch

↓

Allow to sediment

↓

Decent off liquid and discant

↓

Wash starch 3 times, sedement finally
and decant off liquid layer

↓

Slurry starch in 5 times its weight of water

↓

Cook for 30 minutes with stirring

↓

Spread starch on aluminium or stainless steel trays

↓

Dry at 55 - 60°C in a convection air
oven to a moisture content of 2 - 4%

↓

Dry - mill → Pre-gelatinized cassava starch → Cool and packaged of the packages offered perfect protection. This implies that there was air exchange between the environment inside and outside the packages, though the rate varied among the packages.

There was slight increase in oxidation values of the oils in the breakfast cereal. This increase in oxidation is associated with the soybean and maize as they contained unsaturated fatty acid. Some of which were oxidized during processing when they exposed to air, especially during drying.

It was observed that those products packaged in sealed polythene bags (primary packages) placed inside a plastic container with a plastic snap-on cover as the secondary package obtained highest protection against moisture absorption, oxidative rancidity, barrier against weevil and white ant infestation, discolourating caking and mould grown, followed by these packaged in sealed polythene bags only.

6. *Production and nutritional assessment of soybean fortified puffed-corn using extrusion cooking technology*

Puffed-corn was produced from different blends of corn and soybean meals. Chemical analysis and sensory evaluation was conducted on the products. Fortified soy-corn extrudates made from 70/30 (% W/W) blend of corn with soybeans had the highest nutrient based but did not puff and was very heavy. Others made from ratios 80:20, 90:10, 95:5 of corn/soybean blends had more protein and fat than the control 100% corn.

Tables 3.71 and 3.72 show the chemical composition of soy-fortified puffed-corn and the sensory evaluation of soy-fortified puffed-corn. The defatted soybean meal used to fortify corn meal at the ratio of 90:10 (corn:defatted soy) greatly improved all the nutrients level. This mix was found to have satisfactory nutritive value and organoleptic properties. Fat level of about 5% in corn-soybean blends affected the puffing ability during extrusion cooking process. All the products had low and tolerable anti-nutritional factor levels (NAD - 4.3 mg/g).

Table 3.71 Chemical composition of soy-fortified puffed-corn

Sample	Moisture %	Protein %	Fat %	Total ash %	Carbohydrate %	Tannin mg/g	T.I. mg/g
Puffed corn-soy 70/30	4.1	19.0	6.3	3.0	67.6	0.7	4.3
Puffed corn-soy 80/20	4.0	15.4	5.8	2.6	72.2	0.7	2.6
Puffed corn-soy 90/10	3.8	12.5	5.0	2.3	76.4	0.7	2.3
Puffed corn-soy (defatted) 90/10	3.9	14.3	3.5	3.2	75.1	0.6	NAD
Puffed corn-soy 95/5	4.0	10.1	4.2	2.4	79.3	0.5	NAD
Puffed corn-soy (control)	3.2	8.0	3.6	2.0	83.2	0.4	NAD

* NAD - No activity detected.

Table 3.72 Sensory evaluation of soy-fortified puffed corn

Product	Flavour	Colour	Taste	Puffiness	Overall Acceptability
Puffed corn-soy 70/30	6.8a	7.8a	5.3c	3.2c	4.1b
Puffed corn-soy 80/20	6.0b	7.5a	5.5c	3.5c	4.4b
Puffed corn-soy 90/10	6.3b	7.6a	6.0b	3.4c	4.0b
Puffed corn-soy (defatted) 90/10	7.4a	7.5a	8.5a	8.3	8.2a
Puffed corn-soy 95/5	6.0b	7.7a	6.4b	5.5b	4.5b
Puffed corn-soy (control)	5.7c	7.5a	8.3a	8.5a	8.4a

Hedonic scale 9 = extremely like, 1 = extremely disliked

Note:- Values followed by the same letters within each column are not significantly different at the 5% level (Duncan's Multiple Range Test)

7. *Production and nutritional evaluation of soybean fortified malted sorghum meal extrudate*

Several sorghum/soy combinations were prepared using the following proportions and treatments; Malted sorghum-soy 50:50, malted sorghum-soy 70:30, malted sorghum-raw soy 50:50; malted sorghum-raw soy 70:30, unmalted sorghum-soy 50:50 and unmalted sorghum-soy 70:30. Figure 3.39 shows the flow chart for the preparation of meals. Sorghum-soy meal blend was extruded.

The result of the sensory analysis of the 6 samples of sorghum-soy meal extrudates are reported in Table 3.73. The blends of malted sorghum-raw soybean in ratio 50:50 and 70:30 was highly acceptable but majority of the panelists preferred the 70:30 blend to 50:50.

Table 3.74 shows the proximate composition of meal extrudate prepared from sorghum and soybeans malted and unmalted.

8. *Development of an extruded convalescence food (soyco-meal)*

In order to improve the nutritional status of malnourished children and convalescent individuals, a dry powdered mix of an extruded blend of soybean, cocoa, starch and sugar was developed (Table 3.75).

Chemical analysis was conducted on the extruded sample (soyco-meal) and compared with "Nutrend", a commercial weaning food (Table 3.76). The developed product (soyco-meal) had its protein value as 19%, fat content of 3.5%, moisture content of 4.6%, ash content of 2.0% and carbohydrate content of 69.0% while the commercial product (Nutrend) which it was compared to contained 16% protein with a fat content of 9%.

Fig. 3.37 Flow chart for the preparation of meals from malted sorghum and soybeans

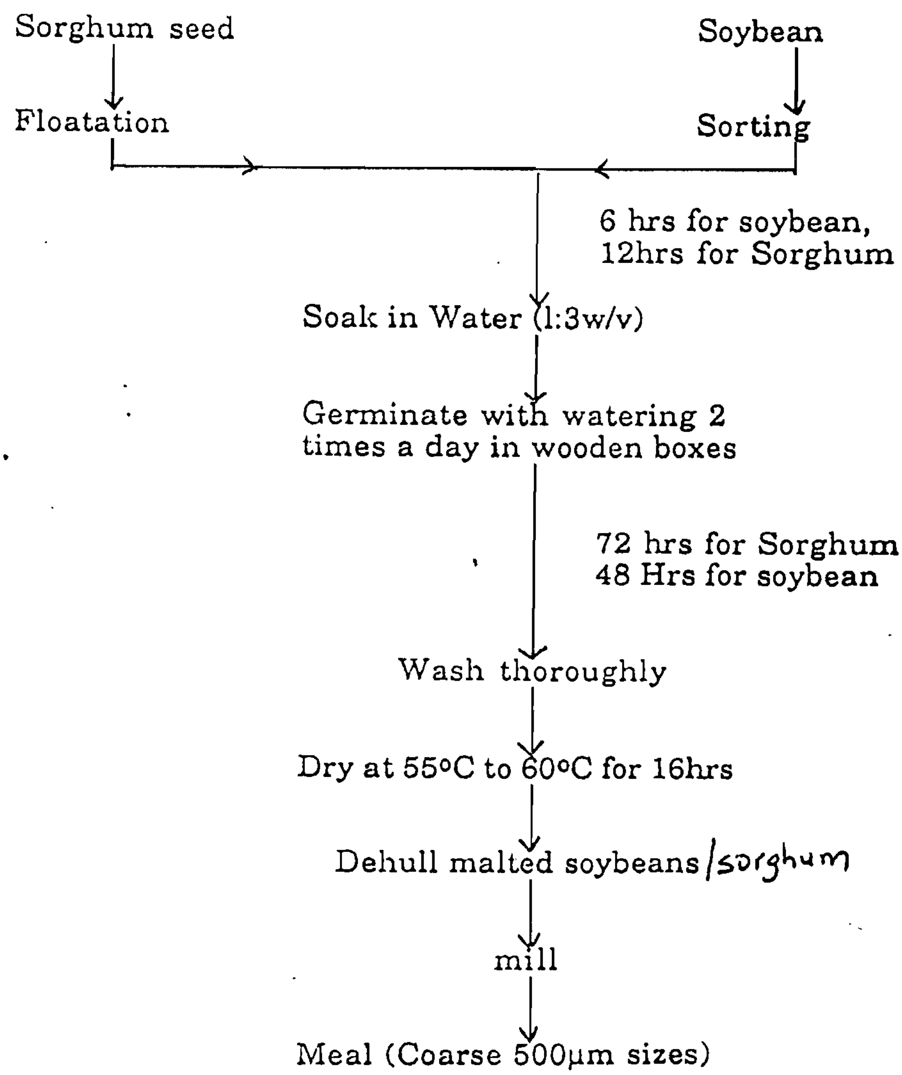


Table 3.73 Organoleptic score of different attributes of extruded sorghum soy blends

Judges Score	A	B	C	D	E	F
Colour	2.8d	3.7c	4.9a	3.5c	4.8a	6.1b
Mouthfeel	3.3d	3.6b	4.1c	3.9b	5.7a	5.6a
Flavour	3.1c	3.7b	3.8b	4.1b	4.8a	5.2a
Overall Acceptability	3.4d	3.7c	4.3b	4.0c	4.6b	5.1a

* Scores of 10 judges

* Values with the same letters are not significantly different at the 5% level of Duncan multiple range test on a scale of 1 (dislike to a like)

A Extruded Malted Sorghum - raw soy 70:30
B " Malted Sorghum - raw soy 50:50
C " Unmalted Sorghum - soy 70:30
D " Unmalted Sorghum - soy 50:50
E " Malted Sorghum - soy 50:50
F " Malted Sorghum - soy 70:30.

Table 3.74 Proximate composition of meal extrudate prepared from sorghum and soybeans malted and unmalted

Nutrient Per 100g	Extruded malted Sorghum-soy 50:50	Extruded malted Sorghum-soy 70:30	Extruded malted Sorghum raw -soy 50:50	Extruded malted Sorghum raw -soy 70:30	Extruded unmalted Sorghum- soy 50:50	Extruded unmalted Sorghum- soy 70:30
Moisture (g)	5.1	6.3	7.1	4.6	6.0	6.9
Protein (g)	29.5	20.4	21.9	18.9	25.0	18.1
Fat (g)	9.7	2.8	10.3	5.1	9.8	3.0
Ash (g)	3.6	3.0	4.5	3.0	3.7	3.2
Carbohydrate (g)	52.1	67.5	56.2	68.4	61.7	68.8
Energy (KCal)	413.7	376.8	405.1	395.1	434.2	374.6
Crude Fibre (g)	2.4	4.0	2.1	3.5	1.9	3.1
Calcium	70.0	120.0	120	270	160.0	80
Phosphorus (mg)	100.0	90.0	110	130	120	100
Potassium (mg)	650.0	960.0	950.0	580.0	800.0	640
Magnesium (mg)	140.0	160.0	170.0	120.0	140.0	130
Sodium (ppm)	3414.4	3424.6	5587.0	3587.5	4019.0	4574.6
Zinc (ppm)	30.0	33.3	32.6	30.4	34.1	27.4

Values are average of two determinations: expressed on dry weight basis

Table 3.75 Soyco-meal formula

Soybean	40%
Cocoa powder	8%
Starch	37.4%
Salt	0.2%
Sugar	14.3%
Mineral/Vitamin	0.1%

Table 3.76 The proximate analysis of soyco-meal and Nutrend weaning foods

	Soyco-meal	Nutrend
Protein %	19.0	16.0
Fat %	3.5	9.0
Carbohydrate %	70.8	69.0
Moisture %	4.6	4.0
Ash %	2.1	2.0

* Means of 3 readings.

Table 3.77 Chemical analysis of cowpea-corn blend and soy-corn blend before and after extrusion

Blends	Moisture %	Protein %	Fat %	Ash %	Carbohydrate %	Trypsin mg/g	Tannin mg/g
Soy-corn blend							
before	8.3	15.7	2.7	5.0	68.3	7.8	0.09
after	8.1	16.1	3.6	4.9	66.7	1.7	NIL
Cowpea-corn blend							
Before	7.3	12.8	7.0	5.5	67.4	0.9	0.05
After	6.5	13.3	5.3	5.6	69.3	0.8	NIL

Table 3.78 Sensory evaluation of cowpea corn blend and soy-corn blend

Diets	Flavour	Colour	Taste	Mouthfeel	Overall acceptability
Soy-corn blend	7.32	8.19	6.86	7.20	7.51
Cowpea-corn blend	7.21	7.91	7.01	7.14	7.35
Control	7.50	8.01	6.9	7.16	7.67
Mean	7.3	8.04	6.92	7.17	7.51
SE	0.06	0.06	0.03	0.02	0.08

9. <u>Chemical, and sensory evaluation of extruded cereal complemented with soybean and cowpea</u>

Cowpea and soybean were used individually in the fortification of maize through extrusion cooking. The proximate analysis of the blends before and after extrusion is shown in Table 3.77. The result of the proximate analysis show a higher level of protein in the mixture with soybean, while the extrusion cooking increased the protein slightly. The anti-nutritional factors were significantly reduced after extrusion cooking.

Table 3.78 shows the sensory evaluation of the two test-diets compared with a popular baby cereal in Nigerian market as the control. The result shows that the control was more acceptable.

10. <u>Chemical and organoleptic evaluation of weaning foods formulated with defatted extruded soybean flour and cereals</u>

Weaning foods were formulated from defatted extruded soybean flour and cereals which are recommended as weaning food in Nigeria. The diets were formulated in such a way that 70% of the protein was contributed by the defatted extruded soybean and 30% by the cereals. The total protein content of the formulated food was 15%. The mixes were fortified with 10-12% sugar, 3.5% mineral mix and 1% vitamin mix.

The chemical composition of the raw materials used are summarized in Table 3.79. Table 3.80 shows the chemical composition of the defatted soy flour-cereal blends. The defatted extruded flour contained a higher fat content of 9.4% than the cereal blends of about 1.75-5.4%.

Table 3.81 shows the means scores of organoleptic evaluation of different defatted extruded soy flour-cereal weaning foods. The sensory evaluation of the product showed that the products were accepted when compared with Nutrend, a commercial weaning food.

Table 3.79 Proximate composition of raw materials used for dietary formulation

Samples	Composition						
	Moisture %	Protein %	Fat %	Ash %	Carbohydrate %	Tannin mg/g	Trypsin inhibitor mg/g
Defatted extruded flour	9.1	53.03	9.4	5.9	22.57	1.8	1.4
Cooked Sorghum flour	10.25	6.4	5.4	2.4	75.55	0.23	3.0
Cooked Rice flour	10.54	5.9	2.7	0.7	80.16	0.96	2.85
Cooked Corn flour	9.9	6.58	1.75	1.5	80.27	1.19	2.0

* Mean of 3 readings

Table 3.80 Proximate composition of extruded defatted - soy-corn flour blends

Blend	Ratios	Moisture %	Protein %	Fat %	Ash %	Crude Fibre %	Carbohydrate %
DSC	70.30	9.0	12.0	20	2.5	5.5	56.05
DSC	65.35	6.5	16.0	18	2.0	1.0	57.5
DSR	70.30	6.5	12.0	15	2.5	4.5	64.0
DSR	65.35	7.0	8.0	15	1.5	2.0	68.5
DSS	70.30	4.0	16.0	16	3.0	5.0	61.0
SDD	65.35	6.5	15.0	16	4.0	1.0	60.5
Nutrend	40	9.0	16.0	20	20	50	69.0

DSC - Defatted Soybean corn weaning food
DRS - Defatted Soybean rice weaning food
DSS - Defatted Soybean sorghum weaning food
* Mean of 3 readings

Table 3.81 Mean scores of organoleptic evaluation of different defatted extruded soy-flour-cereal weaning foods

Attribute	Products and scores						
	DCON Nutrend (control)	DSC 70:30	DSC 65:35	DRS 70:30	DRS 65:35	DSS 70:30	DSS 65:35
Colour	8.53^{a}	8.06^{a}	7.25^{a}	8.17^{a}	7.47^{a}	6.28^{b}	6.0^{b}
Texture	8.03	7.92	7.50	7.78	7.64	7.39	7.5
Flavour	8.47^{a}	8.47^{a}	7.14^{a}	6.78^{a}	6.75^{ab}	6.58^{b}	6.39^{b}
Overall Acceptability	8.64^{a}	8.67^{a}	8.31^{a}	8.17^{a}	6.81^{b}	6.03^{bc}	5.5^{c}

Nutrend
Values in the same row with similar superscripts are not significantly different

11. Appropriate weaning foods based on extruded full fat soybean cereal blends

Extruded full fat soybean was mixed with either corn, sorghum or rice in such a way that 70% of the protein was desired from soy flour and 30% from the cereal flours. The mixes were fortified with vitamin and minerals and subjected to sensory and chemical evaluation with "Nutrend" a commercially based product as the control. The chemical composition of the raw materials used for formulation of the mixes in shown in Table 3.82.

The results shown in Table 3.83 showed that the soy-cereal blends contained more proteins, calcium and phosphorus than the control organoleptically, the soy:corn mixtures were similarly accepted when compared with control ($P<0.05$) (Table 3.84).

The soy-corn mixtures and control were significantly better accepted ($P< 0.05$) than the soy:rice mixture, soy-sorghum blends were the least accepted.

Table 3.82 Chemical composition of extruded full fat soy flour, sorghum flour, rice flour and corn flour

Products	Moisture %	Protein %	Fat %	Ash %	Carbohydrate %	Tannin mg/g	Trypsin mg/g
Extruded full fat soy flour	7.31	38.81	17.61	5.3	30.97	2.20	4.40
Cooked sorghum flour	10.25	6.40	5.4	2.4	75.55	0.23	16.67
Cooked rice flour	10.54	5.9	2.7	0.70	80.16	1.02	2.9
Cooked corn flour	9.93	6.58	1.7	1.50	80.29	0.35	14.07

Mean of 3 readings

12 Biological evaluation of full soy-cereal blends

Weaning foods based on extruded defatted soybean, extruded full-fat soybean, cooked soybean and either corn or sorghum were nutritionally evaluated on weaning albino rats, the diets were formulated in such a way that the soybean contributed 70% of the protein and cereal, 30%. Casein was used as the control. The rats were fed the diets, the control and water ad libitum. The growth, organ weights, protein efficiency ratio (PER), net protein utilization (NPU) and Biological Value (BV) were evaluated.

Tables 3.85 and 3.86 shown that the casein control diet induced higher weight gain, PER, kidney weights and NPU than the soybean/cereal mixes. The full-fat extruded soybean/cereal mixes were better than the defatted mixes.

13. Development of soy fortified local staple foods using extruded soy flour

Local staple foods, including ejiyi (Guinea corn) from white and red varieties, tuwo masara (maize) from white and yellow varieties, chigeni (pounded yam) and tuwo shinkafa (rice)were fortified with extruded soy flour in three ratios 1:1, 2:1 and 3:1 respectively, with control samples of individual unfortified meals. Proximate analysis of the samples were carried out. The trypsin inhibitor activity and the levels of tannin in the samples were monitored table 3.87.

Processing effectively eliminated tannin while trypsin inhibitor was noticed in chigeni and Ejiyi (white). The protein and ash contents increased significantly in the fortified samples while moisture and carbohydrate contents decreased.

Sensory evaluation was carried out on the samples. All samples were acceptable to the panelists. The fortified samples scored slightly lower mean values in most parameters tested, though most of the scores were not significant at 5% level.

Table 3.83 **Chemical composition of formulated full-fat extruded soy-cereal blends**

Products & ratios	Moisture %	Protein %	Ash %	Fat %	Crude fibre	Carbohydrate %	Calcium %	Iron %	Phosphorus %	Energy K/Cal
Full fat soy-corn (70:30)	6.5	19.96	10.5	11.0	1.5	52.04	0.513	0.013	1.425	387.00
Full fat soy-corn (65:35)	6.5	19.07	8.5	13.0	1.0	51.930	0.469	0.013	1.538	401.00
Full fat soy-rice (65:35)	6.0	19.70	8.5	9.0	1.0	56.80	0.463	0.010	1.913	387.00
Full fat soy-rice (70:30)	5.0	19.70	7.5	10.0	0.5	57.80	0.456	0.009	1.163	400.00
Full fat soy-sorghum (70:30)	2.5	21.02	8.0	8.0	1.5	60.48	0.488	0.014	1.350	397.92
Full fat soy-sorghum (65:35)	3.0	20.14	9.0	11.0	2.0	56.86	0.525	0.018	2.050	407.00
Nutrend (control)	4.0	16.00	2.0	9.0	5.0	69.00	0.310	0.010	0.020	401.00

* Means of 3 readings

Table 3.84 **Organoleptic scores of different attributes of full-fat extruded soy-cereal blends**

Attributes	Control	(ART) Soy:Corn	(STC) Soy:Corn	SRZ Soy:Rice	TDX Soy:Rice	SFX Soy:Sorghum	PRX Soy:Sorghum
Ratios		70:30	65:35	70:30	65:35	70:30	65:35
Colour	8.46±0.2a	6.29±0.3b	6.14±0.2b	6.23±0.3b	6.26±0.3b	4.09±0.3c	3.91±0.2c
Flavour	8.06±0.3a	7.86±0.3a	7.51±0.3a	8.11±0.3a	6.94±0.4b	5.43±0.3c	5.57±0.3a
Texture	8.20±0.2a	7.49±0.4a	7.89±0.3a	6.31±0.3b	6.26±0.3b	5.63±0.3c	5.91±0.4c
Overall Acceptability	7.63±0.4a	7.49±0.3a	6.11±0.3b	6.09±0.3b	4.97±0.3c	4.83±0.4c	

Table 3.85 Food intake, weight gain, protein efficiency ratio, liver and kidney weights of animals

Parameter	Diet						
	DC	D1	D2	D3	D4	D5	D6
Food intake (g)	2.15±1.80	225.4±3.6	236.6±3.6	209.0±3.7	22.4±3.1	227.7±7.4	219.6±29
Weight gain (g)	52.67±3.1	41.17±4.2	45.30±6.4	29.5±9.9	24.67±4.8	35.83±6.2	28.5±3.9
Protein efficiency ratio (g/g)	2.45±0.03	1.82±0.17	1.91±0.19	1.57±0.32	1.10±0.32	1.59±0.14	1.34±0.22
Liver weight (g)	4.70±0.06	4.83±0.18	4.30±0.08	4.30±0.08	3.71±0.14	4.46±0.18	3.68±0.13
Kidney weight (g)	0.97±0.01	0.76±0.02	0.81±0.01	0.67±0.01	0.59±0.01	0.69±0.02	0.57±0.02

DC - Casein control diet
D1 - Full fat extruded soybean/corn (70:30)
D2 - Full fat extruded soybean/corn (70:30)
D3 -
D4 -
D5 -
D6 -

Table 3.86 Biological value (Bv) and Net Protein Utilization (NPU) of diets

Parameter	Diet						
	DC	D1	D2	D3	D4	D5	D6
NPU	80.87±5.6	68.88±4.87	68.66±10.94	61.66±9.59	57.46±5.10	54.24±13.5	55.28±12.62
BV	92.20±0.86	87.45±3.37	78.84±4.88	90.12±1.99	81.74±6.68	79.29±9.14	

Table 3.87 Proximate composition of fortified and unfortified meals

Food/Type Ratio	M.C. (%)	Fat (%)	Protein (%)	Ash (%)	Carbo-hydrate (%)	T.I mg/g	Tannin mg/g
GCW0	77.8	0.3	0.01	0.3	21.6	1.7	NAD
GCW1	75.8	1.1	6.4	0.9	21.2	2.6	NAD
GCW2	74.8	0.9	5.8	0.8	22.6	0.9	NAD
GCW3	76.1	0.6	ND	0.7	NF	0.7	NAD
GCR0	78.4	0.2	1.8	0.3	19.3	NAD	NAD
GCR1	75.9	0.9	5.5	0.9	16.8	NAD	NAD
GCR2	77.0	0.7	5.2	0.8	16.3	NAD	NAD
GCR3	74.6	0.7	4.6	0.7	23.3	NAD	NAD
MTW0	81.4	0.1	0.6	0.1	17.8	NAD	NAD
MTW1	77.0	0.8	5.3	0.7	16.0	NAD	NAD
MTW2	79.6	0.5	4.0	0.5	15.4	NAD	NAD
MTW3	80.5	0.4	1.5	0.4	17.2	NAD	NAD
MTY0	78.9	0.1	1.7	0.1	19.2	NAD	NAD
MTY1	75.4	0.9	5.7	0.7	17.3	NAD	NAD
MTY2	79.6	0.6	4.5	0.6	17.1	NAD	NAD
MTY3	80.5	0.4	3.7	0.4	16.4	NAD	NAD
YT0	69.8	0.1	2.1	1.2	26.8	0.9	NAD
YT1	63.3	3.1	10.9	1.8	20.9	2.7	NAD
YT2	62.2	2.7	10.2	1.8	23.1	NAD	NAD
YT3	64.1	1.7	7.4	1.5	25.3	NAD	NAD
TS0	77.3	0.1	1.5	0.2	20.9	NAD	NAD
TS1	70.7	1.7	7.2	1.0	19.4	NAD	NAD
TS2	73.9	0.9	5.1	0.7	19.4	NAD	NAD
TS3	73.6	0.4	5.1	0.6	20.3	NAD	NAD

KEY: NAD = No activity detected; ND = Not determined;
TI = Trypsin inhibitor; MC = Moisture content;
GCW - Guinea corn tuwo; (white variety); GCR - Guinea corn tuwo; (red variety)
MTW - Maize tuwo (white variety); YT - pounded yam; TS - tuwo shinkafa
- Codes with 0 are unfortified products
- Codes with 1 are fortified at a ratio of 1:1
- Codes with 2 are fortified at a ratio of 2:1
- Codes with 3 are fortified at a ratio of 3:1. Soybean being the 1 part.

14. *Consumer acceptability of texturized vegetable protein products in Nigeria (Part 1)*

A texturized vegetable protein (Nutrela) was evaluated both chemically and organoleptically and the results shown in tables 3.88 and 3.89. The protein value of the product ranged from 48.0-53.1% while the fat content was less than 1% in all the samples analyzed. The mineral content as represented by total ash was between 6.6% and 7.0%.

The anti-nutritional factors were extremely low in the product (tannin 0.05mg/g). The sensory evaluation of the product revealed that Nutrela was highly acceptable when used in traditional dishes. It was easy to re-constitute nutrela for menu preparation. Six menu recipes were developed for house-hold uses. The sensory evaluation of the dishes prepared from nutrela shows that nutrela was highly acceptable. Similarly, the public acceptability survey conducted revealed that nutrela was acceptable in traditional foods to all age groups.

Table 3.88 Nutrient Composition of texturized vegetable protein (NUTRELA)

Nutritional Component	Chunks 200 g pack-size	Chunk whole bag 50 kg pack-size	Chunk 100 g pack-size	Granules 1 kg pack-size
Moisture %	13.7	10.4	12.0	6.5
Protein %	50.9	50.3	48.7	53.1
Fat %	0.3	0.5	0.4	0.4
Ash %	6.9	6.6	6.7	7.0
Carbohydrate %	28.2	32.2	32.2	33.0
Trypsin Inhibitor mg/g	NAD	NAD	NAD	NAD
Tannin content mg/g	0.05	0.02	0.03	0.00

Where NAD = No Activity Detected

Table 3.89 Sensory evaluation of Nutrela dishes

	Meat (Fried)	Nutrela in Meat stock (Fried)	Nutrela in fish stock	Fried fish	Stick TVP meat	Nutrela in stew
Flavour	7.40a	6.8a	7.55a	7.3a	7.60a	7.40a
Colour	6.55a	6.55a	7.35a	6.60a	7.42	7.30a
Taste	7.90a	6.96c	7.7ab	7.15bc	8.20a	7.90a
Tenderness	6.50b	7.20ab	6.90ab	7.60a	6.72ab	6.45b
Mouthfeel	7.15a	7.20a	7.55a	7.10a	7.80a	7.00
Overall Acceptability	7.35	7.05a	7.40a	7.15a	7.50a	7.45a

* 1-9 scale: 1 = very poor, 9 = very good

Note: Values followed by the same letter within each column are not significantly different at the 5% level (Duncan's multiple range test) of significance

SECTION 10

Development of small scale equipment for soybean processing and utilization

1. *<u>Design and fabrication of grinder/soymilk extractor</u>*

In view of the high cost of powdered and tinned milk, soymilk is now rapidly gaining popularity among the Nigerian populace, especially the low and medium income earners. However, the extraction of soymilk from the slurry after grinding the blanched seeds is rather tedious and time-consuming particularly at the household level.

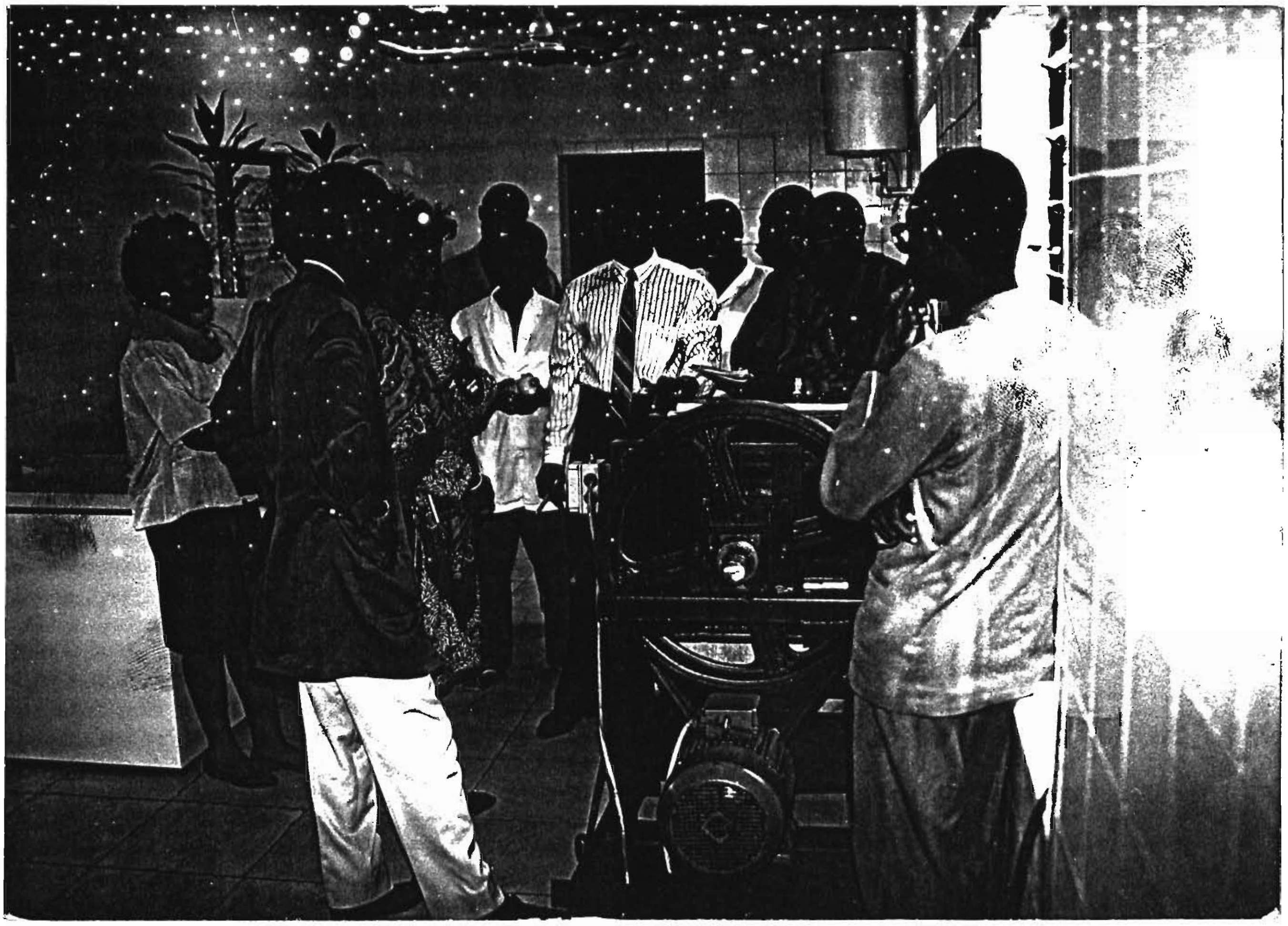
The fabrication of an affordable soymilk extractor will definitely alleviate or reduce the difficulty in preparing soymilk at the household level. The fabricated extractor will also improve the hygiene in processing soymilk. Therefore, the objective of this experiment was to design and fabricate a soymilk extractor.

Various materials used for the construction of the machine were sourced locally from Bida market. The name, description and quantity of these materials are shown in Table 3.94. While Figure 3.40 showed the basic design of the equipment.

A proto-type soybean Grinder/milk Extractor was developed in National Cereals Research Institute Engineering Workshop. Its size is 810 x 800 x 246mm and it weighs 30 kg, including the separate frame. Major components of the machine are: grinding wheel, hopper, feed pipe, adjusting handle, frame, outer can, perforated inner can, and separation filter. The output is about 200 litres per hour. All the components are detachable, easy to maintain and handle. One or two persons can operate it. The machine's power requirement is 1 h.p with speed of 1400 r.p.m. It is a continuous feed machine. Picture ~~10~~ 21 shows Drs Michael Bassey, S.M. Osho and some NCRI scientists commenting on the fabricated machine.

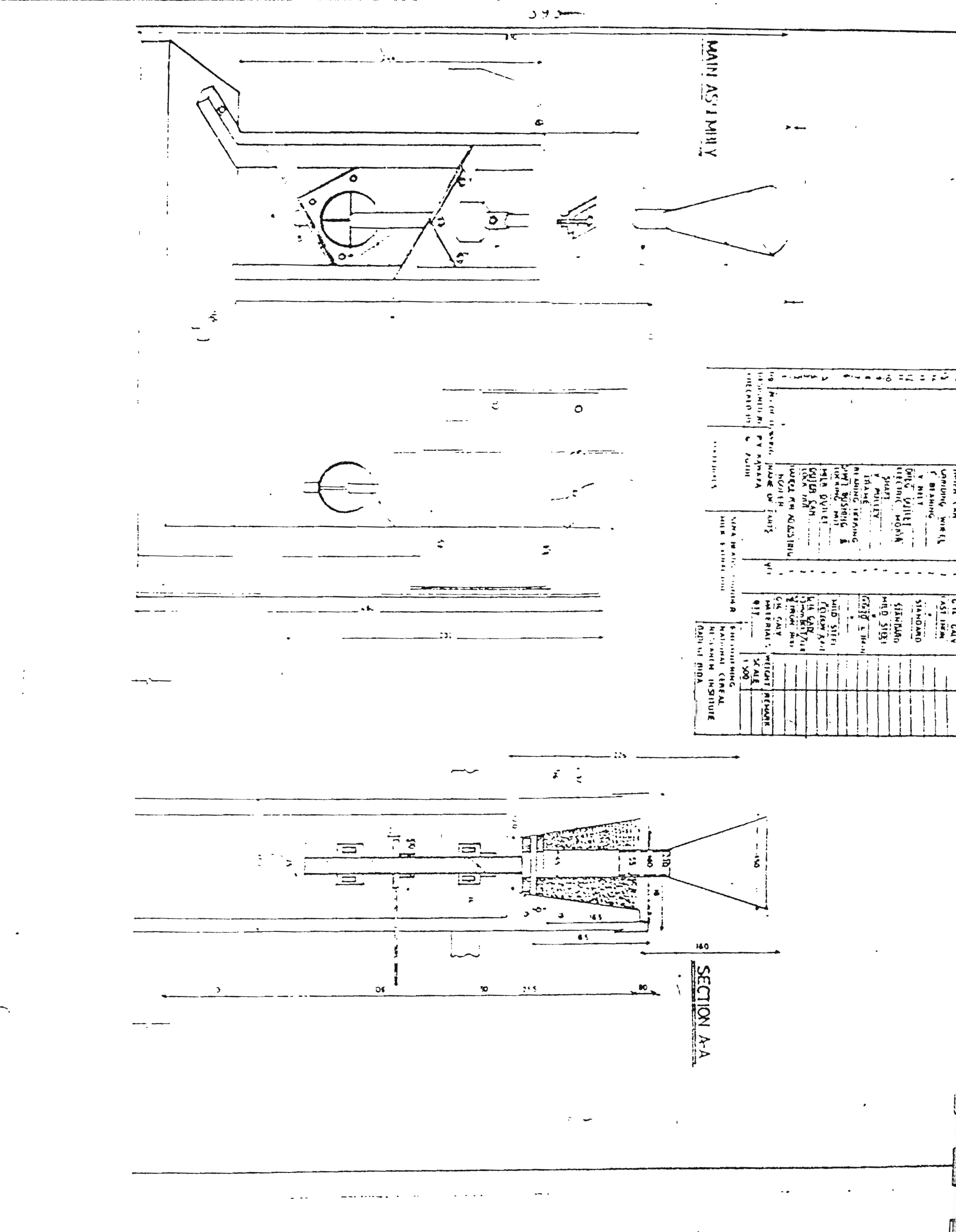
Table 3.90 List of materials used for the fabrication of soybean grinder/milk extractor

S/No.	Materials and description	Quantity
1.	Gauge 14 Galvanized Sheet - for hopper, Outer and Inner can	1 sheet
2.	15 x 6 diameter iron rod - for adjusting handle	40 cm long
3.	13mm diameter belt and nuts - for fastening	24
4.	Elbow joint - for outlet	1
5.	Galvanized pipe - for feeding (37mm x 500mm)	60 cm long
6.	Shaft (25mm diameter)	40 cm long
7.	Bushing (1" 25mm diameter)	2
8.	Bearing and Housing (25mm diameter) complete	2
9.	25mm x 25mm x 500mm Angel Iron - for frame	1 length
10.	50mm x 50mm x 500mm Angle Iron - for frame	1 length
11.	V-pulley	1 length
12.	V-belt	1 length
13.	Grinding wheet - to grind the soybean	2
14.	Separation filter - to separate the milk from residue	1
15.	1-Joint (37.5mm diameter) for adjusting	1
16.	50mm x 0.25mm x 500mm flat bar	16 cm long
17.	1-Joint (37.5mm diameter) for adjusting	1
18.	Welding Electrodes	1 packet
19.	Oil paint (Blue)	1 tin (small)
20.	Electric motor (2 h.p)	1



Picture 24: Drs Michael Bassey and Sidi Osho commenting on fabricated machine.

Figures 3.38 Basic design of the soybean grinder/milk extractor



2. *Extrusion technology: IITA concept*

Extrusion technology is currently one of the most economic means available for converting vegetable protein flours into products with a wide range of applications as supplements or extrudates in meat food systems (Smith, 1971). Raw-materials such as modified cereal flour and starches, textured proteins, snack foods, breakfast cereals and pet foods may be produced as well.

Extrusion is a process which combines several unit operations including mixing, cooking, kneading, shearing, shaping and forming (Harper, 1979). The process also involves food materials to be forced to flow under one or more of a varieties of conditions of unit operations like mixing, heating and shear through a (die) restricted opening which is designed to form and/or dry the extruoate.

There are two basic groups of extruder the wet and the dry, typical examples of these are the Wenger and the Insta-Pro extruders respectively. The IITA extruder is an Insta-Pro Model 600Jr. The IITA extruder was installed in 1987 and since then it has been used to process soybean and cowpea flours. It was installed for use in developing industrial products from soybeans.

The Insta-Pro 600Jr is a single screw extruder. The set up has two broad parts; the external and internal and some optional accessories. The external parts include an HTP nosecap, clamps and bolts, inlet chamber, middle chamber, lock-plug, lock bolt, nose cone 1/2", nose cone 5/16", inlet feeder spout. Other supplementary equipments required for extrusion are cleaning and milling equipment, grinders and mixers for preparations of materials, driers and coolers for finished products, various driers and packaging machine. The internal accessories for extruding whole soybean and corn soybean blends are shown in Figures 3.44 and 3.45.

Full-fat extruded soybean is produced with the internal configuration setting of two single-flight screws, three double-flight screws and steam locks of 8,5,5,5 as well as keys and five sleeves in-between the flights. The feed intake is set to discharge 300-350 kg seed per hour. The temperature range of 150-160^{o}C is then built up by running the machine with whole soybean seeds and subsequently, the prepared soybean grits are fed in. The extruded full-fat soybean shooting out in a very viscous state is passed into cooling drum rotor which blows off the heat in form of dry air and the resulting gritty product is packaged in polythene bags and then sealed. The cooked grit is what is being given to the national collaborators as full-fat extruded soybeans.

The schematic diagram for processing full-fat soy flour, snack foods and weaning foods using extrusion cooking technology is shown in figure 3.46.

3. *Defatted cake processing and soybean oil extraction using mechanical screw-press technology: IITA Concept*

Regardless of the method of oil extraction, the oil expelling industry is geared to producing oil for edible and industrial purposes, while the spent cake is used predominantly for livestock feed. In recent times, great emphasis has been placed on the use of soybeans, not only for oil but also as a source of edible protein for human food. In the developing countries where this need is strongly felt, extraction of oil using continuous screw presses is being widely practised. When the press cake from oil milling is intended for human food, it is important that the process must ensure adequate heat treatment of the cake in order to reduce the levels of anti-nutritional factors removal. Where maximum oil yield is the criterion of emphasis, it is not uncommon to make several passes through the expeller. While this increases oil recovery, it also results in excessive heating of the cake resulting in a brown colour and scorched flavour. Increased oil recovery is also accompanied by over-heating, darkening and deterioration of oil (Rittner, 1987).

Expellers, also called screw-presses, consist of a shaft with an attached interrupted worm gear that rotates within a cage (a series of metal bars separated by small openings). As the material to be extracted is introduced at one end of the expeller, it is subjected to high pressures between the edges of the worm gear and the cage. This pressure forces oil out of the material, and the oil flows laterally between the cage bars as the press cake moves parallel to the shaft.

The expeller installed at IITA, APVII MRN expeller has capacity to process 80-100 kg seed per hour. It has efficient material handling system because less material loss is experienced when being used.

The pre-extraction operations are cleaning and sorting using non-motorized gravity separator and coarse grinding is done with hammer mill. The split seeds are fed into diesel oil burner carrying kettle which toasts the seeds. Extraction is done at 80-100°C by feeding the toasted seeds into the screw-press. The oil flows out of the narrow linings and defatted cake is collected at the extreme end of the press. The oil is allowed to sediment over-night and then filtered. The cake is allowed to cool and then milled with attrition mill to produce defatted soybean flour. The oil and the defatted soy flour are given to the national collaborators for their various food recipe development. Figure 3.44 showed the schematic diagram of soybean processing by expelling.

4. *Cleaning and destoning equipment*

Soybeans that arrive in the processing industries are supposed to be clean and free of any contamination but, usually this is not so in Nigeria. Generally, they are free of chaff and stalk but are contaminated with sand, stones and dust. The source of this contamination is not known. The farmer accuses the middle men, while the middle men accuse the retailers or wholesalers. Studies are at present going on in IITA in collaboration with University of Ibadan to identify the sources and level of contamination of soybean seeds.

Cleaning is a very important operation in soybean processing. Harvested soybean seeds are contaminated with impurities such as stalks, chaffs, stones, sand, dust, kernels and diseased or damaged seeds. These have to be separated from the healthy clean seeds before further processing. Dirty or contaminated soybean seeds can damage subsequent processing machines.

Seed cleaning and destoning are usually achieved by an air-screen cleaner (Fig. 3.48). This is basically a combination of air and screen separators. The air is used to remove or separate the very small and light materials in the seeds while the screen is for the removal and separation of bigger stones, stalks and smaller stones. The screen separates either according to size or shape but in most cases, into size fractions with the use of multiple screens. The screens are usually given some vibratory movements which is a combination of horizontal oscillatory and vertical movements. If the seeds are free of chaff and light materials, and are contaminated only by stones and damaged seeds, the cleaner/destoner could be made mainly of vibrating screens. It is then called a sorter/destoner.

6. *Milling grinding machine*

Milling machines are size-reduction equipment. Size reduction is usually undertaken for any or all of the following reasons:-

(i) To aid the digestibility of some food materials.
(ii) To increase the surface area of the material so as to increase the rates of many processes like drying, extraction of some solutes, fermentation and to reduce the time required for such processes as heating, cooling and blanching.
(iii) To aid the extraction of juice or oil from such materials as sugar cane, fruits, vegetables, cassava or oil seeds.
(iv) To aid the mixing of particles.
(v) To achieve a specific product requirement like flour, and powder.

In the case of soybean, size reduction is usually undertaken to aid the extraction of oil and milk from the seeds.

The equipment used in soybean size reduction are mainly grinders or mills. The size reduction is achieved by a combination of shear, impact and compressive forces.

There are basically two types of grinders or mills - Hammer mill and Disc (Plate) mill.

Figure 3.39 INSTAPRO - 600 EXTRUDER CONFIGURATION FOR WHOLE SOYBEAN EXTRUSION

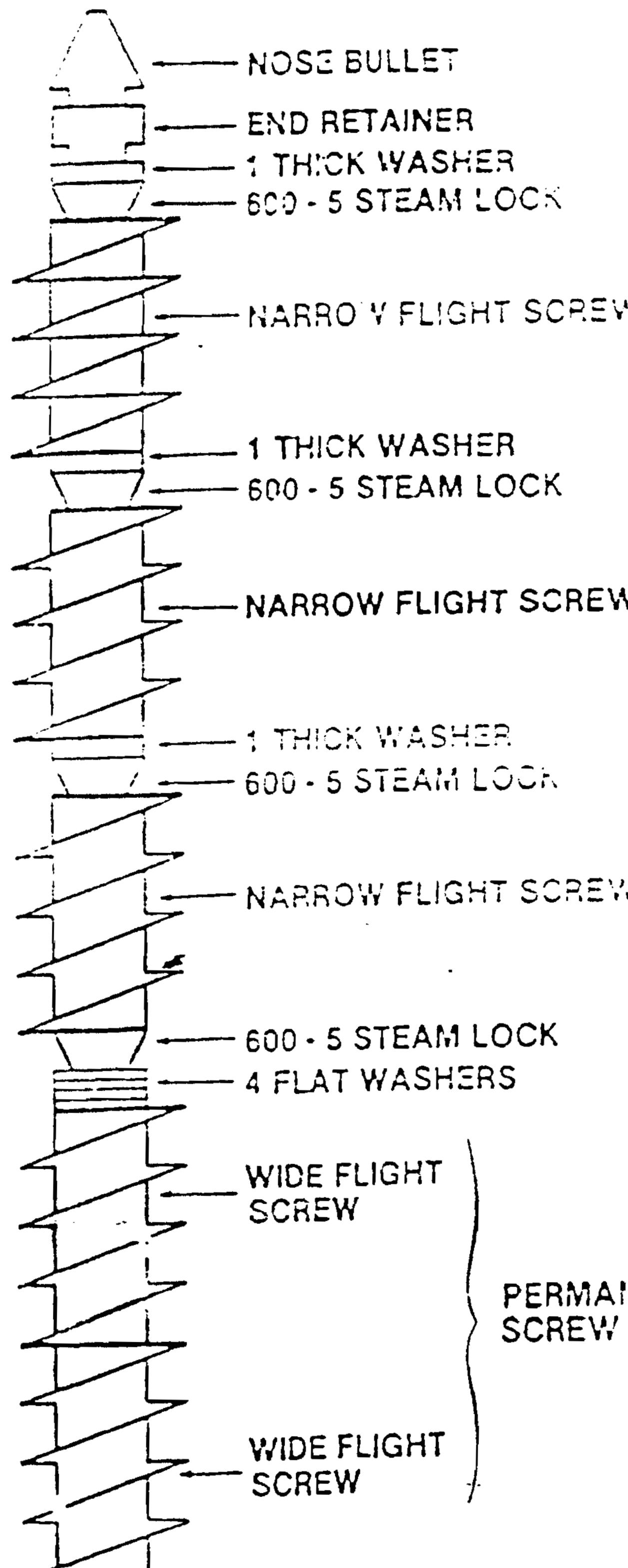


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Figure 3.40 INSTAPRO - 600 EXTRUDER CONFIGURATION FOR CORN/SOY EXTRUSION

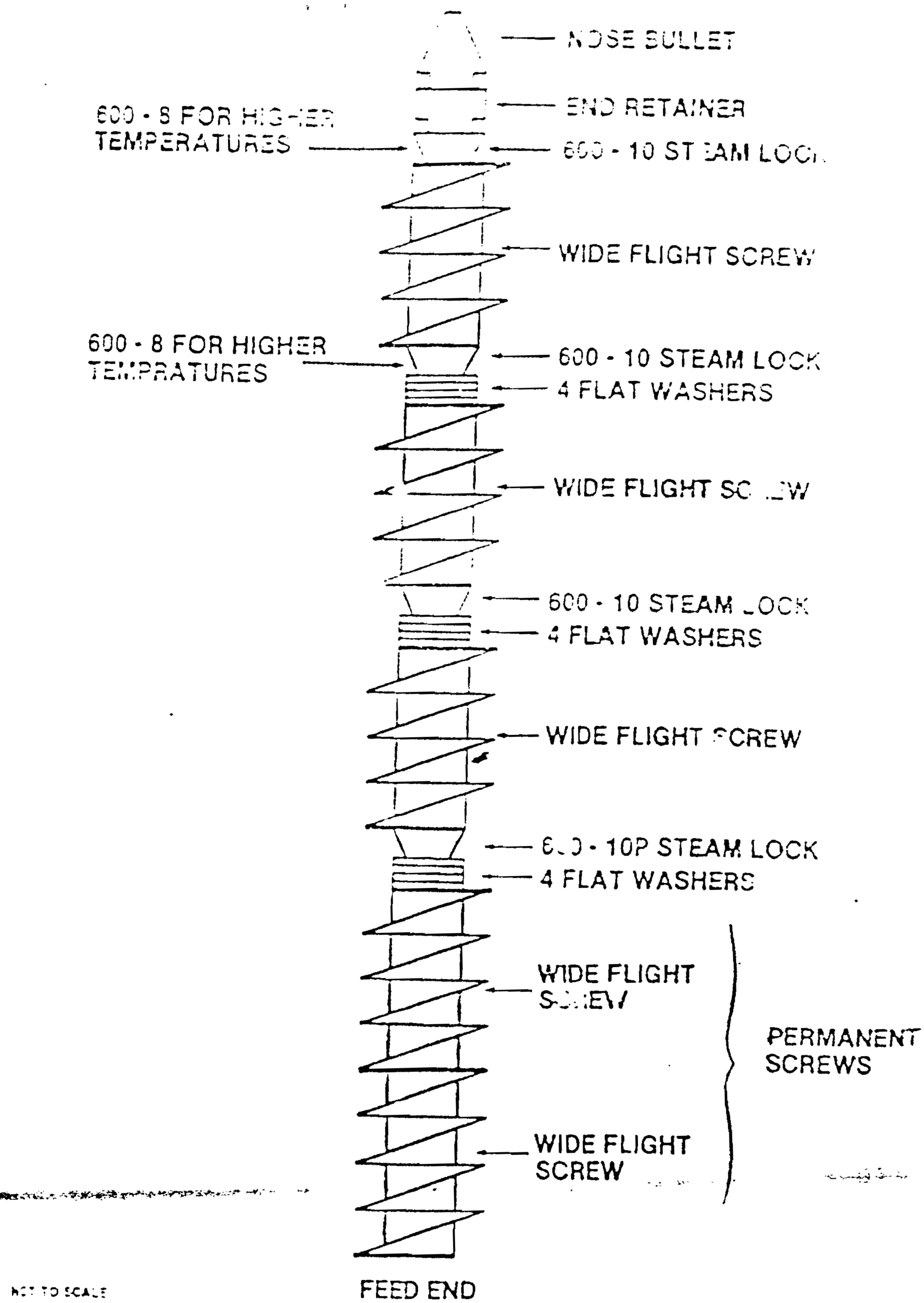


Figure 3.41 PROCESSING OF SOYBEANS AND CEREALS BY DRY EXTRUSION

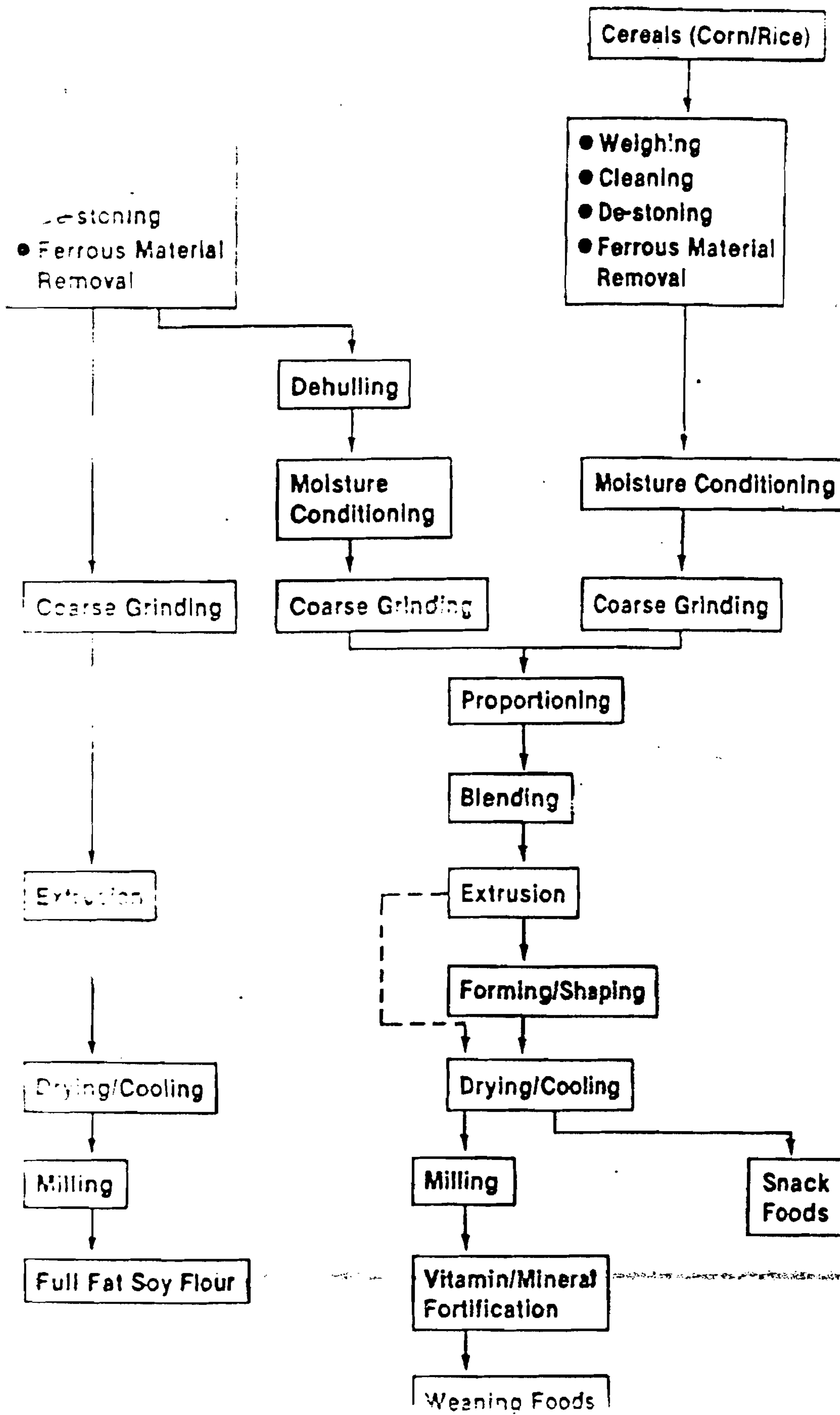


FIG. 3.42 SOYBEAN PROCESSING BY EXPELLING

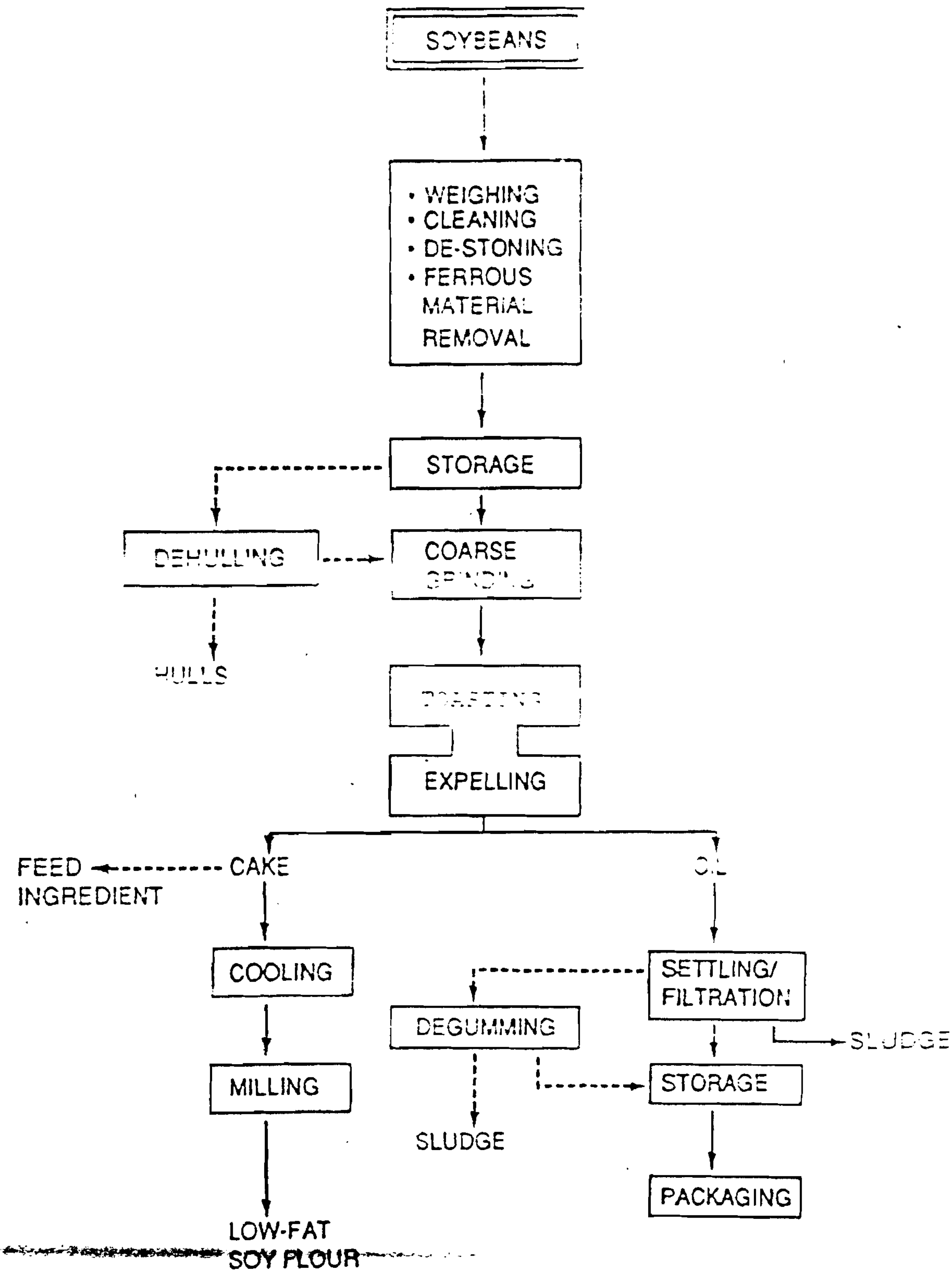
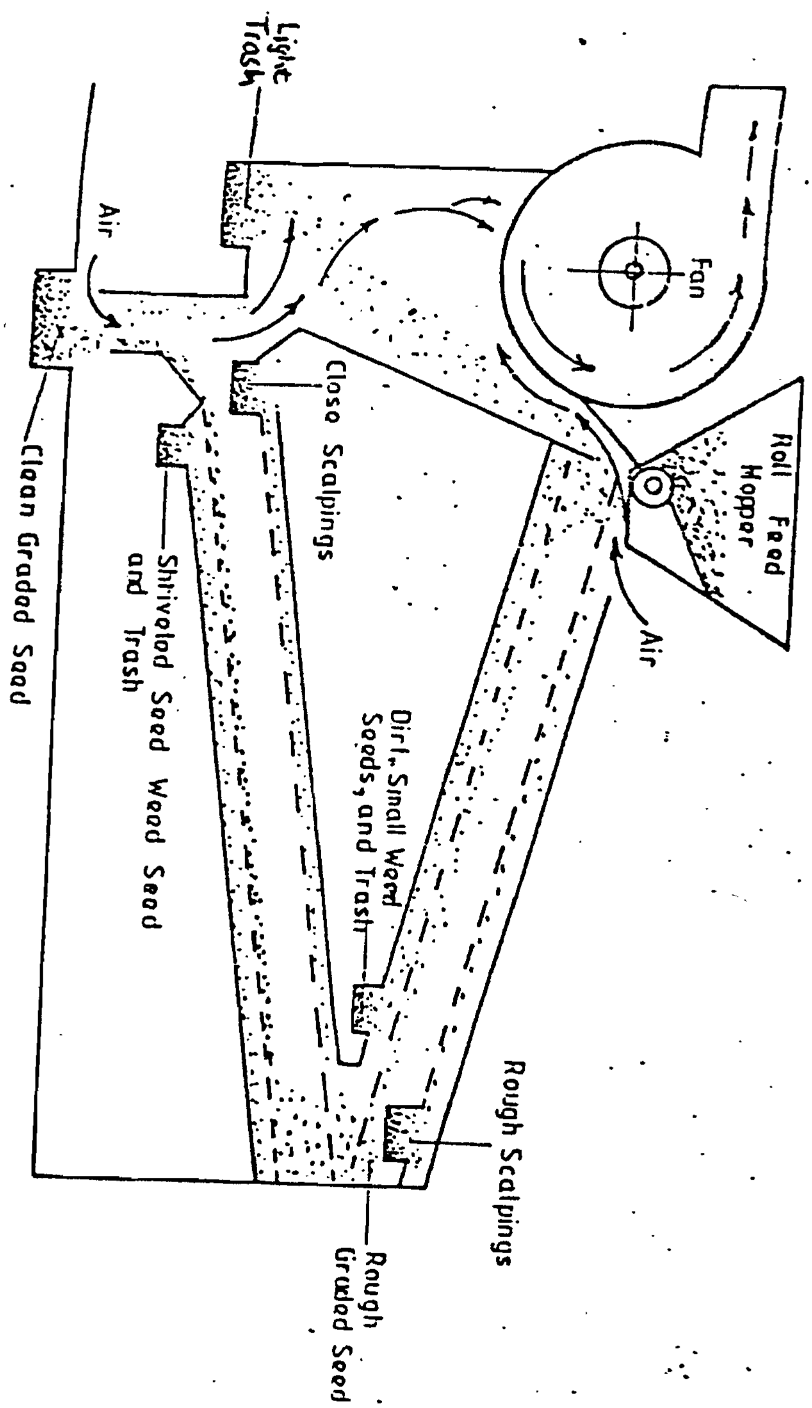


Fig. 3.43 Schematic view of air-screen seed cleaner



A hammer mill (Fig. 3.49) consists of a rotating beater attached to a rotor which rotates at high speed inside a heavy hardened perforated screen. The material is crushed and pulverized by the rotating beater in the mill until it is fine enough to pass through the screen. The fineness of the product is determined by the screen hole size, the feed rate and the speed of the rotor. It is simple in features, versatile in use and has the ability to withstand damage due to foreign materials in the feed. On the other hand, it has high power requirement.

A disc or plate mill (Fig. 3.50) is made of two circular plates mounted horizontally or vertically (one rotating for single disc mill and two rotating for double disc mill). The material is fed between the two discs and passes into the narrow gap between the rotating grooved discs resulting in intensive shearing action that reduces the feed size. The gap between discs can be adjusted to give the required size of product. The disc mill gives relatively uniform product, has low initial cost and low power requirement. It is the most popular grinder used for soybean wet milling. On the other hand, foreign objects can cause breakage and operating empty can cause damage. The consumable parts of the mill are the discs.

7. Soymilk filter press

This is a filtration machine but different from that of the oil filtration machine. Soymilk is filtered from a liquid slurry, as opposed to pressing oil from cake. There are two basic designs of filter presses: the chamber and the plate - and - frame presses. The design and operation are similar.

Basically, the filter press consists of hollow metal frames or solid plates (the faces of which are grooved or perforated to permit drainage). A filter medium, usually a fabric, covers one or both faces of each plate. The plates are then arranged in series in a vertical or horizontal position and supported on a pair of supporting bars on both sides, held tightly together by heavy screw or hydraulic device. Figure 3.51 is a simplified sketch of a typical filter press in which the mash or slurry is in a filter bag.

Different design of filter presses are available. A simple one for soymilk filtration is available in Nigerdock Nigeria Ltd Company in Snake Island, Lagos. The filter material is usually made of fine cotton-duck cloth or finely woven hessian bag materials.

Fig 3.44 HAMMER MILL

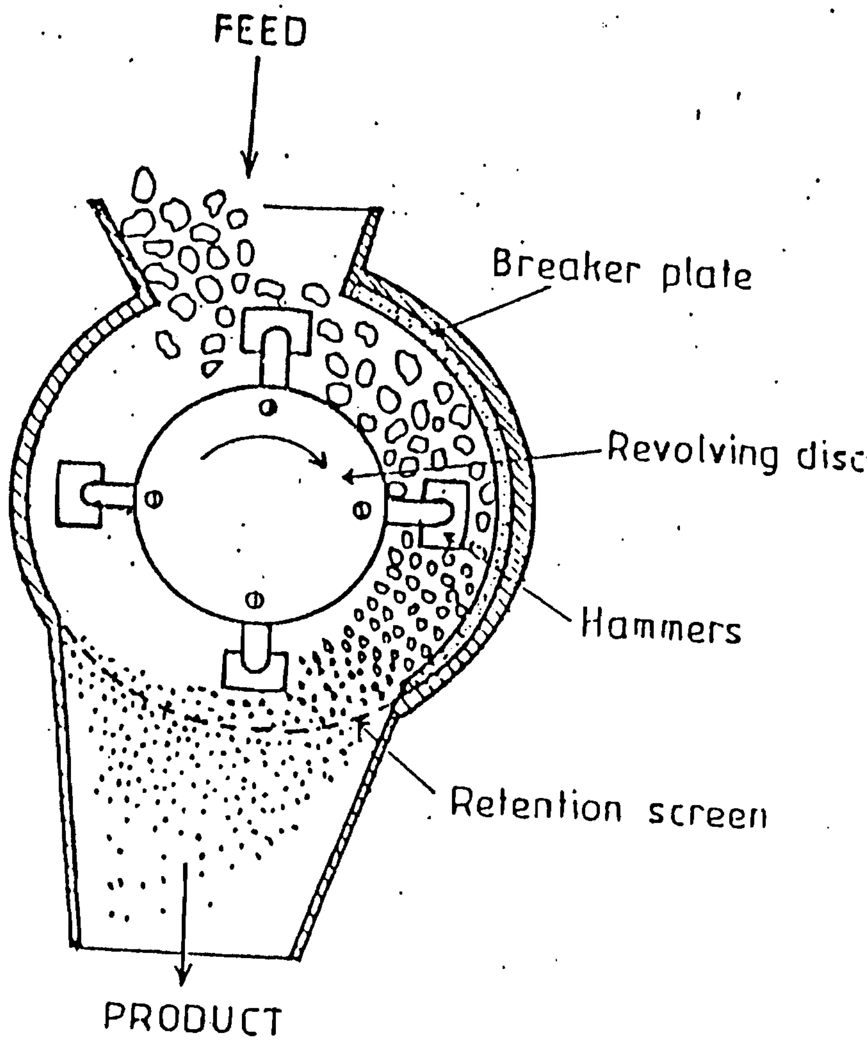


Fig. 3.45 DISC MILLS (a) SINGLE (b) DOUBLE

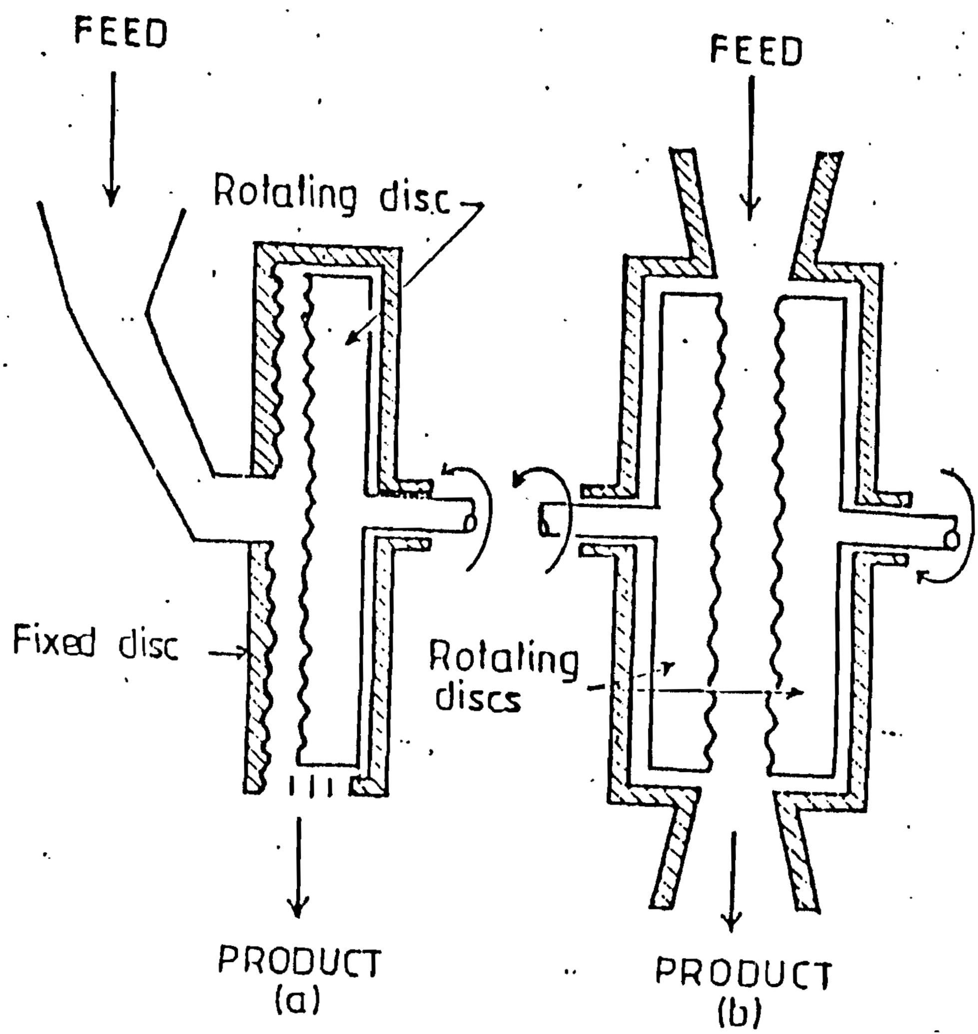
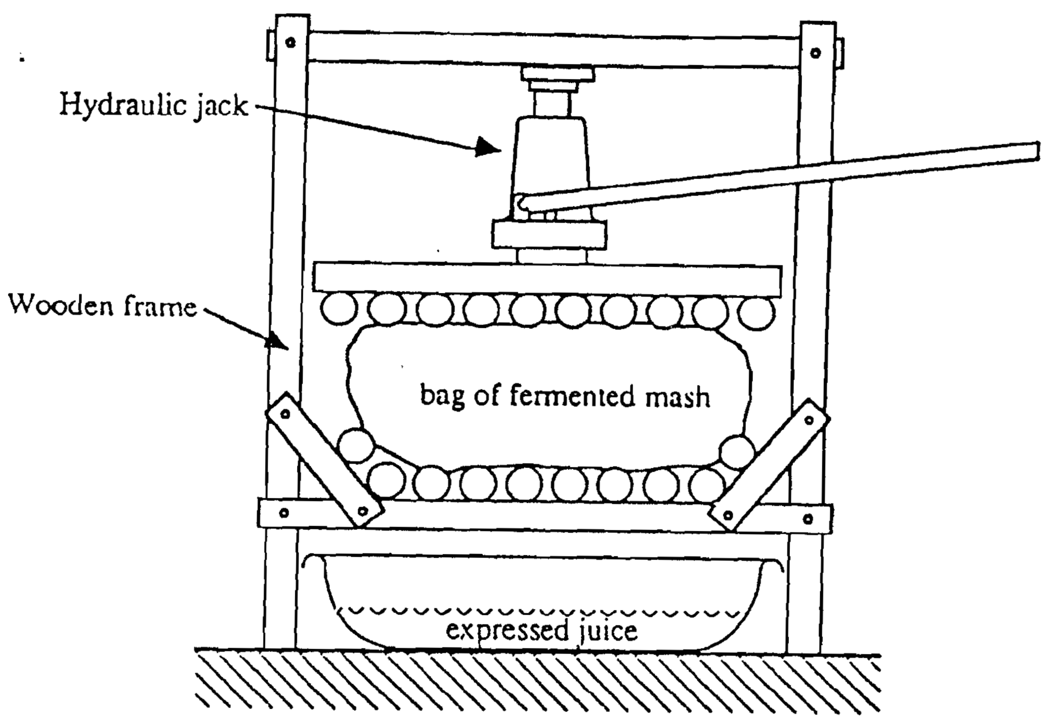


Figure 3.46 "HYDRAULIC JACK" PRESS STRUCTURE



CHAPTER FOUR

TRAINING ACTIVITIES

The use of soybean in the home offers a practical approach to improving the diets of those who need more and better protein. Thus, training and demonstration activities were designed to educate people on soybean utilization. This was an integral part of the soybean utilization project.

Training activities were conducted by the participating institutions including IITA. The number of trainings conducted are shown in tables 4.1 to 4.5. The training are usually conducted in the local language or English depending on the audience. The training encompasses production and utilization of soybean with particular reference to incorporation into the traditional diets. To facilitate training, various recipes were developed by each participating institution to suit regional needs. Pictures 11, 12, 13 and 14 shows some of the demonstrations undertaken at villages and workshops.

Table 4.1 IITA training programs

Date	Location	Organisation involved	No of females	No of males	Total participants
05-08-91	President of Nigeria and entourage	IITA	10	10	20
23-08-91	Global 2000/ General Obasanjo entourage	IITA	0	15	15
26-30-08-91	IDRC/Project Personnel	IITA	12	0	12
26-09-91	Oni of Ile-Ife and entourage	IITA	2	23	25
08-10-91	Women in Business	IITA	32	0	32
10-10-91	British Chamber of Commerce & Industry	IITA	2	6	8
11-10-91	Niger Dock, Apapa, Lagos	IITA	30	70	100
11-10-91	Nigerian Railway Corporation, Lagos	IITA	320	80	400
11-11-91	International Federation of Agricultural Producers	IITA	14	26	40
21-11-91	Chairman, Akinyele Local Government	IITA	3	5	8
06-12-91	Ghana Grains Development Project	IITA	1	4	5

Table 4.1 continued

Date	Location	Organisation involved	No of females	No of males	Total participants
16-12-91	University of Cambridge U.K	IITA	2	28	10
16-12-91	UNIDO	IITA	14	42	56
8-01-92	Women Cooperatives Nigeria	IITA	21	0	21
14-02-92	Food Basket, Lagos	IITA	0	5	5
14-02-92	National Training, Ibadan	IITA	6	6	12
24-03-92	Plenty Canda, USA	IITA	1	2	3
09-04-92	Women in Cooperatives, Ibadan	IITA	23	0	23
07-05-92	Great Nigeria Supplies	IITA	0	4	4
25-05-92	Dr. Mumba	IITA	1	1	2
28-07-92	Food Science, Faculty of Agriculture, Cotonou	IITA	2	10	12
07-10-92	British School, Lome	IITA	10	7	17
29-10-92	IDESSA/Embrapa	IITA	-	3	3
3-11-92	Suzzates Nigeria Ltd Lagos	IITA	0	3	3
05-11-92	Shuzo Jida (JAPAN)	IITA	-	1	1
0-12-92	Representative Women Group	IITA		2	5
05-02-93	Ondo State University	IITA	13	17	30
17-02-93	URT, Dodoma, Tanzania	IITA	2	1	3
08-03-93	CRIPT, Bazzaville, Congo	IITA	-	2	2
14-03-93	ITV - Ibadan	IITA	-	1	1
15-03-93	OYSADEP, Oyo State	IITA	14	7	21
10-04-93	BATOG Nig. Ltd.	IITA	-	2	2

Table 4.1 continued

Date	Location	Organisation involved	No of females	No of males	Total participants
13-04-93	FUT, Minna	IITA	1	1	2
29-04-93	KNARDA, Kano.	IITA	2	-	2
02-05-93	SIAT, Belgium	IITA	-	1	1
05-05-93	FAO, Philippines	IITA	-	1	1
11-05-93	Institute of Food Science & Technology Philippines	IITA	-	1	1
09-06-93	Ajaokuta Steel Co. Ltd. Ajaokuta	IITA	-	3	3
18-06-93	COWAD Nig	IITA	15	2	17
01-07-93	Rice Research Station SA. Lesue	IITA	2	3	5
12-07-93	Chitedze Research Station, Malawi	IITA	4	1	5
25-07-93	Post-Harvest Dev. Unit, Crop Services Dept., Ghana	IITA	3	6	9
04-08-93	COUN Rural Development Program Vom., Jos	IITA	5	10	15
05-08-93	Alemaja University, Ethiopia	IITA	1	1	2
16-08-93	Crop Storage Unit, Bvumbwe Research status, Malawi	IITA	1	2	3
07-09-93	NIHORT, Ibadan	IITA	1	-	1
21-09-93	KWADP, Ilorin	IITA	5	2	7
23-09-93	Ibadan Chamber of Commerce	IITA	-	8	8
27-10-93	Irawo-Owuro Ltd., Ibadan	IITA	2	4	6
02-11-93	Ministry of Science & Technology, Abuja	IITA	2	3	5
13-12-93	ANCE Ltd., Ibadan	IITA	1	2	3
	TOTAL		**580**	**424**	**1,004**

Table 4.2 IAR&T training programs

Date	Location	Organisation involved	No of females	No of males	Total participants
March '91	Family Planning Section UCH, Ibadan	IAR&T	20	2	22
March '91	Oni Memorial Clinic, Ibadan	IAR&T	34	10	54
09-04-91	Ikoyi	IAR&T	-	-	-
18-04-91	Ijaiye	IAR&T	10	-	10
26-04-91	Iwo	IAR&T	22	5	27
06-05-91	Tapa	IAR&T	-	-	-
28-05-91	Tapa	IAR&T	29	13	42
June '91	Adeoyo Hospital, Nurses, Ibadan	IAR&T	5	0	5
04-06-91	Igboora	IAR&T	24	3	127
20-06-91	Ijaiye	IAR&T	4	2	6
27-06-91	St. Anne's, Ibadan	IAR&T	144	6	150
06-08-91	Ikoyi	IAR&T	39	15	54
08-08-91	Ijaiye	IAR&T	8	1	9
14-08-91	Tapa	IAR&T	40	18	58
29-08-91	Akure	IAR&T	58	31	89
10-09-91	Ikoyi	IAR&T	25	10	35
12-09-91	Ijaiye	IAR&T	15	2	17
17-09-91	Igangan	IAR&T	20	4	24
19-09-91	Tapa	IAR&T	26	16	42
26-09-91	Igboora	IAR&T	104	3	107
22-10-91	Rotary Club Apata/ Ibadan	IAR&T	15	-	15
29-10-91	Ikoyi	IAR&T	20	5	25
4-5-11-91	Akure	IAR&T	40	21	51
19-11-91	Onilaru	IAR&T	30	18	48
28-11-91	(ADP)	IAR&T	15	6	21
28-01-92	Idimu	IAR&T	5	-	5
29-01-92	Kudefu	IAR&T	41	8	49
3-4-2-91	Akure	IAR&T	39	26	65
11-02-92	Imota	IAR&T	28	-	28

Table 4.2 continued

Date	Location	Organisation involved	No of females	No of males	Total participants
13-02-92	Tapa	IAR&T	28	10	38
18-02-92	Ikoyi	IAR&T	30	7	37
18-02-92	Ijaiye	IAR&T	8	1	9
03-03-92	Idimu	IAR&T	21	2	23
12-03-92	Imota	IAR&T	30	-	30
20-03-92	Ikoyi	IAR&T	26	10	36
26-03-92	Tapa	IAR&T	41	2	43
07-04-92	Idimu	IAR&T	18	1	19
08-04-92	Ikoyi	IAR&T	32	10	41
13-04-92	Igboora	IAR&T	103	10	123
04-04-92	Imota	IAR&T	28	-	28
24-02-92	Tapa	IAR&T	24	8	32
12-05-92	Igboora	IAR&T	98	1	99
14-05-92	Ikoyi	IAR&T	28	20	48
21-05-92	Tapa	IAR&T	32	4	36
26-05-92	Imota	IAR&T	30	-	30
28-05-92	Idimu	IAR&T	24	7	31
02-06-92	Igboora	IAR&T	121	3	124
10-06-92	Ikoyi	IAR&T	52	8	60
12-06-92	Idimu	IAR&T	24	10	34
18-06-92	Tapa	IAR&T	41	1	42
25-06-92	Lagos ADP	IAR&T	15	-	15
07-07-92	Igboora	IAR&T	140	-	140
08-07-92	Onilaru	IAR&T	32	6	38
12-07-92	Idimu	IAR&T	126	2	128
16-07-92	Tapa	IAR&T	46	8	54
27-07-92	Imota	IAR&T	32	2	34
12-10-92	Idimu	IAR&T	-	-	-
24/08/92	Igangan	IAR&T	4	5	9
27/08/93	Ikoyi	IAR&T	20	10	30
08/09/92	Idimu	IAR&T	-	14	14
17/09/92	Iroko	IAR&T	15	-	15

Table 4.2 continued

Date	Location	Organisation involved	No of females	No of males	Total participants
22/09/92	Ijaiye	IAR&T	2	12	14
24/09/92	Imota	IAR&T	-	20	20
5-8/10/92	Women in Agric, ADP, Akure	IAR&T	-	25	25
22/09/92	Ikoyi	IAR&T	10	15	25
27-29/10/92	Training Legume Utilization	IAR&T	11	15	26
03/11/92	Inner Wheel Circle Women	IAR&T	-	46	46
12/11/92	Imota	IAR&T	-	24	24
21/11/92	Tapa	IAR&T	12	34	46
26/11/92	Igangan	IAR&T	1	8	9
08/12/92	Idimu	IAR&T	3	14	17
19/01/93	Lioness Club, Ibadan	IAR&T	-	14	14
21/01/93	Queens School, Ibadan	IAR&T	6	112	118
09/02/93	Ikoyi	IAR&T	14	15	29
18/02/93	Soybean Demonstration, OAU, Ife	IAR&T	10	64	74
23/03/93	Soybean Demonstration, Oluyole, LGA	IAR&T	20	40	60
09/03/93	Oni-Memorial Children Hospital	IAR&T	-	10	10
22/03/93	Family Planning Unit, UCH, Ibadan	IAR&T	2	8	10
25/03/93	Kwara ADP, WIA, Ilorin	IAR&T	-	25	25
01/04/93	Ondo State, ADP	IAR&T	5	14	19
05/04/93	Home-Economics Teachers, Oyo State, ADP	IAR&T	1	20	21
13-16/04/93	Lagos State, ADP	IAR&T	2	24	26
21-05-93	Tapa	IAR&T	32	4	36
26-05-93	Imota	IAR&T	30	-	30
28-05-93	Idimu	IAR&T	24	7	31
11-06-93	Imota	IAR&T	28	-	28

Table 4.2 continued

Date	Location	Organisation involved	No of females	No of males	Total participants
13-06-93	Tapa	IAR&T	28	10	38
18-06-93	Ikoyi	IAR&T	30	7	37
12-07-93	Idimu	IAR&T	126	2	128
16-07-93	Tapa	IAR&T	46	8	54
27-07-93	Imota	IAR&T	32	2	34
12-08-93	Imota	IAR&T	30	-	30
20-08-93	Ikoyi	IAR&T	26	10	36
26-08-93	Tapa	IAR&T	41	2	43
08-09/93	Idimu	IAR&T	-	14	14
17-09-93	Iroko	IAR&T	-	15	15
22-09-93	Ijaiye	IAR&T	4	12	16
24-09-93	Imota	IAR&T	-	20	20
5-8/10/93	Women in Agric., ADP, Akure	IAR&T	-	25	25
22-10-93	Ikoyi	IAR&T	20	15	35
27-29/10/93	Training Legume Utilization (IAR&T)	IAR&T	11	15	25
03-11-93	Inner Wheel Circle Women	IAR&T	-	40	40
12-11-93	Imota	IAR&T	-	24	24
21-11-93	Tapa	IAR&T	14	34	48
26-11-93	Igangan	IAR&T	1	8	9
08-12-93	Idimu	IAR&T	3	14	17
	TOTAL		**2,754**	**1,193**	**3,947**

Table 4.3 UNN training programs

Date	Location	Organisation involved	No of females	No of males	Total participants
23-26 May '91	Nsukka	UNN	60	-	60
9 May '91	St. Theresas College, Nsukka	UNN	272	-	272
16-05-91	Eha Amuja	UNN	92	14	106
04-06-91	Okutu	UNN	39	17	56

Table 4.3 Continued

Date	Location	Organisation involved	No of females	No of males	Total participants
06-06-91	Ozalla	UNN	42	9	51
06-06-91	Nsukka	UNN	16	2	18
10-07-91	Okutu	UNN	20	20	40
12-07-91	Amino	UNN	20	40	20
20-07-91	Ozalla	UNN	22	5	27
10-08-91	Nike Town	UNN	170	4	174
01-09-91	Enugu	UNN	60	2	62
13-09-91	Enugu	UNN	52	1	53
10-11-91	Nsukka	UNN	80	-	80
12-02-92	St. Theresas College, Nsukka	UNN	252	-	252
14-04-92	University Campus	UNN	30	8	38
09-04-92	Ozalla	UNN	29	7	36
27-04-92	University Campus	UNN	58	24	82
28-04-92	Okutu	UNN	37	39	76
15-05-92	Eha Amuja	UNN	92	4	96
03-06-92	Okutu	UNN	39	7	46
05-06-92	Ozalla	UNN	42	9	51
05-06-92	Nsukka	UNN	6	2	8
09-07-92	Okutu	UNN	20	20	40
13-07-92	Amino	UNN	20	20	40
22-07-92	Ozalla	UNN	22	5	27
11-08-92	Nike Town	UNN	172	-	172
12-09-92	Enugu	UNN	52	1	53
14-10-92	University Campus	UNN	20	9	29
09-11-92	Ozalla	UNN	29	7	36
27-11-92	University Campus	UNN	68	34	102
28-12-92	Okutu	UNN	37	39	76
26-29 Feb. '93	Nsukka	UNN	60	-	60
9 March '93	St. Theresas College, Nsukka	UNN	373	-	373
14-04-93	University Campus	UNN	30	8	38
09-04-93	Ozalla	UNN	49	7	56
27-04-93	University Campus	UNN	58	24	82

Table 4.3 continued

Date	Location	Organisation involved	No of females	No of males	Total participants
28-04-93	Okutu	UNN	37	39	76
12-05-93	Eha Amuja	UNN	94	4	98
13-06-93	Okutu	UNN	39	7	46
05-06-93	Ozalla	UNN	42	9	51
10-06-93	Nsukka	UNN	26	2	28
19-07-93	Okutu	UNN	40	20	60
15-07-93	Amino	UNN	20	10	30
24-07-93	Ozalla	UNN	26	15	41
11-08-93	Nike Town	UNN	152	-	152
22-09-93	Enugu	UNN	52	1	53
10-10-93	Ozalla	UNN	30	5	35
21-11-93	Okutu	UNN	40	2	42
05-12-93	Enugun	UNN	58	4	62
	TOTAL		3,196	506	3,702

Table 4.4 NAERLS training programs

Date	Location	Organisation involved	No of females	No of males	Total participants
March '91	MTRM, Bauchi Improving Nutritional Values of Snacks	NAERLS	40	40	80
August '91	MTRM, Kano Nutritive Values of Soybean, FDA	NAERLS	50	30	80
21-30 August '91	MTRM, Kano	NAERLS	21	26	47
03-03-92	Kurmin Masara	NAERLS	60	60	120
04-03-92	Makera	NAERLS	30	-	30
06-04-92	Kaya	NAERLS	30	-	30
07-04-92	Kurmin Masara	NAERLS	35	-	35
02-07-92	Kaya	NAERLS	25	-	25

Table 4.4 continued

Date	Location	Organisation involved	No of females	No of males	Total participants
16-12-91	Kaya	NAERLS	25	25	30
04-02-92	Kurmin Masara	NAERLS	128	52	180
05-02-92	Kaya	NAERLS	30	-	30
06-02-92	Bamawa	NAERLS	30	-	30
07-02-92	Makera	NAERLS	50	-	50
10-03-92	Kurmin Masara	NAERLS	49	23	72
11-03-92	Kaya	NAERLS	35	-	35
12-03-92	Bamawa	NAERLS	21	-	21
13-02-92	Makera	NAERLS	29	12	41
07-04-92	Kurmin Masara	NAERLS	57	40	97
08-04-92	Kaya	NAERLS	38	-	38
09-04-92	Bamawa	NAERLS	32	-	32
10-04-92	Makera	NAERLS	33	17	50
30-06-92	Kurmin Masara	NAERLS	42	-	42
01-07-92	Kaya	NAERLS	27	21	48
02-07-92	Bamawa	NAERLS	17	-	17
03-07-92	Makera	NAERLS	34	12	46
04-08-92	Kurmin Masara	NAERLS	28	7	35
05-08-92	Kaya	NAERLS	17	-	17
06-08-92	Bamawa	NAERLS	14	-	14
07-08-92	Makera	NAERLS	26	10	36
01-09-92	Kurmin Masara	NAERLS	43	-	43
06-10-92	Kurmin Masara	NAERLS	58	-	58
07-10-92	Kaya	NAERLS	31	-	31
08-10-92	Bamawa	NAERLS	18	-	18
08-10-92	Makera	NAERLS	24	-	24
03-11-92	Kurmin Masara	NAERLS	54	-	54
04-11-92	Kaya	NAERLS	27	-	27
05-11-92	Bamawa	NAERLS	22	-	22
06-11-92	Makera	NAERLS	30	-	30
11-12-92	Kurmin Masara	NAERLS	55	-	55
02-12-92	Kaya	NAERLS	32	-	32

Table 4.4 continued

Date	Location	Organisation involved	No of females	No of males	Total participants
03-12-92	Bamawa	NAERLS	25	-	25
04-12-92	Makera	NAERLS	32	-	32
05-01-93	Kurmin Masara	NAERLS	54	-	54
06-01-93	Kaya	NAERLS	28	-	28
07-01-93	Bamawa	NAERLS	21	-	21
08-01-93	Makera	NAERLS	27	-	27
02-09-93	Kaya	NAERLS	36	-	36
04-09-93	Bamawa	NAERLS	24	-	24
05-09-93	Makera	NAERLS	8	31	39
03-10-93	Kurmin Masara	NAERLS	30	15	45
04-10-93	Kaya	NAERLS	50	-	50
05-10-93	Bamawa	NAERLS	48	5	53
06-10-93	Makera	NAERLS	21	26	47
01-11-93	Kurmin Masara	NAERLS	60	30	90
02-11-93	Kaya	NAERLS	30	-	30
03-11-93	Bamawa	NAERLS	30	-	30
04-11-93	Makera	NAERLS	35	-	35
05-12-93	Kurmin Masara	NAERLS	57	17	74
06-12-93	Kaya	NAERLS	40	-	40
07-12-93	Bamawa	NAERLS	32	-	32
08-12-93	Makera	NAERLS	38	-	38
	TOTAL		**2,173**	**499**	**2,673**

Table 4.5 NCRI training programs

Date	Location	Organisation involved	No of females	No of males	Total participants
26-29 May '91	North Central, In Service Training by NAERLS	NCRI	60	32	92
8-20 April '91	Agriculture, Youth, Self Employment program	NCRI	70	56	126
25-04-91	Mungorota	NCRI	60	12	72

Table 4.5 continued

Date	Location	Organisation involved	No of females	No of males	Total participants
30-08-91	Diko	NCRI	70	14	84
14-11-91	Child Clinic Bida	NCRI	65	-	65
16-12-91	Workshop on Soybean at Bida	NCRI	15	5	20
14-17-03-92	Fed Polytechnic, Bida	NCRI	60	17	77
30-04-92	Diko	NCRI	15	-	15
16-05-92	Women Group, Minna	NCRI	40	2	42
18-06-92	Mungorota	NCRI	35	85	120
06-07-92	Diko	NCRI	32	160	192
30-07-92	Umaru Sheshi Primary School	NCRI	110	163	273
29-10-92	Mungorota	NCRI	44	12	56
17-10-92	Bida	NCRI	50	3	53
12-11-92	Diko	NCRI	64	8	72
24-11-92	Mungorota	NCRI	70	10	80
19-01-93	Diko	NCRI	80	15	95
24-05-93	Bida	NCRI	4	10	54
11-06-93	Mungorota	NCRI	30	-	30
12-06-93	Diko	NCRI	15	14	29
17-07-93	Bida	NCRI	72	15	87
20-07-93	Association of Home Economics	NCRI	40	2	42
28-07-93	Mungorota	NCRI	30	5	35
20-08-93	Diko	NCRI	11	2	13
14-09-93	Women Co-operatives	NCRI	55	-	55
23-09-93	Cirico, Bida	NCRI	20	10	30
26-09-93	Wives Association, Bida	NCRI	44	-	44
02-10-93	Mungorota	NCRI	60	2	62
10-10-93	Bida	NCRI	84	4	88
18-10-93	Diko	NCRI	64	11	75
22-10-93	Polytechnic Studies	NCRI	40	30	70

Table 4.5 continued

Date	Location	Organisation involved	No of females	No of males	Total participants
26-10-93	Umaru Primary School	NCRI	108	90	198
05-11-93	Diko	NCRI	40	2	42
25-11-93	Child Health Clinic	NCRI	59	6	65
09-12-93	Mungorota	NCRI	20	3	23
10-12-93	Diko	NCRI	41	32	73
13-12-93	Bida	NCRI	64	10	74
29-12-93	Lioness	NCRI	89	-	89
	TOTAL		**1,930**	**842**	**2,772**

Discussion/comments

The result of the training activities shows that 580 females and 424 males have been trained by IITA, 2,754 females and 1,193 males were trained by the IAR&T working team during the project life span. This gives a total of 3,334 females and 1,617 males that were trained in the South-western Nigeria.

In the Eastern region, 3,196 female and 506 male (table 4.3) were given training on soybean processing and utilization training.

Table 4.4 show that 2,173 female and 499 male in the Northern part of Nigeria were trained by NAERLS.

A total number of 1,930 female and 842 male were trained in the Middle Belt of Nigeria by NCRI.

A total of 14,098 people from different part of the country were trained by the project staff during the project life span.

Picture 25: Dr Sidi Osho discussing with a woman processing soybean for sale.

Picture 26

Picture 27

Picture 28

Pictures 26; 27 and 28: Demonstration scenes.

Pictures 29 and 30:

Participants during demonstration tasting the soybean products.

Picture 29

Picture 30

Picture 31: Soybean products on display after demonstration.

Picture 32:

Soybean products on display during a workshop

Picture 33:

A representative of the first lady of Kaduna State tasting soybean products during an exhibition.

Picture 34:

Industries processing soybean displaying their products during an exhibition.

Picture 35: Participants at a national workshop on soybean processing and utilization.

CHAPTER FIVE

MONITORING SURVEYS

SECTION 1

Monitoring survey (and formative evaluation) of soybean production, processing and utilization in Oyo and Lagos states

Introduction

At the commencement of the IDRC Soybean Project Phase II, socio-economic baseline surveys were carried out between March 1991 and July 1991 on soybean production and utilization works in Oyo and Lagos states respectively.

After the baseline surveys, soybean project works was intensified in the sites. A monitoring, and evaluation survey was carried out to assess the impact of the project with respect to trainings and demonstrations on production and utilization of soybean. It should be noted that 'visits' to Ikoyi, Igangan and Iluju were more in the form of 'follow-ups' of the previously trained communities on soybean. Monitoring findings were discussed under the aspects of soybean production, trainings and demonstrations, processing/utilization, constraints and recommendations.

The project sites are Ijaiye, (Iroko, Ijaiye, Ojutaye), Igangan (Tapa, Igboora) Ikoyi (Ikoyi Ile, Oniyo Omilaru, Iluju)in Oyo State, and Ikeja (Idimu) and Epe (Imota) in Lagos state. The survey was done at the end of the second year of the project. The participatory rural appraisal technique was used. The PRA team comprised of a plant breeder, home economist, and agricultural economist.

Findings in Oyo state

i. <u>*Soybean production*</u>

In Oyo state farmers awareness of soybean production started in 1984, at Ikoyi. Presently, 37.38% of the women interviewed grew soybean (table 5.1). The bulk of soybean production in the area was undertaken by men, cooperative groups and corporate farms. Initial introduction of the small scale farmers to soybean production was reported to involve provision of free seed and some training in soybean cultivation. IAR&T and IITA's training programs for farmers was accompanied with farmers extension bulletin on how to grow soybean in Yoruba. Most of the soybean cultivated by farmers in the project sites were sold. Only 1 out of about 7 bags harvested was kept for household consumption and seed for the following year.

Large scale farmers followed recommendations in IAR&T guidelines for growing soybeans, only about 60% of the small-scale soybean farmer grew the crop sole or at correct spacing, the other often intercropped soybean with other crops like maize, cassava or vegetables and usually did not apply fertilizer to the soybean. Most of the soybean planting of small scale farmers was done on ridges at a spacing of about 30cm square on the fat-topped 'Tiv' ridges at 2-3 seeds per stand.

Sole soybean farm sizes ranged from 0.02 - 0.2 ha for individual and averaged 0.6 ha for cooperatives. At Oniyo (Ikoyi site) individual mixed-crop soybean farms ranged between 1 and 2 ha which was 2.5 times as much as what a similar farmer cultivated at Iroko (Ijaiye site) and 1 - 2 times as much as the area cultivated by like farmers in Igangan.

Threshing of soybean was considered as the most tedious operation in soybean production and often the most expensive, as it was always difficult to get labour for the threshing. Motorized soybean threshers has been introduced by IAR&T to the farmers but such threshers were not widely available.

ii. Awareness of soybean processing

Major awareness to soybean processing among women in Oyo state came into prominence in 1988 through IAR&T soybean utilization team Weekly television series on soybean processing and utilization programs by IAR&T under a Ford Foundation Project for women from 1989-1991, were detected to have played significant roles in creating awareness among television audience and health workers in Oyo state. For the facilitation of increased soybean awareness in the IDRC new project sites, training were conducted for cooperative members on soybean processing and utilization. The training location was usually the venue where the women normally hold their meetings. Processing equipment were brought along by the trainer. The training topics (table 5.3) comprised preparation of sole soybean foods and other legumes, and cereals or starchy foods fortification with soybean. Trainings were conducted in Yoruba.

The training process allowed maximum participation by the trainees, and the procedure encouraged the trainees to eventually discover alternate recipes and modify some ingredients mix.

iii. Utilization of soybean

The various foods being prepared at household level in descending order of preference is shown in table 5.2. Industrial processors turned out soy milk and soy oil. Most prominent among these processors were: Deagbo Industries Limited (processing 'Soy vita' milk), Orman Soybean Industries producing oil and extruded full-fat soy cake and partially defatted soy meal. The Milkman and Jomartex processed soy milk from cottage level industries.

Soybean and soy products were used in nutritional rehabilitation of malnourished children, for diabetic treatment in hospital and as ingredients in pigs feed. The nutritional rehabilitation of malnourished children and motherless babies, was notably evident in Kersey Children Home at Ogbomoso. Kersey Home purchased from Ogbomoso environs 149,000 kg of soybean in 1992; and processed averagely 500 kg soybean every month. Soy products (in order or prominence) processed and usually fed to patients in the home were soymilk, soy eba, soy eko, soy akara, soy moinmoin.

iv. Soybean marketing

Soybean was available in several urban daily and periodic rural markets in the state. The retailers were women traders. The soybean grain or flour were held in polythene packs of 43 gm weight at a price of ₦1.00 per pack. Popular daily urban markets retailed soybean in kongo (the government standard measure: 1.5 kg) at a price of ₦19 per kilogram. Kersey Children Home retailed soybean which was sold to outpatients at ₦12.00/kg, a price considerably lower than that of the open market. Wholesale of soybean at a price of ₦7,500.00 per tonne.

Soy flour and soy cereal mixtures were observed to be domestic processors' major articles of local retail trading. Soymilk was sold in Ikoyi town to school children, by a woman (Mrs Adeyemi), a local leader of Better Life Program. Soy milk was produced by some retired female civil servants and teachers in contract with private nursery primary schools and hospitals.

In cities (for example Ibadan) factory processed soymilk was hawked in ice mobiles. Brands of soy oil in 3.7 litre sizes, costing ₦40 per litre, were on shelves at supermarkets of major towns. Soy iru (fermented soybean for seasoning soups) was also traded at a pack price of ₦1.00.

Rate of returns (in percent) from soybean and soy products at retail marketing were 200% on soy iru, 180% on soy milk and 120% on soy flour.

Findings In Lagos state

i. Soybean production

Farmers awareness of soybean production in Lagos state started in 1988 through the Lagos State Agricultural Development Program's (LSADP) Soybean "Small Plot Adoption Trials (SPAT). Presently, soybean production has been adopted by 35.71% of the women farmers interviewed (Table 5.3). The soybean production was on individual and group basis.

The average individual soybean farm size ranged 0.05 ha - 0.2 ha, in private holdings, and 0.10 ha - 0.375 ha in group holdings. Pressure on land was so severe that Idimu Cooperatives sited their crop farms on undeveloped building plots, where the soybean farm sizes were indirect relationship to available land and amount of seeds supplied freely by the project.

Soybean was sole-cropped on heaps or ridges within the months of July and August. Two or three seeds were planted on heaps; seeds drilling was the practice on ridges. The use of fertilizer was discretionary. Germinated soybean suffered setback of damping off disease which was suspected to be due to soil acidity. The few plants that survived the setbacks, though atimes fertilized were not sprayed, and never reached maturity (as the leaves were eaten by insects); hence no grain yields.

ii. <u>*Awareness of soybean processing*</u>

Awareness to domestic soy processing and utilization in Lagos state had commenced in 1987 with the efforts of ADP's Women in Agriculture. To facilitate increased awareness several other trainings on soybean food processing were undertaken by IDRC project official IAR&T in 1991/1992.

iii. <u>*Utilization of soybean*</u>

Extent of soy processing and utilization among the project site's cooperatives was in direct relationship to the remnant soybean available from the planting of the project supplied free seed materials. Domestic utilization was also dependent on harvests from soy farm. Local pepper mill was used in grinding soybean. The fevered and adopted soy foods were soy soup, soy moinmoin, soy cereal mixture, soy iru and soy milk.

Soybean was also being used as feed for dogs. Wilmere (La Cuison) Ltd, at Ojudu, produced soybean fortified cassava flour.

iv. <u>*Soybean marketing*</u>

Soybean grains was sold, at ₦2.60 per "Peak - Milk Can" volume (0.15 kg) in Oja Nla and Agbalata markets, by male Igbo retailers. Wholesales of soybean at ₦10.00 per kilogram, in Mile 12, was by an Hausa man who sourced his soybean stock from Gboko; an average weekly sale of 1 tonne was recorded in wholesaling.

Soy yoghurt, soy ice cream, and soy milk, soy crips, soy flour and its industrial analogue-instant soya, were traded in Lagos state metropolis public markets and supermarkets. Soy iru was sold mainly to tertiary institutions in Lagos city. "Uncle Soyo" soybean beverages from Farina Ltd were retailed in bicycles, and mopeds, all over Lagos metropolis.

Conclusion

A useful start and a continuing basis of training had been established in the project sites processing and utilization situations. Also a necessary degree of sustained follow-up, and audio-visual demonstrations by trainers were needed as means towards correcting and further refreshing trainees learnt techniques, in order to complement the promising start. At the end of the IDRC project it is advised that a physical structure (a processing center) should be built in a project site. This processing center can continue to fund itself. This IDRC can proudly point to physical terms as reminiscence of the huge sum of money committed to the soybean utilization project in Nigeria.

Table 5.1 Awareness of, a soybean production among Women Cooperatives in Oyo state. (Iroko, Igangan, Ikoyi)

	Item/Element	Project sites		
		Iroko:	Tapa/Igangan Ikoyi	Tapa/Igangan
(a)	Awareness of soybean production			
	i. Year of awareness	1992	1986	1988
	ii. Source of awareness	IAR&T	COWAD	IAR&T
(b)	i. Individuals within the cooperatives	50	20	37
	ii. Soybean farmers in the cooperatives	25	5	10
	iii. Soybean seeds source	UNICEF	IAR&T/ PZ OYSADEP	NSS/IAR&T
	iv. Average sole soybean farm size/ha			
	- individual	0.02	0.20	0.60
	- cooperatives	0.60	0.6	n.a
	v. Average soybean dry grains yields kg/ha	375	n.a	375

Source: End of Phase II (1992) monitoring survey in IAR&T/IDRC Project sites of Oyo state

Table 5.2 Frequencies of soy foods mentioning* among trainees within Women Cooperatives as indices of acceptance and adoption of introduced soybean technologies in Oyo state

Introduced soy food		Project sites and adopters frequencies technologies			
		Iroko	Tapa/Igangan:	Ikoyi:	Total
(a) i.	Soy soup				
ii.	Soy flour	9(36)	6(30)	3(37.5)	18(34)
(b)	Soy cereal mixture		4(20)		4(7.5)
(c)	Soy moinmoin		3(15)	2(25)	5(9)
(d)	Soy gari				
(e)	Soy milk	6(24)	4(20)	1(12.5)	11(21)
(f)	Soy iru	10(40)	2(10)	1(12.5)	13(24.5)
(g)	Soy akara		1(5)	1(12.5)	2(4)
(h)	Soy eba				
(i)	Soy amala				

Source: End of Phase II (1992) monitoring survey in IAR&T/IDRC project sites in Oyo state.
Figures in percentage based on columns total.
* "Mentioning" with regards to soybean incorporation that diet consumed at home by the trainee.

Table 5.3 Awareness of, and soybean production among Women Cooperatives in Lagos state

Item/Element			Project sites	
			Ikeja (Idimu)	Epe
Imota				
(a)	Awareness to soybean production			
	i.	Year of awareness	1988	1990
	ii.	Source of awareness	LASDP	LASDP, IAR&T
(b)	i.	Individuals within the cooperatives	42	14
	ii.	Soybean farmers in the cooperatives	10	10
	iii.	Soybean seeds sources	IAR&T	IAR&T
	iv.	Average soybean farm size/ha		
		- individuals	0.05	0.20
		- Cooperatives	0.10	0.375
	v.	Average soybean dry grains yield kg/ha	-	-

Source: End of Phase II (1992) monitoring survey in IAR&T/IDRC project sites in Lagos state

SECTION 2

Monitoring survey of soybean production, processing and utilization in Diko, Mungorota and Bida villages in Niger state of Nigeria

Introduction

In order to assess the impact of the soybean utilization project executed by the NCRI, a monitoring survey using RRA approach was undertaken in April, 1993 in the IDRC project sites namely: Diko, Mungorota and Bida. This is an on-going activity of the IDRC sponsored soybean utilization project Phase II.

Result and discussion

Diko village (production site)

(i) <u>Awareness</u>

In the past two year (1991 and 1992), more people have come to know more of the production, processing and utilization. The monitoring survey showed that about 10, 2, 20, 29 and 7% of the indigenes have come to know more of the crop through IDRC/IITA/NCRI programs, Ministry of Agriculture/Local Government Areas, parents, individuals and others respectively (Table 5.4).

(ii) <u>Soybean production</u>

The estimated production level of soybean in Diko is about 30% of the total domestic crop production annually (Ibanga et al., 1992). In 1991, about 25% of the indigenes grew soybean. This percentage has increased to about 59% in 1992 (Table 5.5). It was observed that the quality of soybeans (Mudu) cultivated has also increased. Based on result of 1992 soybean production activities, 37% of the farmers grew soybean for the first time. Average yields obtained by first time growers for M-351 and TGx 923-2E were 1250 and 826 kg/ha, respectively. About 54% of the farmers claimed that soybean has replaced some of the crops cultivated in the village. The farmers claim that they grow the crop as sole, intercrop, sole or intercrop. The crop is mainly intercropped with cereals. The spacing observed in cropping soybean in the area was between 50cm, 75cm and 100cm. Farmers were observed to cultivate their crops with crude implements mainly. Farm input used by farmers include seeds, fertilizers, labour and labour/fertilizers. Principally, the fertilizers applied were single superphosphate (SSP) and NPK (15-15-15).

(iii) Soybean processing

The finding showed that about 66% of the respondents process soybean into the different soy products. It was confirmed that about 37, 5, and 17% of the farmers processed soybean before 1990, 1991, and 1992 respectively. About 10, 5, 24 and 24% learnt of soybean processing from IDRC/IITA/NCRI team, Ministry of Agriculture agents, parents and others sources respectively. During the survey, it was discovered that about 34% of the respondents have received special training on soybean processing from IDRC/IITA/NCRI team.

Most of the respondents ascertained that soymilk, and soy daddawa were the first soy products processed by them. The grains used for the operations were obtained from personal farms, markets and from friend. They claim that they utilized soybeans for the first time in 1991 and 1992 respectively. In all, the soy products prepared by the methods taught by IDRC/IITA/NCRI team have been declared to be highly and moderately acceptable. These soy products were made for household consumption or sold out to non-family dwellers. The soy products generally sold are soymilk and soy daddawa. The costs of these products per unit varied from 50 kobo to ₦3.00 only. The information obtained showed that soy daddawa are sold mainly at 50 kobo and ₦1.00 as claimed by the respondents. While soymilk sold for 50 kobo, ₦1.00 and ₦2.00 only. The soy products are sold mainly in the village markets.

Some problems encountered in the processing of these products were power failure (electricity supply problem). Part of these problems were solved by the government agents and other means deviced by the farmers as claimed by 2 and 29% of the respondents respectively.

(iv) Soybean utilization

It is worthy to note that various soy products exist. Some of these products include soymilk, soy cheese, soy daddawa, soy kosai, soy ogi, just to mention a few. In this village 17, 41 and 5% of the respondents accepted that soy milk, soy daddawa and other soy products respectively were known before 1991

The consumption of soy products is not a daily affair. In this study, it was gathered that about 10, 20, 7 and 29% of the people consume soybeans once, twice, thrice and everyday respectively (Table 5.6). the quantity of soybeans consumed in a home per week varied from less than a mudu (where a "mudu" is 1.27 kg). There is a remarkable decrease in the rate of consumption of soybean in this village. This decrease in consumption may be prompted by the increase in the price of soybean grains. The farmers are attracted by the increase in the price of grains hence they tend to dispose more of the grains than consume them. Previously there was the problem of market for the grains and during this period more of the grains were consumed than sold off.

Mungorota village (non-production site)

(i) Awareness

Soybean was first introduced into the village through some of the villagers who were members of staff of Ministry of Agriculture. The initial produce from the first planting (about 350 kg) were thrown away because of poor cookability, lack of market and knowledge of its utilization potentials (baseline report, 1991). Since 1991, about 58, 38, and 4% of the indigenes have come to know the crop/grains through IDRC/IITA/NCRI team, Ministry of Agriculture, Local Government and individuals respectively (Table 5.4).

(ii) Production

In 1991 and 1992, more farmers were observed to produce soybean. The result of the recent evaluation survey showed that in 1991 and 1992, about 46 and 96% of the farmers in the area cultivated the crop, respectively (Table 5.5). The difference of 50% farmers between 1991 and 1992 showed a positive impact of IDRC/IITA/NCRI Soybean Utilization team on the people of the area to grow soybeans. The average yield of the female farmers (412 kg/ha) was about 54% greater than the yields of the male farmers (189 kg/ha). The survey revealed that the farmers cherished some production assistance from external bodies. The result of the study showed that about 92 and 8% of the farming assistance in soybean cultivated in the area were obtained from IDRC/IITA/NCRI team and Ministry of Agriculture, respectively.

The major crops grown in the village in preference order are cassava, sorghum, sugarcane, maize, groundnut, yams and rice (Ibanga et al 1991).

Soybean production faces some biotic and abiotic hazards. The constraints in soybean production in the area include poor seed germination, rodent attack and high cost of production as claimed by about 4, 8, and 8% of the respondents.

iii) <u>Soybean processing</u>

The major commercialized crop processing technology in the area is gari production. Recently, a woman from Emimajin compound Nnagilami prepared "soy lai lai" and "soy kosai". Now, it was gathered that about 75% of the people are aware and have knowledge of soybean processing into some of the soybean products. According to the data obtained, about 25, 33 and 13% of the people in the area first learnt of processing soybean in 1991, 1992 and 1993 respectively. About 75% of them acquired the knowledge from IDRC/IITA/NCRI team, while about 8% of them obtained their knowledge from other sources.

The villagers' techniques for processing soybean into soy products differ. The soy products that are produced by the processors are claimed to be highly acceptable and moderately acceptable by about 63 and 8% of the consumers, respectively. The products are preserved when the need arises. It was stated that the preservation can be in refrigerators, dry storage and some other ways. The processing of the soy products entails some costs. The survey discovered that between ₦1.00 and ₦10.00 were used in processing one mudu (1.2 kg) of soybean grains into different products. The unconsumed soy products which were claimed to be sold to others outside the farmers' families were mainly disposed at 50 kobo, or ₦1.00. While soy daddawa was sold for ₦1.00. In the same vein, soymilk was mainly sold for 50 kobo. The people in the area were not able to quantify the problems encountered in processing and storage of soy products.

Bida - urban

(i) <u>Awareness</u>

It was recorded during the baseline survey that soybean was first introduced into the area by an expatriate in 1955. Some other inhabitants have heard of its utilization from a workshop manual. However, the result of the evaluation survey showed that about 41, 6, 3, 15, and 32% of the people got first knowledge of soybeans per IDRC/IITA/NCRI, Ministry of Agriculture, Local Government Area, parents, individuals and others, respectively (Table 5.4).

(ii) <u>Soybean production</u>

Bida-urban was carved out as utilization site by the project team. But efforts have been made by the inhabitants to grow soybeans. Also, the project team encouraged the city dwellers to grow, process, and utilize soybean in their homes, offices, and schools. Hence in 1991 and 1992, 12 out of 34 respondents accepted to have grown soybeans (Table 5.5). The crop growers in the city claimed to have cultivated between less than 1 - 10 mulus of soybean in 1992.

The people in the area cultivate other crops. The survey revealed that cereals, tubers, tubers and cereals; legumes and cereals; legumes, cereals and tubers; legumes, vegetables and cereals are grown around the area as claimed by about 24, 0, 9, 18, 12, 3, 3, and 29% of the respondents. Soybean is planted either as a sole or intercrop. The crop intercropped with soybeans are mainly cereal. The planting space in soybean production in the area observed varied from <50cm, 50cm, 75cm to 100cm. Some of the farmers do not know the actual planting space that exist for the crop in the zone. About 38, 3 and 3% of the producers claim to consume all, consume part and consume and sell part, respectively.

Some constraints encountered in producing soybean include poor seed germination, rodent attack and others.

(iii) *Soybean processing*

About 71% of the people interviewed claimed to have known the processing of the crop into the various products.The period of acquisition of the knowledge of processing soybean for the first time differed. About 12, 15, 32, and 9% of the respondents claimed to have known the methods of processing soybean before 1991, 1992 and 1993 respectively. About 38 of them stated that they were taught how to process the crop by IDRC/IITA/NCRI team. The people or persons involved in processing soybeans into the various soy products in the families include: self, female children, all the children, and groups in the household. The grain was observed to be processed between once to thrice times a week in the households. This rate of processing per week has obvious effect on the consumption rate of the bean in homes of the respondents.

The equipment used in household processing of soybean include: engine grinder and stone grinder which are also used for processing maize (akamu), beans, other cereals and pepper. The processed products have been declared highly acceptable by the respondents. The processors did not produce for the household or self-consumption only. Some were even left over by the household after the family's satisfactory consumptions. These ones were preserved for the future. The soy products were preserved in refrigerators and through other ways as stated by 35 and 18% of the respondents.

In soybean processing, the average cost of processing one mudu (1.2 kg) of soybean into the various soy products before 1991 ranged from ₦1.00 - ₦5.00; ₦5.00 - ₦10.00 and greater than ₦10.00.

The processors were not able to disclose the prices of some of the soy products. This was so observed when the price of soy kosai (akara); soy daddawa and soymilk was requested from the respondents. However, the processor stated that they encounter some problems in their processing and storage of soy products.

(iv) *Soybean utilization*

Since 1991 to date, about 21, 15, 12, 3, 15 and 15% of the respondents claimed to know of soymilk, soy kunu (a non-alcoholic during beverage), soy akara, soy soup, soy daddawa and other soy products, respectively.

Problems which are associated to soybean utilization include: beany flavour, prolonged processing periods and others.

Result from the survey conducted show that the number of soybean recipes known to the respondents before 1991 and after 1991 have increased in all the project sites. The improved awareness in Mungorota is very significant.

Table 5.4: Frequency Distribution of respondents according to source of first knowledge of soybeans.

	Bida		Diko		Mungorota	
	Frequency	%	Frequency	%	Frequency	%
IDRC	14	41.2	4	9.756	14	58.3
MOA, LGA	2	5.9	1	2.439	9	37.5
Parents	1	2.9	8	19.512	0	0
Individual	5	14.7	12	29.268	1	4.2
Others	11	32.4	3	7.317	0	0
No respon.	1	2.9	13	31.707	0	0
Totals	34	100	41		24	100

Table 5.5 Frequency Distribution of Producers of Soybeans in 1991 and 1992.

	Bida				Diko				Mungorota			
	Frequency		%		Frequency		%		Frequency		%	
	1991	1992	1991	1992	1991	1992	1991	1992	1991	1992	1991	1992
Yes	8	12	23.5	35.3	10	24	25.0	58.5	11	23	45.8	95.8
No	26	22	76.5	64.7	30	17	75.0	41.5	13	1	54.2	4.2
Tot.	34	34	100	100	40	41	100	100	24	24	100	100

Table 5.6 Quantity of Soy Product Consumed Per Week.

Quantity (Mudus)	Bida		Diko		Mungorota	
	Frequency	%	Frequency	%	Frequency	%
< 1	11	32.4	6	14.6	6	25.0
1	8	23.5	6	14.6	5	20.8
2	2	5.9	4	9.8	5	20.8
3	0	0.0	5	12.2	2	8.3
4	0	0.0	1	2.4	0	0.0
< 5	0	0.0	5	12.2	0	0.0
No Response	13	38.2	14	34.1	6	25.0
Total	34	100	41	100	24	100

SECTION 3

Soybean production and utilization monitoring survey in Kaya, Kurmin Masara and Makera in Kaduna State of Nigeria

Introduction

Soybean production and utilization are making significant in-roads in Kaduna state. This is being reflected by the increased commercial activities relating to the crop and by the increasing number of soybean producing communities in the state. At household levels, utilization has also increased remarkably within the last two years. The IDRC soybean project has been responsible primarily in generating utilization technologies as well as in the disseminating of production, processing and utilization technologies in the state. It may be mentioned that the success achieved by the IDRC project has also served in sensitizing promotional activities for soybean in the state by a number of other agencies such as the State Ministry of Agriculture and the Federal Department of Agriculture. A multi-institutional approach to the promotion of soybean is desirable and should be sustained in order to fully harness the benefits of the IDRC soybean Phase II project in Nigeria.

A multi-disciplinary team made up of a socio-economist, a food technologist, a home economist and an agronomist conducted a two-day surveys at Kaya, Kaduna (Makera) and Kurmin Masara (project sites).

Results

(i) <u>Production</u>

The survey revealed that production activities have gained significant attention at the three project sites since the inception of the project. Soybean growers population increased from 1000 to 1023 in Kaya, from 4% to 8% of respondents (households interviewed) in Kaduna and from about 82% to 100% (every households) in Kurmin Masara between 1991-1992. The factors responsible for increased participation in soybean production at the locations include, improved knowledge of processing and utilization procedures for the crop, increasing prices for the crop in the areas and increased extension activities in the area. About 60% of the farmers growing soybeans at Kurmin Masara were women against only 2% in Kaya and 74% in Kaduna.

Average farm holding per farmer increased from 2 ha to 3 ha between 1990-1992 in Kaya but remained stable at 0.75 ha at Kurmin Masara. The scale of production at Kaduna was negligible.

About 44% and 54% of the farmers intercropped soybean with other crops against 56% and 46% that grew the crop sole in Kaya and Kurmin Masara, respectively. The result show a gradual shift from intercropping to sole cropping of soybean in the areas, probably due to expanded area under cultivation of the crop.

Average yield per farmer increased from 500-800 kg/ha in 1991 to 700-1000 kg/ha in 1992 in Kaya but declined during the same period from almost 1000 kg/ha to between 500-650 kg/ha in Kurmin Masara. The increased in average yield in spite of the late rains, in Kaya probably reflect an improved understanding of the agronomic practices for soybean in the area, the decline in average yield in Kurmin Masara may have been occasioned by poor fertilization, low plant density adoption. Farmers in Kurmin Masara however, reported that there were serious bird attacks on the crop at seedling stage and poor viability of seeds which also contributed to the decline of yield.

The largest soybean producer in Kaya produced about 10 tons in 1992 against 6 tons in 1991. The figures for the largest producer in Kurmin Masara declined from 4.5 tons in 1991 to 3 tons in 1992. The largest producer in Makera district (Kaduna) produce just above 100 kg. The cost of cultivating one hectare of soybean from land preparation to harvest was variable at the project sites (Table 5.8). It was highest in Kaduna at ₦10,600/ha) and lowest at Kaya.

(ii) *Marketing*

Marketing of soybean grain was not a problem at all the project sites in 1992. The pricing of soybean grains also improved remarkably in 1992, with the peak price rising up to ₦22.00/kg in July-August 1992 at Kaduna. The peak price at Kaduna during the same period in 1991 was just about ₦2.2/kg. The increase in price was due to increased industrial and household level utilization. For instance, in 1992 AFCOT, a major cotton producer and seed cotton crusher, commenced the crushing of soybean. The large scale demand for soybean grains by the oils mills is a welcome development because of its implications in stabilizing price and indirectly, stimulate local production.

(iii) *Processing and utilization of soybean in Kaya, Kurmin Masara and Makera*

Our investigation revealed that soybean is a well known crop in Kaya among the women and even the children present. However, most of the households consume less than 6 kg of soybean per week. This little knowledge of utilization can be due to the fact that soybean production was only initially introduced to men, while the women know about it through their husbands that had guides written by IITA. Most of them cannot read, so it made no meaning to them. The consumption of soybean products by people in Kaya seems to be low as of the time RRA. The average quantity consumed per week was estimated at 0.44 kg and the frequency was only 1:5 a week.

Soybean daddawa was the commonest product produced and this was done by few women using their local way of processing. Most women now incorporate soybean into their food because of the transfer of technologies carried out. They now know the right method of processing soybean both wet and dry methods. Daddawa and dakuwa are the commonest product for sale at Kaya. Other developed recipes were prepared and consumed at home. These developed recipes are processed using the traditional equipment for processing at home.

The recipes developed with the women are daddawa, soy-hatsi, tuwo dawa, Masara, gyero and shikafa. These tuwo are fortified with soybean at ratio one to three. Other include kunu, dakuwa, danwake and talia.

Soybean crop is well known in Kurmin Masara for a long time but its utilization at household level was not popular until recently. For long the crop was only used in the processing daddawa as soup condiment. The community has come to know of soybean uses through the help of agricultural extension agents since early 1980's. About 90% of the households now consume soybean regularly. Information gathered revealed that a family consumes over 2 kg of soybeans in a week in the form of kosai, daddawa and soup. The adults prefer eating prepared daddawa in soup while the children are fed mostly on soymilk, pap, kosai etc. Most households visited can prepare products made from soybeans using the improved method of processing soybean for consumption. Some of the acceptable products processed on commercial scale are alele, kosai, and daddawa.

During the monitoring survey we noticed great significant in processing and utilization of soybeans. During the baseline survey only 9 households out of 19 consume soybean. All the nineteen households now use soybean everyday for consumption during harvesting periods especially October/November - April/May soybean is used daily for daddawa, the improved pap and other days, it is used for milk, cheese, fortification with local recipes is done. The use reduced after April/May because of the high cost. The women in Makera purchased all their item as they do not produce them as the other two sites.

During the monitoring survey, some women in Makera informed us that because they wish for a continuous use of soybeans all year round, they went out of their way in 1992 to try to produce the crop. However, they were discouraged by low germination of seeds, cutting off of the stems by rodents and insects. This problem called for the agronomist interaction with the women.

(iv) *Preservation of soybean products*

Very few of soybean products can be preserved, daddawa is the only products that can be preserved traditionally by drying. With the new technologies transferred, soy-hatsi, dakuwa, daddawa, powdered soybeans flour can be preserved between one week and three months depending on the product and mode of preservation.

Cost of processing soybeans in the three sites is good. The charges given are similar and less expensive. Wet milling of soybean has to be milled two-four times before a smooth paste is obtained. Milling in the urban area is slightly higher because of house rent, electricity and water charges incur by owners of the mill.

(v) *Small scale processing technologies in Kaya*

Kaya and Kurmin Masara being rural area have less processing technologies at hand to use. There are no improved tools, equipment and electricity for use. Even if there is one or two milling machines in the villages, there is always people waiting to grind, this discourages most household in processing soybeans. The need to get local fabricators to mass produce and develop tools and equipment and improved on the performance of existing ones cannot be over-emphasized.

Kaya and Kurmin Masara have few milling machines that uses petrol, local appliances used in the home like mortar, pestle, local sieve are used for the technologies they practised like daddawa, soy-hatsi, dakuwa soup and milk, these are sold in the schools and markets.

Kaduna an urban area has all the facilities for processing most of the technologies learnt are used for daily household consumption. Sources for raw materials for use in Kaya, Kurmin Masara are from their yearly harvest, because their men and women produce soybeans themselves. Kaduna south which is an industrious use area purchases soybean from the market for use, getting land for farming in urban area is a problem.

(vi) *Cost /economic benefits of using soybeans in the selected sites*

Soybean food processing contribute to the economic development of a family. With the transfer of technology to selected sties, most households process soybean for family consumption and income generating. The product they now sell are mainly milk, soy -hatsi (in white polythene leather), daddawa, dakuwa, cheese, talia and waina. Women processors disclosed that they make between ₦100 - ₦300 per week. Soybeans has been the cheapest source of protein in Kaduna state.

Through observation, we noticed that soybean is available all year round in the market for purchase although with fluctuation in price. most households now use soybean for sauce which represent eggs, cheese for beef, etc. Whenever soybean products are produced for sale, especially in schools or market, the products are always rushed for, even demanding for more. Soybean products always have available market and people are ready to buy them because they now know the value of soybean.

Processing constraints in the selected sites can be summarized as follows:

- Inadequate improved processing tools and equipment and even knowledge of where to get them by local processors.
- Poor storability of soybean products.
- Cost of soybeans is getting higher.
- Poor milling of soybean into finer paste.

SECTION 4

Monitoring survey of soybean production, processing and utilization in Enugu state

Introduction

The soybean utilization project Phase II has the general objective of promoting production and use of soybean in rural and urban areas of Nigeria. Production promotion activities were carried out in two rural communities, while processing and utilization activities were carried out in the two rural communities (Okutu and Ozalla) and one urban town, (Enugu) all in Enugu state. One year of soybean promotion was carried out after a baseline survey to determine the status of soybean production, processing and utilization in these three locations. The survey revealed that production was unknown in Enugu urban and Ozalla. In Okutu there was soybean production by very few farmers between 1987 and 1989, but this was discontinued because the people could not utilize nor sell their harvest.

Processing and utilization promotion involved a number of demonstrations by the IDRC/IITA/UNN soybean team. A large number of respondents knew about soybean and were processing and utilizing it in different forms in Enugu while utilization was unknown in Okutu and Ozalla during the baseline survey. In Enugu soybean has been used for the production of liquid milk, dry powder used as substitute for milk, moinmoin, akara, and soup. Also used for enriching pap, rice and other foods given to young children. Soybean was also utilized for feeding livestock. During demonstrations in these three locations, the people were taught many ways of processing soybean and incorporating it in their commonly eaten foods. They were taught how to prepare soymilk, soy gari, soy vegetable soup, soy flour, soy yam, soy okpa, soy cassava fufu, soy eba, soy corn ayaraya. The objectives of this monitoring were therefore to determine the level of adoption of soybean production, processing and utilization in Okutu, Ozalla, and Enugu; identify any problems in their adoption; and make recommendation for further work based on our findings.

Okutu communities

(i) <u>Production</u>

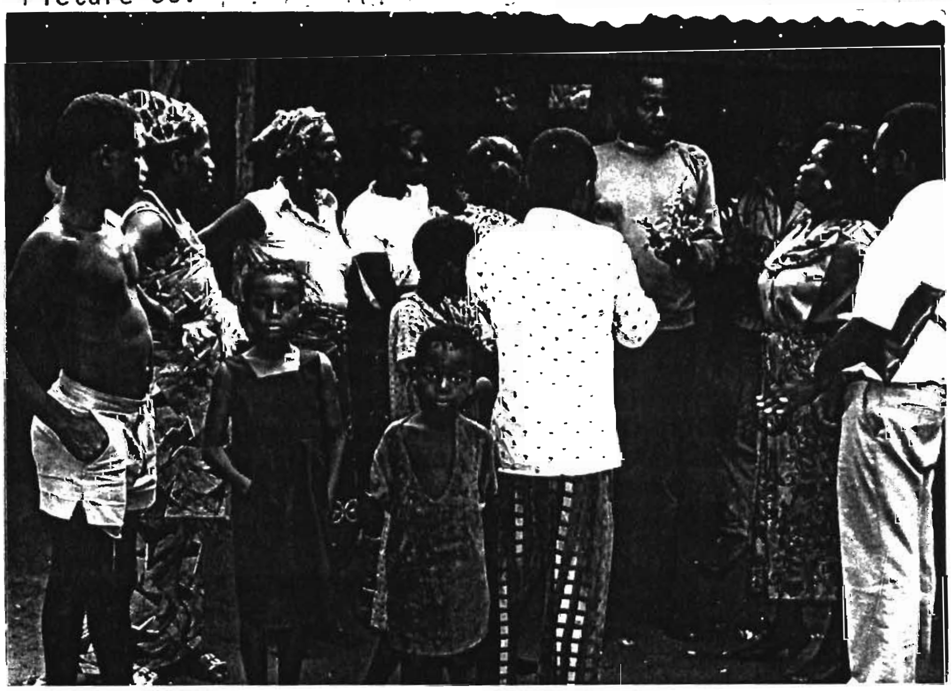
Soybean was introduced earlier in this rural community by the Ministry of Agriculture of the then Anambra State Government but production was discontinued because the harvest could not be sold or eaten. The advent of the IDRC/IITA/UNN Soybean Utilization Project in 1991 with wholistic activities involving production and utilization made possible the growing of soybean again in 1992. Only few farmers actually produced soybean in this community though they got 50 kg of seed, which were meant to be distributed to interested farmers. More than eleven farmers received soybean seed for planting. Soybean farm sizes averaged 0.1 ha as sole crop.

Yield ranged between 460 and 740 kg/ha in this community. Sources of labour for soybean production included family and hired labour. The distribution is as shown on Table 5.7. Both sole and mixed cropping of soybean were practised in this community. Soybean was intercropped with cassava, cowpea, cajanus cajan and groundnut.

According to the people, though they would want to plant more soybeans, their established and cultural food crops receive higher priority attention in view of limited labour for production. Picture 16 shows the project agronomist and some project personnels with a farmer.

Picture 36:

Picture 36:
Project personnel and a farmer walking to farmer's soybean farm.



Picture 37:

Soybean farmer explaining some of the production constraints to project personnels

Picture 38:

The project agronomist explaining as aspect of production to farmers and other project personnels

Table 5.7 Sources of labour, gender involvement and cost of production operations in Okutu

Production operation	Source of labour	Gender	Cost
			₦
Clearing and burning of trash	Family and hire	Male and female	2,000.00/ha
Hoeing	Family and hire	Male	3,000.00/ha
Planting	Family	Female and children	-
Weeding	Family and hire	Male, female and children	1,5000.00/ha
Harvesting	Family	Male, female and children	-
Drying and threshing	Family	Male, female and children	-
Winnowing	Family	Women	-
Further drying	Family	Women and children	-

(ii) <u>*Processing and utilization of soybean*</u>

Soybean was first processed in this community in 1992 after the IDRC/IITA/UNN Soybean Utilization Project team carried out the first demonstration. Soybean was processed and used to make soybean soup, soybean stew, cowpea-soy-moinmoin, soy cassava alibo, soy - yam pottage roasted soybean flour, soybean snacks, in the course of the demonstration carried out in this community. The respondents in this community are unanimous in accepting soybean products as good. However, they were not able to process and use soybean as much as they wanted because of the milling. At present there is only one milling machine in Okutu. The milling machine is a large lister engine type used for milling 'Okpa' (Voendzela Subterrgrea), and the operators are unwilling to mill the few cups of soybean that were process at any one time. A few people have use grinding stones or mortar and pestle which was very tedious. Put together, soybean processing and utilization in Okutu was low and the adoption process slow despite the numerous demonstration in the community which were very enthusiastically attended to by the people. However, there is indication that many people have accepted the soybean idea but use is hampered by some limitations. Only about 20% of the respondents processed and utilized soybean.

Ozalla community

(i) <u>*Production*</u>

Soybean production has been on for only one season, because soybean was first introduced to the community by the IDRC/IITA/UNN Soybean Utilization Project in 1992. The farmers were given soybean seeds and taught how to plant at the same time. Farmers however maintained contact one another sharing information on who has planted, when planted, when to weed, presence of any problem and when to harvest.

Farm size was small, no farmer had a soybean farm greater than 0.1 ha. Grain yield was low because of problem of chickens as well as pods that did not fill properly. Labour for soybean production was supplied by family labour. Most women farmers had their fields hoed by their young boys. Planting was done by men, women and children. A few farmers hired labour to prepare the fields especially when they intercropped soybean with cassava. Such plots were generally large than the sole cropped soybean. Very limited inputs were utilized. The low production in this community was due to the fact that the crop was introduced for the first time and most of the farmers who took part in the demonstration on processing and utilization of soybean were women. The community has limited productive land and can only give a very limited amount of space to an untested crop.

(ii) *Processing and utilization*

After one year of promoting soybean processing and utilization, adoption was at a low level in the community. They are particularly concerned that soybean cannot be eaten like cowpeas or pigeon peas. Very few of the women prepared soybean foods such as milk, soy vegetable soup, soy yam pottage as they were taught during demonstration. Although other foods such as rice, yam, cassava, cocoyam, cocoyam chips, bambara groundnut, maize and cowpeas are eaten, only soup and yam were enriched with soybean. However, all of them could accurately describe the processing of the other products.

Some respondents complained of the drudgery involved in processing soybean such as dehulling and milling. There was no milling machine in the community for either wet or dry milling. Those people who processed soybean relied on their mortar and pestle or grinding stone. Women used the grains and mostly for milk, toasted flour, vegetable soup and enrichment of porridges.

Enugu

(i) *Processing and utilization*

In Enugu urban, the level of adoption and progress in processing and utilization were evaluated in five markets in the town. There were new market, Ogbete market, new haven and kenyatta market. Processors in new market, comprised of two groups, the small processors and large processors.

(ii) *Small processors*

These processors process melon, 'akparata', dry pepper, soybean etc. Small processors (processing between one and ten cups soybean per process) interviewed started processing between 1990 and 1991. They processed for their own personal use and for their customers.

Processing soybean into raw flour comprise about 90% of the processing done for their customers. The raw flour is used for preparing soup either as substitute for melon or in combination with it. One of the processors said he processed roasted soybean flour for some of his customers on request. These people used the roasted soybean flour as substitute for milk in their tea or pap or used it for enriching their rice dishes.

The small processors also sell soybean in their stores. One cup of soybean cost ₦2.50. Their customers either buy the soybean from them or bring it along with them to the market and pay them for processing it at the cost of 1 cup for ₦1.00 and 5 cups for ₦2-₦4. soybean sold in new market is bought from warehouses and in Ogbete market. One bag of soybean cost ₦1000.00. Some of the processors did not consume soybean products, other consume it occasionally.

(iii) *Marketing of soybean and its products*

In 1990 when one of the processors started selling and processing soybean, they were only a few of them. Today there were up to hundred sellers. Although the total quantity of soybean sold and processed in the market has increased due to greater awareness, the quantity sold and processed by each processor has decreased because there are many sellers and processors now. They may sometimes sell between 15 to 50 cups per day and a bag for 2 weeks or more. Contrary to the situation in 1990 when 1 bag was sold in one week when there were few sellers/processors. Soybean products marketed in new market is raw and roasted soy flour which is usually used as soup thickners.

The roasted soybean flour are stored in empty bournvita, peak milk, coast milk etc and tightly covered to prevent spoilage due to moisture and oxygen uptake.

(iv) Other markets (Ogbete, Onu-Asata, New Haven, Kenyatta)

In Ogbete market, there are both small and large processors. The situation was similar to what is obtained in new market. Processing of soybean was occasional. Dry and wet-milling was used for processing. The large processors also process soybean for human and animal consumption. It cost ₦120 to process 1 bag of soybean into flour human consumption and about ₦50 for that of animal consumption. This is because soybean processed for human consumption is milled 3 to 5 times to produce fine powder while it is milled only once for animal consumption.

One important discovery in the market was the adulteration of soybean flour with "akparata" flour with soybean. A group thickner akparata was being adulterated with soybean and maize. Soybean, maize and akparata. were mixed in the ratio of 2:1:1/4, processed into flou. with addition of a little palm oil. The flour produced is sold as akparata which is much more expensive than maize or soybean.

Chapter Six

SECTION 1

TERMINAL SURVEYS

Level of adoption of soybean production, processing and utilization in Lagos and Oyo States (terminal surveys)

Introduction

The successful implementation and completion of IDRC/IAR&T Soybean Utilization Phase I (1987 - 1990) Project, led to the Phase II of the project.

The IDRC Soybean Utilization Phase II (Feb. 1991 -Feb. 1994) Project, was focussed at improving soybean production and utilization techniques; facilitating the domestic qualitative (soy fortified) nutrition; minimizing the soybean/soy products marketing problems; and increasing the income generation, of the general populace, from soybeans.

A terminal survey was conducted to document the status of soybean production, processing and utilization during the Phase II IDRC/IITA Soybean Utilization Project. The report formed the main theme of this document which was in three parts. The first part provided a joint introduction, objectives and methodology cum limitations of the survey; while the second and third parts dealt with the terminal findings in Oyo and Lagos States respectively. Specifically, the terminal survey findings exposed the 'projects' household/industrial usage and local soy production; citizenry perception of the 'projects' performance in isolation and relative to 'Other Projects' intervention in its (IDRC Project) enclave; the health/nutritional status, and the attendant techno-economic cum social-cultural implication.

This work could, of course, serve as data-base for other similar but immediate future works at the present sites, and to extent in Oyo State.

Objectives

(i) <u>*Board objectives of the terminal survey*</u>

To assess and analyse Soybean Cultivation, processing, use and acceptability in Oyo/Lagos State, and to find out Soybeans contribution to the improvement of households food nutrition and income generation.

(ii) <u>*Specific objectives*</u>

(a) To document the (1991 - 1993) production, processing and utilization of soybean in Oyo and Lagos States.

(b) To evaluate the implementation and achievements of the IDRC Soybean project works in Oyo and Lagos States.

(c) To highlight the constraints to the IDRC Soybean project works.

(d) To draw out recommendations from all the findings.

Methodology

The survey was carried out in January 1994. A dual approach was followed: the 'formal' based on four sets of questionnaires, and the informal based on conversation with the target audience. Before the actual survey started, the questionnaires were pre-tested and appropriately modified.

The project sites were purposively covered in representing the various agro-ecological zones and had base-line survey reports with which present findings could be compared. The samples were randomly selected.

Sample distribution were as follows:

(a) Oyo - project sites: Ikoyi/Onilaru 4, Iluju 8, Iroko 10, Aiyete 2, Tapa 20, Onikoko 16, Oniyo 15, Ogede 6.

- health institutions, 3.
- industries, 1.
- state-wide, 180 (OYSADEP) cells.

(b) Lagos - Project sites: Imota Farm Settlement, Idimu.

- health institution, 1.
- industries, 1.

The collected data were analyses. Statistical averages, proportions and range were used in the report.

Limitation of the terminal survey:

Funds set for the Terminal Survey were enforced by the collaborator in IITA rather than the joint consideration of participants' 'Budget - Estimates' of barest sufficiency. A short-coming that placed a serious limit on Terminal Survey works in Lagos State.

Findings In Oyo State

(i) *Soybean production*

Soybean is gradually becoming a popular field crop in Oyo State. Response from 180 cells revealed 114 cells with a 445.62 ha soybean farm cultivated by 2770 farmers (Table 6.1). All farmers were aware of Soybean. Soy production awareness creations in the state's agro-ecological zones were by IAR&T/IDRC in Ogbomoso, UNICEF/IITA in Oyo, IITA and IAR&T in Ibadan/Ibarapa; and the various retired elite farmers cum ONADEP/OYSADEP/IAR&T in Saki.

Men and (including children and the handicapped), institutions, groups and organizations produced soybean. The nucleus of commercial production included Oniyo, Onikoko, Ogede, Ikoyi and Ajawa in Ogbomoso zone; Irawo-owode, Aroje and Igbope in Saki zone; Okaka 'Block' in Oyo zone; and to an extent Ijaiye Orile in Ibadan/Ibarapa zone. Apart from those locations' 'extensive-community-plantings', of soybean farms were seasonally made throughout the State.

Soybean production was encouraged/promoted in the state through:

(a) Awareness created by IAR&T demonstration group on the importance of soybean;

(b) Farina Limited 1992 cash loaning, gifts and guarantee purchase to the soy farmers at Oniyo, Ikoyi and Igangan;

(c) Raw Materials Research and Development Council (RMRDC) 1992 Seed production at Ikoyi and Ojo-Oratu, for the initiation of Soybean Growers Association.

(d) OYSADEP annual SPAT and Demonstration Plots in most parts of the state.

(e) UNICEF, long existing multi-location, household food security project involving women at Iroko, Ikoyi, Ijaiye, Tapa/Igangan, Idoode, Ilua, Komu etc; and the most recent.

(f) WORLD VISION inducement of women to farming.

Nearly all (table 6.2) the farmers at Oniyo produced soybean. In totality of the sampled (table 6.3), 41.54% and an extra 27.7% of the soybean farmers entered into soy production during the IDRC/IAR&T Soybean Project Phases I and II respectively. Normal benefit was reported to be the main inducement (to production), though a sixth of such farmers with 3 years experience conceded their entry to the motive of substituting a part of their usual maize with soybean-owing to unavailability of fertilizer.

The IDRC/IITA/IAR&T project sites' farmers, on first attempt at soy planting, attested to having received soy production training from IAR&T personnel; and also an accompanying free soybean 'seed inputs' of about 5 - 10 kg per individual. The free seeds given were decreased with each successive year of the project life. Certified seed lots sold by seed companies and institutions-like NSS, and IAR&T; and some supplement of 3 - 18% from (farmers) harvests' reserves constituted the major sources of farmers planting materials.

In the project sites, the average individual soybean farm was largest at Oniyo being 1.99 ha, 2.4 ha and 2.82 ha for the 1991, 1992, and 1993 production years respectively (table 6.4). Soybean farm sizes within 0.002-0.5 ha, mostly individually owned, were manually operated, with hired manual labour accounting for 69% of the production costs. Plantings of 1 - 8 ha, involved substantial use of tractors, ploughs, planters and atimes mechanical harvesters; whereas farms above 8 ha were mechanized in all operations. Best-Foods and Onigbinde farms at Ikose near Ogbomoso possessed and utilized combined harvesters in soybean production. The mechanized producers grew soybean sole, on flats by drilling, and at correct spacing. Manual producers mixed/intercropped on ridges/heaps. Crops in the mix being anyone or more *Chocorus*, *Solanun*, *Okra*, *Manihot* and *Zea mays* species. The M351 and TGX536-02-D Soybean varieties were planted.

Planting spacing, on flat-top 'Tiv ridges', was 30cm^2 with 2-3 seeds per stand. Few plantings were indiscriminately spaced. Fertilizer was not applied (to soybeans). Pursuit Plus and Squadron were the herbicides found effective on mechanized plots.

Birds, lizards and toads constituted nuisance on soy plots and necessitated the supply of 3 - 5% vacant stands on planted fields. Rabbits and Hares were destructive on tender and flowering plants. The fruiting soybean plants stem are cut or weaken by termites - accounting for about 8% crop loss in Oyo North (Saki). Flaming torches adapted form lighted 'diesel - filled' tins (Jango Lamps) were strategically erected within farms at night to scare off rabbits and hares from soy cropped plots, just prior to and at soy-flowering stages. Birds were controlled by scaring using juvenile labour within 2 - 12 days of soy planting.

Soybean threshing was considered in all sites as the most hazardous, laborious and tedious post-harvest (production) operation. The motorized soybean Threshers introduced, by 'IDRC Thresher project', to the state farmers were limited (3) in number. There was 16.5% post-harvest loss in yield/ha owing to the field manual threshing.

Over the years (1991 - 1993), at Onikoko, the average soy farmer's yield/ha increased. Diminishing yields/ha were detected at Oniyo. Average yield/ha of 225 kg, 295 kg and 360 kg, for the years 1991, 1992 and 1993 respectively - were achieved at Ikoyi/Onilaru for all mixed-cropping production practices taken together. The harvested soy grains were either stored or disposed off.

(ii) <u>Storage of soybean</u>

Soybean grain batches were stored in various containers: Bagco and polyethylene bags were common in farmers rooms; Kenaf/Jute bags and non-functioning coolers were used in Kersey's Home; while the enamel bowls and plastic buckets were the vogue of domestic processors.

- Procedure of soybean storage in bags:

i. Wash, the thoroughly with soap detergent, then sun-dry.

ii. Line the inner part of the old sun-dried bags with polyethylene sheets or bag.

iii. Put clean well dried soybean in the polyethylene bags contained inside the bags.

iv. Make the polyethylene bags air tight by ceiling with machine.

v. Tie the mouth of the bag with rope.

vi. Put the tied bag, containing soybean, on a raised platform, in a cool room.

Farmers disposal, of harvested/stored soy grains - for either consumption/utilization, sales, reserves or gifts - vary from one location to another (table 6.5).

(iii) *Utilization of soybean*

The aspects of soybean utilization found, were grouped as:

(a) Domestic processing of soy foods for family and locality consumption.

(b) Attempts at soybean utilization for ameliorating health conditions and physiological functioning.

(c) Soybean as raw material inputs for industrial processing.

Domestic soy food processing for family and locality consumption

Soybean incorporation into the target groups' food staples was introduced. Among the target-groups', 61 women were trained, on the soy food preparation, by an experienced Home Economist of the (IDRC) project. Ten training were conducted per location. The soy fortified foods extended in all the agro-ecological zones were soy soup, soy flour, soy cerelac mixture, soy moinmoin, soy gari, soymilk, soy iru, soy akara, soy eba

Of the introduced soy foods, 5 were fully adopted; these included soy vegetable soup $^{o+}$, soy flour ^{o}, soy milk $^{o+}$, soy cerelac mixture ^{o}, soy iru $^{o+}$

Of the adopted, the soy flour, soy vegetable soup, soymilk and soy iru were utilized in all the project sites. The trainees had developed the soy akara using cassava with soybean and the boiled soy cowpea mixture. Soy cheese making had been with a few people in Iluju.

Though gari (the dry granular product made from roasted wet milled and fermented cassava, *Manihot spp*, tuber) constituted a major starchy food staple in all the project sites, yet processing equipment still serve as a deterrent in the adoption of soy gari processing.

Soy flour is solely soybean. There were two types - the full-fat soy flour and the defatted soy flour. With regards to soy flour processing technique, there was full adoption of the Trainers recommendation at the Domestic users' level, and a partial adoption at the commercial level. Traders offered for sale, in exposed or polyethylene packed forms, the dry-milled full-fat soy flour to some 'bukateria', canteen managers who used it in preparing soy vegetable soup.

The soy vegetable soup was made with either wet or dry-milled soy flour. Favoured leaf vegetables component in the soup were *Amaranthus* spp and *Talinum triangulares*. The non compatibility of soybean in either *okra* leaf or *chocorus* leaf, soup was recounted. The cultural taste and characteristic drawness were reportedly absent in soy okro leaf soup; whereas on cooling, there was a drastic reduction in drawness and a gradual brownish tint to the usual greenish colouration of soy *chocorus* leaf soup. All categories of people take soy vegetable soup. When well-prepared, few people who have been found to shy away from soy foods had unknowingly eaten the soy vegetable soup, with relishment.

The technology of domestic soymilk processing, as demonstrated by the trainer seemed wholly adopted by the villagers; though soymilk of various dilution strength (for economic reasons), and packed forms were observed. In the main, educated youths and adults take soy milk.

Two preparatory methods and variant forms of Soy iru existed. The methods were; the dry 'roasted and crushed' dehulled; and the wet or water soaked' dehulled. The forms were the wet (>15%M.C.) and the partially-dried (<15% M.C.) products. Some women were found, at the time

^{o} Soyfood for locality trading.

$^{+}$ Soyfood for domestic consumption.

of survey, project areas (Onikoko, Iroko and Aiyete) trading in self processed soy iru as a means of livelihood or as a supplement to farming. Cream coloured soybean variety (only available) was processed to soy iru in all areas. The soy iru was purchased, mostly, by house-wives, within the localities.

Preparation of boiled soy cowpea mixture'

i. Parboil for 20 minutes, in a pot of 1 litre water, 1 cup of whole grain clean soybean.

ii. Drain the water; dehull the soybeans and wash.

iii. Reboil, for 30 minutes, the dehulled soybean in another 1 litre of water inside the drained pot, till the grains soften.

iv. Add 2 cups of any cleanly washed easy cooking (Mala) cowpea variety to the soft dehulled soybean.

v. Add (according to taste) these ingredients - salt, ground pepper, onion and tomatoes; and oil - to the boiling Soybean cowpea mixture after 75 minutes from cooking.

vi. The whole cooking is completed within 95 minutes.

(a) *Quantity of soybean processed and technologies*

Every household that produced soybean processed and consumed soybean in 2 - 5 meals per week. The local stone-mill and market-place motorized pepper-mills were used in grinding soybean. The source of heat was the indigenous 'stone-built wood fueled' fire place or at best the kerosene stove. The size of the individual household's soybean harvest influence the proportion of soybean retained for domestic consumption. Averages of 126.35 kg and 6.41 kg were annually retained at the project sites - Oniyo and Tape/Igangan respectively (Table 6.5). A less than 1.5 kg soybean per week was processed by the average non-producers that utilizes soybean. The greatest use of soybean (in Oyo State) was at Ibadan.

(b) *Soybean utilization in health institutions*

In the project areas, the health institutions sampled were Ogbomoso Kersey Children Home, Iroko Health Clinic and Igboora Maternity Center Agogo. Kersey Home had been utilizing soybean in all forms of liquid, solid 'wet' and 'dry' pastes; the 'others' used only the utilization of soybean, for over 4 years, as supplement to protein in feeds of babies - that were being breast-feed, weaned, or Malnourished. Soybean was also believed to possess the efficacy of ameliorating the 'black-spots' disease on legs.

Health Institutions officials attested to having an access to soy food preparation through audio visuals, demonstrations/training by IDRC personnel from IAR&T. The Nursing officials techniques of passing their gained knowledge on soy foods, to young mothers, was through group discussion in states clinics; but especially through practical soy foods preparation/demonstration at Kersey Children Home (KCH); a Home which utilized annually, over 10 tonnes (Table 6.5). Among the soy foods prepared at KCH and fed to inmates (kwarshiokor and marasumic children) were soymilk, soy eko, soy cheese, soy akara and soy tuwo.

Every child that passed through the health clinics within the last 3 years (1991 - 1993) was said to be a soya (fed) baby.

(c) *Soybean as raw material input for industrial production*

Notable soy processing industries in Oyo State started production in 1991. Foremost among such industries is Deagbo Industries Nigeria Limited, which has increased its raw material input of soybean from 10.8 tonnes (in 1992) to 24.3 tonnes in 1993. Premium industrial soy products were 'Chocolate soymilk' and the bottled 'Vanilla soymilk'.The Soy Industries major constraints were spoilage/rapid wear of processing machines and poor storability of products.

Marketing of soybean and soy products

(a) *The soybean marketing problem*

Some pleasant farmers had cash-flow problems immediately after Soybean harvest and prior to Soybean sales. Consequently, those farmers were unable to meet their financial commitments to hired 'Contract labour' as well as purchase the essentials for the end of year activities; hence the farmers urgency for high Soy-price marketing /cash earnings. The industrialists' (the main users of Soybean) purchasing department, who at the equivalent period (December) were normally, on their end-of-year book balances, stressed that it would be unreasonable and too early to make a beginning of year stock purchase. These conflicts had accounted for the temporary doldrums periodically experienced in soybean marketing. Apart from the afore-mentioned the industrial bulk-buyers were unfascinated by 'unpolled - together' small piece-lots of small-scale soybean producers.

(b) *Modes of marketing soybean and related products*

There are many markets in Oyo State; each project area has at least one periodic or daily market (Table 6.6) accessible by motorable road. Purchasing power for and volume of trade in soybean vary with markets. Soybean batches of within 1<100 kg were usually sold by kongo (1.2 kg) measures at the daily markets. Soy grains were also sold through some other (Fig. 1) distribution channels. Oniyo/Onikoko farmers sold the 1992 soybean harvests through the Soybean Association of Nigeria (SAN). The Association accumulated the individual farmers soybean small quantities and then sent the trailer loads to Farina Limited in Lagos State. That arrangement entailed increased marketing cost, competition and reduced marketing margin of individual farmers. The Ikoyi farmers as pre-arranged sold their 1992 harvested soybean seeds of 13.82 tonnes to the RMRDC.

(c) *Demand for soybean and its products*

The project areas had their specific favourite food staples. The availability of the food staples affected the demand for soybean, in cases where the staples could be substituted for, rather than complemented with soybean. At the peak of melon harvests, the demand for soybean decreased. The demand for soybean and soy products also varied with the:

i. Period/season of the year

- Soy flour purchases increased with the bloom of vegetables in April - June.
- Soybean purchases increased during the soy planting season in June/July.
- Soymilk and milk analogues demanded more in dry season (hot weathers).

ii. Type of product: Products with longer shelf-life attracted more purchases.

iii. Discretion of the soy producers: With increasing harvest and unguaranteed market, farmers use of soybean increased. Generally consumption of soymilk tended to be higher in urban towns.

(d) *Supply of soybean and soy products*

The supply of the commercial soybean, cottage level soy flour and soy cereal mixture were subject to seasonal variation. Industrial instant soy flour was scarce at supermarkets. The supply of industrial soymilk and soy oil was devoid of seasonal effect; the offer being spread throughout the year.

(e) *Price trend of soybean*

The selling price of Soybean was highest (#18000/tonne) in June 1993; and lowest (#8000/tonne) in December 1993. The price was relatively stable at #12,000/tonne in between the above periods.

(f) <u>Project sites' commercial trading in specific soy products</u>

There was trade, in 'oil-fried and sliced' soy cheese, at the periodic market of Iluju; and Soy iru at Onidundu and Obada markets, whereas Soy flour and soybean, packed separately in polyethylene sachets, were sold at all the project sites daily markets.

Evaluation of (and summary on) IDRC Soybean Utilization Project Phase II in Oyo State

The IDRC Soybean Project Phase II was evaluated through the clienteles' perception of the projects performance in their project sites; and the analyses of collected data, together with the observations made, by the socio-economist during surveys. The project performance and achievements were considered in relation to the IDRC (Soybean projects) set objectives that fell within technical, socio-cultural and economic aspects.

(I) Technical (Training & Technologies)

A Implementation and Achievements:

(i) Soybean awareness creation by the IDRC/IAR&T soybean projects aided the increase in proportion of farmers growing soybean at the project sites to 54.48.

(ii) The supply of free soybean quality-seed meant for initiation of new farmers, and the production training were timely.

(iii) Production success or successful plantings helped the sites male farmers to go beyond the reliance on free seeds from IAR&T or IITA and learn more on their (farmers) own 3 - 18% reserves from harvest.

Another IDRC project - the 'threshers project' had developed, and supplied the IAR&T designed and fabricated, soybean Threshers during threshing periods to farmers in Shaki, Onikoko and Oniyo.

iv. Some farms (e.g. Onigbinde) had fully mechanized soybean production.

v. Altogether over 200 women were trained on soy foods preparation through several demonstrations per site. Utilization training were adjudged, by the participants (trainees), as precise and useful.

vi. Five soy foods (soy flour, soy vegetable soup, soymilk, soy iru and soy cerelac mixture) were fully adopted. The trainees had developed 2 soy foods (boiled soy cowpea, and the soy akara - 'cassava mix'), and modified 2 other soy food to suit local taste.

B Short comings

i. Mono-provision of inputs: Only soybean seeds for the projects' new farmers. This is at variance with 'other projects' (table 6.7) provisions.

ii. Non-provision of small-scale processing equipment, nor supply of soy processing 'practice sample-soy grains' consequently the trained women (soy processors) were less equipped to practice the learnt technologies at home. Moreover, there were instances of the conversion/diversion of the free soy planting seeds to processing seed by some women farmers.

(II) Socio-cultural (population and infrastructure)

A. Achievement

i. Growth of villages in population and extent had taken place. Soybean farmers among farming population had increased in and around Oniyo; though 91.4% at Oniyo itself. The increase in farming population had been due to farmers knowledge about the importance of soybean as a crop.

ii. Increased knowledge and information gained by farmers population, on production, processing and marketing was through contact with IDRC/IITA researchers, and project staff. Farina Limited gave (freely) small radios, to soy producers at project sites of Onikoko, Oniyo and Ikoyi - in recognition of the farmers production achievement.

B. Short coming

No infrastructure was set up by the IDRC in the project sites, with which the IDRC Soybean project could be identified. There was not even a meeting hall for participants.

(III) Economic

A. Achievements

Real Benefits (Welfare and Nutrition).

i. Less weedy environment around village sites. Plots from which well cultivated soybean had been harvested, presented relatively cleaner view of field-land.

ii. Drastic reduction in fertilizer requirement for early maize crop following on the plots previously cropped with the medium maturing soybean.

iii. More feeds for goats and sheep scavenging on soy harvested plots and threshing floors.

iv. Better health and Nutrition

   a. Reduced kwarshiokor and marasumic cases in Ogbomoso environments. Kersey Children Home recorded reduces malnutrition intakes (301 patients in 1991 to 185 patients in 1993); and had 98.91% success in Soybean utilization for a (2 - 4 weeks duration) curative treatment of infantile malnutrition.

   b. Experimental 'amelioration treatment' of high blood pressure patients using soybean oil had been on at University College Hospital Ibadan.

   c. Soy-babies were shown with appreciation to IDRC soybean project evaluators, by mothers at Iluju and Iroko.

   d. Bodily growth and maintenance through 'indigence' incorporation of soybean in 2 - 5 meals.

Nominal Benefits (Prosperity and Opportunities).

i. Commercialization of soybean in Oyo State stemming from, increase in average soybean hectarage cultivated per farmer; sole cropping increase of 42% at Oniyo (1.99 ha to 2.82 ha), 42.36% at Onikoko (0.72 ha to 1.025 ha) and 159.26% at Ogede. Mixed cropping increase of 119% at Ikoyi/Onilaru (0.468 ha to 1.025 ha).

   In 1993, of the sampled OYSADEP cells, in Oyo State, 52% of the total soybean hectarage was from Ogbomoso where IDRC/IAR&T Soybean Project was operating nearly in isolation from other donors projects.

ii. A Profitable soy production level per average farmer in Oniyo has led to the farmers increased seasonal net earning of at least #8986.8 (from 1.75 tonnes x #12000, less 2.82 ha x #4,260). The cummulative of such net earnings had furnished;

   a. Increased purchasing power for soy farmers personal and household effects in the villages.

   b. Capital for the establishment of other supplementary enterprises (for example the corn-mill at Oniyo).

iii. a. Soy processing Industries have sprung up in the State; thereby adding to the Ad-Valorem tax accruing to the State Government coffers.

b. Existing Soy Industries (Ormans Industries, Deagbo, Milkmans and JOMARTEX) have been kept in production by the locally supplied soybean inputs.

c. Poultry industries have been profitably revitalized in the State through Soybean based feeds.

iv. Means of livelihood furnished by soybeans to project sites old women in soy iru trade; and employment opportunities for children and retired men in soybean production and processing.

v. Inter-state trade in soybean between Oyo and Lagos States. Increased locality and intra-state trade in soybean and soy products.

Conflicts of the project

a. Increased settlement of aliens in the project sites had brought in varied culture, with a concomitant insufficiency in basic social-amenities to cover the expanding population. The DFFRI bored wells at Oniyo/Onikoko temporarily run dry in the mornings during the dry season.

b. Heaps and bulky hauls of garbage dotted fields after soybean threshing; inviting termites incursion into crop-land.

Situations that would have prevailed had the (IDRC/IAR&T Soybean) projects not been undertaken

a. i. A 'None - IDRC Project' situation is faintly sensed in the comparative analysis of data on savannah zones of Shaki (No IDRC, but some other donor projects existence) and Ogbomoso (IDRC project and rarely other donor projects). The data revealed the average individual soyfarm size in Ogbomoso to be about 5 times (or 289.57%) as much as in Shaki.

ii. In Ibadan zone where both IDRC and other projects were fully operational, though average individual soyfarm size was 0.0769 Ha, the 'other projects', through their credit/cash inducements on target group, might have served as disruptive rather than be associative with, or complementary to IDRC project works.

b. A 'None IDRC Soybean Project situation' would definitely have meant below average realization or unattainment of those detected achievements listed in this report.

Lessons learnt from the IDRC/IAR&T Soybean Utilization

a. Innovative projects for rural development achieved sufficiently observable success on a micro rather than macro operational level.

b. Success story can serve as adoption infiltration from the micro to macro areas.

Management (in IITA) of the project

(i) Merit

Funds for utilization and production aspects were disbursed on time.

(ii) Demerit

Average area:

The project had taken to too much coverage area than available donor funds could excellently cope with.

Conclusion and recommendation

A lot of patented technological and infrastructural investment will be needed in the IDRC/IAR&T Soybean project sites, to promote sustained, continuous and improved production, processing and utilization of soybeans. The investment is also necessary to uphold goodwill as well as stamp a 'foot print mark' of IDRC commitment of huge sums of money to Soybean project in Oyo State particularly and Nigeria in general.

Findings in Lagos State

(i) <u>Soybean production</u>

Soybean production in Lagos State was on a subsidiary level. Up to 46.88% and 20.41% of the IDRC/IAR&T project farmers within Imota Farm Settlement and the Idimu Agbelere Women Farming groups respectively planted soybean. Farm-land was limited. The average individual soyfarm size was 0.0015 ha for the Idimu group; and the range 0.15 ha - 0.164 ha for the Farm settlers. The producers had drastically reduced their soyfarm size by nearly half within 1992 to 1993. Sole cropping and mixed cropping were practiced. Cassava, vegetable and maize were the States' crop of great economic importance.

In farming, family labour supplemented hired labour. The hired labour accounted for 73.19% and 42.4% of the 1993, soybean production costs on manually operated and partially tractorised farms, respectively (Table 6.8).

The IDRC production personnel supplied without cost, 5 - 10 kg of M351 variety of soybean seeds to every trained project sites' farmers. Spots planting of 3 seeds per heap, was adopted, while the ridges were drill seeded. The soybean plots were not manured and always manually weeded. Vertebrate pests like rabbits and hares; together with damping off disease constituted the greatest scourge/hazards, during Soybean production.

The soy harvests were manually threshed, with grain yield, (Table 6.10) from an average farm, never more than 1.25 kg for Idimu and 23.44 kg for the Farm Settlers. Harvested soybean grain-size was a half of the planted seeds' size.

(ii) <u>Utilization of soybean</u>

Training in domestic processing of soy foods

The project site members were trained, through practical demonstration, on several soy foods processing technologies, introduced by the IDRC/IAR&T Home Economist. Training were conducted for each of the Idimus' and Farm Settlers' groups. Of the introduced technologies, the soy (vegetable) soup, soy moinmoin/abari, soy akara and soy iru were adopted. In adopting the trainers procedure as outlined for the accepted soy foods, a few modifications, deemed necessary, were effected by trainees on soy vegetable soup and soy moinmoin preparations. The method adopted by the trainees are briefly described below.

Soy moinmoin/abari

The final milled slurry made from dehulled 1 part soybean, and 2 parts cowpea or maize, and the ingredients (pepper, + onion + simmered oil) was diluted with boiled water.

Soy (vegetable) soup

Melon paste and a little quantity of water should be added to milled soybean, at the making of soybean paste solution, so as to eliminate excessive frothing and charring/burning of soy (vegetable) soup during the cooking or boiling process. This method is adopted during soy vegetable soup preparation.

Greatest use of Soybean had been discovered in soy processing Industries of Lagos State. The 'Project Trained' domestic soybean utilization, for soy foods processing, was dependent on the remnant soybean from the free seeds supplied by the IDRC project personnel and the harvests from individuals soybean farms. Farmers occasionally purchased grains from markets.

All of the sampled, except a few of the settlers, consumed the whole grain-yield from their soy farms (Table 6.9). The average soy consumption per household was in 2 meals per week, by soy producers and occasionally by non-producers but utilizers. Major constituents of the peoples' meals were usually of *gari*, cocoyam, *ikokore*, abari, rice; and vegetable or fish soup. Motorized Pepper mills and the local mill-stones were used for grinding soybeans.

Processors complained about non-availability of soybean in their immediate vicinity/neighbourhood.

(iii) *Soybean as raw material input for industrial production*

Most of the reputable soy processing industries in Lagos State started production in 1991. One of such is Farina Limited, whose initial 20 tonnes of Soybean Utilization (in 1991) had increased to 75 tonnes in 1993.

Consumers favoured (Farina's) products were soy yoghurt and soy ice cream, over which the 'Firm' had recorded an average 95% products' sales.

The soy industries major constraints were spoilage/rapid wear of processing machine and poor storability of products.

(iv) *Soybean and soy products marketing*

Soybean was available in wholesale and retail at Mile 12. Soybean retailers were males and females from various tribes; and constituted 18.5% of the 'cereal and legume' sellers . As at January 1994, Derica and Kongo measures of soybean cost ₦15 and ₦20 respectively.

Soymilk and milk analogues were retailed in 'iced-mobiles' throughout Lagos metropolis. Brands of Soy oil, instant soy powder, soy crisps were seen on display in metropolis super-markets. Soy iru was reported as being sold to LASU. Soy meals were sold to livestock industries, nation-wide.

(v) *Some achievements of the IDRC/IAR&T Soybean Project*

i. If not for the project, the people of the project would not have known what soybean is.

ii. Soybean, as recommended, by project staff through Agbowa Primary Health Center was successfully used to treat kwarshiokor that afflicted Yeye Ojo's daughter (Residence No 2 at Imota Farm Settlement).

Conclusion

Efforts so far made to put a portion of the highly scarce Lagos State's land to soybean production were commendable. Comparing the returns form soybean production and the benefits accruable/derivable from vegetable cultivation (Table 6.12 a, b) it is extremely doubtful if soybean production, in actual sense, could be a reality in Lagos city before the end of this century.

Recommendation

i. In the project sites efforts should be concentrated at extending soy flour, soy (vegetable) soup, soy moinmoin, soy iru, and soy akara.

ii. Soybean varieties that could be easily cooked, for consumption - by boiling in water, should be discovered.

iii. An IDRC/IAR&T Soybean project processing house should be constructed at Imota Farm Settlement.

Gari processing machines should be separately installed on 'loaned agreement' for the 'Idimu Agbelere Cooperative', and the 'Ikorodu Women Food First Cooperative'.

Table 6.1 The distribution of 'crop and soybean' farmers, and the soybean farms in sampled 180 zonal cells

Table 6.2 The distribution of crop and soybean farmers in IDRC/IAR&T Project sites of Oyo state

Project	Crop farmers (units)	Soybean crop farmer (units)	Proportion of soybean	Farmers in crop farmers (%)	Proportion of soybean farmers in crop farmers (%)
	Male	Female	Male	Female	
Oniyo	27	20	27	16	91.49
Onikoko	19	20	19	13	82.05
Ogede	11	12	5	7	52.17
Ikoyo/Onilaru	60	21	31	8	48.14
Iluju	39	14	16	3	35.85
Iroko	na	26	na	11	42.31 (women)
Aiyete	na	na	(1)	(1)	na
Tapa/Igangan	36	13	11	4	30.61
Total	192	126	110	63	54.40

Source: Figures adapted from farmers lists submitted by farmers group during IAR&T/IDRC Phase II terminl survey, January, 1994

Table 6.3 The frequencies on 'gender basis' of 65 responses to 'years on soy production' in January

Sites	1-3 Years		4-6 Years		7-9 Years		10-12 Years		
	Male	Female	Male	Female	Male	Female	Male	Female	Total
Oniyo	1	2	4	1	5	1	1	-	15
Onikoko	1	1	5	1	4	1	3	-	16
Ogede	-	2	2	1	-	-	1	-	6
Ikoyi/ Onilaru	-	2	1	-	-	-	1	-	1
Iluju	-	-	3	1	-	-	-	-	4
Iroko	-	3	3	1	3	-	-	-	10
Aiyete	1	-	1	-	-	-	-	-	2
Tapa	5	-	1	2	-	-	-	-	8
Total	8(12.31)	10(15.38)	20(30.77)	7(10.77)	12(18.46)	2(3.08)	6(9.23)	-	65

Source: IAR&T/IDRC Soybean Utilization Phase II terminal survey, January 1994
Figures in parenthesis at the last row are percentage based on row total.

Table 6.4 The farmers age soybean farm and soybean yield for 1991-1993 in IAR&T/IDRC project sites of Oyo State

Project sites	Sampled (1991 to 1993) Men	Soybean Women	Age of soybean farmers (Years) Range	Average	Soybean farm size (ha)) 1991 Range	Average	1992 Range	Average	1993 Range	Average	Soybean farm yield (kg) 1991 Range	Average	1992 Range	Average	1993 Range	Average
Oniyo	11	4	19-68	35.93	0.2-6	1.99	0.4-8	2.4	0.8-8	2.82	120-3500	1271.83	200-5000	1516.67	300-5000	1750
Onikoko	13	3	24-80	51.56	0.2-2	0.72	0.2-1.6	0.85	0.3-2.5	1.025	50-1500	693.75	60-1800	841.375	150-2500	1071.875
Ogede	3	3	33-60	50.17	0.2-1	0.27	0.2-2	0.73	0.2-2	0.7	200-450		100-1000	408.33	50-1000	483.33
Ikoyi/Onilaru	2	2	37-60	48.15	0.2-1.6	0.468	0.4-1.8	0.668	0.4-2.4	1.025	200-500	225	30-1201 110-600	354.25 295	100-750	360
Iluju	2	2	42-58	50	0.2-0.4	0.35	0.4-1.2	0.8	0.4-1.6	1.1	200-300	262.5	300-800	475	300-850	525
Iroko	6	4	40-65	56.8	0.2-1	0.312	0.0-40.8	0.088	0.0-0.4	0.12	100-400	140	50-250	115	0-325	89.5
Aiyete	1	1	29-62	45	0.2	0.2	0.1-0.4	0.25	0.4	0.4	150	150	100	100	100	100
Tapa/Igangan	6	2	36-50	43	0.0-0.8	0.25	0.2-0.8	0.4	0.04-0.8	0.255	0-400	125	100-500	214.29	3-200	119.5

Source: IAR&T/IDRC Soybean Utilization Phase II terminal survey, January 1994

Table 6.5 The major soybean/soy products markets at the IAR&T/IDRC project areas of Oyo state

	Markets (and types)	
Project areas	Daily	Periodic
Ikoyi	Ikoyi	Iluji
	Arowomole (Ogbomoso)	Tewure
	Onidundu	Iware
	Bodija (Ibadan)	
Topa/Igangan/Aiyete	Alemo	Alabi (Aiyete)
	Obaninsun (Aiyete)	
	Kajola	
	Obada (Tapa)	
	Towobowo (Igboora)	

Source: IAR&T/IDRC Soybean Utilization Phase II terminal survey, January 1994.

TABLE 6.6 Comparing the operational systems of some donor agencies in the IAR&T/IDRC soybean project sites of Oyo State

Factors	Onikoko/	Ikoyi/Onilaru			Iluju		Iroko/Ijaiye		Tapa/Igangan	
(a) International donor agencies in sites	IDRC	IDRC	UNICEF	World	IDRC	UNICEF	IDRC	UNICEF	IDRC	UNICEF
(b) Inputs & supply frequencies by agencies	500 kg Soybean Seeds per clientele per annum Free Training on soybean soybean utilization	500 kg Soybean Seeds per clientele per annum Free training on soybean on soybean	Training on Health and Nutrition		500 kg Soybean clientele per annum Free Training on soybean utilization	Training on health Nutrition	500 kg Soybean clientele per annum Free Training on soybean	Soybean seeds of tree crops	500 kg soybeans clientele per annum Free Training on soybean utilization	Training on Health and Nutrition
(c) Infrastructures set-up by agencies in sites	-	-	Health Care Centre	-	-	na	-	Processing Centre (Iajiye) Daycare Centre Modern Toilet Borehole Water (Waston Assisted)	-	Meeting hall
(d) Other incentives group	-	-	na			Water tanks for portable water	-	Adult Education Programme	-	Assistance to Women Training Dept in Joint Baptist Pastor School
(e) Invitation of target group to conferencies	-	-	Once (at least) per annum		-	Once (at least) per annum	-	Once (at least) per annum	-	Once (at least) per annum

Source: IAR&T/IDRC Soybean Utilization Phase II terminal survey, January 1994

TABLE 6.7 Average costs of production on soybean 1 ha and 0.02 ha farms in Lagos state

Operations/Mandays	Cost		
	Hectare		
	Manual ₦	Partial Tractorisation	0.02 ha Manual ₦
Land clearing 10md/acre at ₦/md	2,000	2,000	40
Heaping/ridging 20 md/acre at ₦50/md	5,000		100
Planting (family labour) 5 md/acre at ₦50/md	625	625	12.5
Weeding - 1st weeding 13 md/acre at₦80/md	3,000	3,000	60.0
2nd weeding (family labour) 15md/acre at ₦80/md	3,000	3,000	60.0
Harvesting (family labour) 5 5md/acre at ₦50/md	625	625	12.5
Threshing 8md/acre at ₦80/md	1,600	1,600	32.0

Source: IAR&T/IDRC Soybean Utilization Phase II terminal survey, January 1994
*Hired labour costs - ₦11,600 manually operated soyfarm
- ₦4,600 partially tractorised soyfarm

TABLE 6.8 The average farmers disposal of farm yields of soybean in IDRC/IAR&T project sites of Lagos State

Project sites	Production	Disposal			
		Domestic consumption	Sales	Reserves	Given out as gifts
Ikorodu farm settlement	23.44 (100)	14.58 (62.19)	3.48 (14.84)	3.96 (16.88)	1.42 (6.09)
Idimu cooperatives	1.25 (100)	1.25 (100)	-	-	-

Source: IAR&T/IDRC Utilization Phase II terminal survey, January 1994
Figures in parenthesis are percentage based on row total

TABLE 6.9 Average cost of production on 0.02 ha (dry and wet season) vegetable in Ikorodu farm settlement

	Operations	Cost of production ₦
i.	Rentage of land from ORBDA	40
ii.	Tractorisation	2,000
iii.	Irrigation water from ORBDA	500
iv.	Vegetable beds - 20 bedgs construction at 2 beds/md (1md = ₦100)	1,000
v.	Nursey work:	
	- 5 nursery beds construction at 1 bed/md	500
	- seeds (for Amaranthus, cochorus bitter leaf, egbo)	500
	- Care of nursery seedling by family labour	1,000
vi.	Mannuring	
	- Fertilizer doses (NH_4NO_3 or Urea)	1,000
	- Application by family labour	500
vii.	Spraying	
	- Chemicals	1,500
	- Application of chemicals (family labour)	500
	- Depreciation on equipment	1,500
viii.	Harvesting	
	- Family labour at 2md/week - 104md	5,200
ix.	Marketing	
	- Transportation	5,200
	- Market stalls levey	
	- Family labour	
	- Container/ropes	
		20,940

Table 6.10 Gross returns from 0.02 ha dry and wet seasons vegetable in Ikorodu farm settlement

	Items	Returns ₦
(a)	Rain-fed vegetable yield 1280 dozens (from 40 dozens X 32 weeks) at ₦10/dozen	12,800
(b)	Irrigated vegetable yield 800 dozen (from 40 dozens X 2 weeks) at ₦30/dozen	24,00
		36,800

Source: IAR&T/IDRC Soybean Utilization Phase II terminal survey, January 1994

Harvesting
- Internal is once in 3 days, that is, twice/wweek
- Period, 32 weeks in rain fed, 20 weeks in irrigated yield of vegetables per bed = 2 dozens/week

APPENDIX

Socio-economic terminal (summative evaluation) survey on soybean production, processing and utilization end of (IDRC/IAR&T project) Phase II

Questionnaire No. __________

Date: ______________________

State: _________ Local Government Area: ____________

Village: _________

1. Name of respondent: ____
2. Sex: ____________________
3. Age: ____________________
4. Marital Status: Married/Widowed/Divorces/Single
5. No. of wives (if male): ______________________________
6. No. of children: ______________________
7. Occupation

(a) Farmer
(b) Trader
(c) Home keeper
(d) Others (specify)

8. Religious affiliation:

(a) Christian
(b) Muslem
(c) Traditional
(d) Others (specify)

9. Ethnic group (tribe)

(a) Yoruba
(b) Ibo
(c) Hausa
(d) Ibibio
(e) Tiv

10. Level of education

(1) No formal education
(2) Primary school
(3) School certificate
(4) Others (specify)
(f) Others (specify)

SECTION 1

PRODUCTION:

1. Do you know what soybean is? Yes/No

2. If yes, what was your source of information?

(i) Through the news media
(ii) Through friends
(iii) Through government agencies
(iv) Through Better Life Programme
(v) Others (specify)

3. Do you grow soybean?

(i) Yes
(ii) No

4. When was it introduced to you?

(i) Less than a year ago
(ii) 1 - 2 years
(iii) 3 - 4 years
(iv) 4 - 5 years
(v) Over 5 years (specify):____________________

5. What is your source/organ of Information about soybean production?

(i) Radio
(ii) Television
(iii) Radio & Television
(iv) Publications (written)

6. Who practically introduced you to soybean production?

(i) Research Scientist
(ii) VEA
(iii) Copeer/Friend
(iv) Self (by Trial Method)

7. Which organizations Agent Disseminated information about soybean production to you?

(i) Ford Foundation
(ii) IDRC
(iii) COWAN
(iv) UNICEF
(v) Indigenous Programme (e.g. Better Life)

8. How many people live in this household?

(i) 1 - 3
(ii) 4 - 6
(iii) 7 - 9
(iv) 10 -12

9. Which sort of people grow Soybean in this household?

(i) Nobody
(ii) Self
(iii) Husband & Wife
(iv) Husband, Wife & Children (The whole family)
(v) Everybody in the household

10. Give the number of persons growing Soybean in the household?

11. When did you start growing Soybean?

(i) 1 year
(ii) 2 years
(iii) 3 years
(iv) 4 years
(v) Over 4 years (specify): ______________________

12. What was the size of your Soybean farm at the first time of growing?

(i) Less than 1 hectare
(ii) 1 hectare
(iii) 2 hectares
(iv) 3 hectares
(v) 4 hectares
(vi) Above 4 hectares (specify): ____________________

13. How big was your Soybean farm last year?

(i) Less than 1 hectare
(ii) 1 hectare
(iii) 2 hectares
(iv) 3 hectares
(v) 4 hectares
(vi) Above 4 hectares (specify): ____________________

14. How big was your farm 2 years ago?

(i) Less than 1 hectare
(ii) 1 hectare
(iii) 2 hectares
(iv) 3 hectares
(v) 4 hectares
(vi) Above 4 hectares (specify): ____________________

15. How many other Soybean farmers do you know in your area?

(Specify number): ____________________
Enumerators should direct their questions to the soybean grower.

16. Give the names of other villages around you in which Soybean farms could be found

17. Give the names of other soybean farmers (know to you) in the other villages mentioned.

18. What institutions/agencies have helped you in soybean production?

(i) None
(ii) Government
(iii) Companies: (Please name): ____________________
(iv) Educational institutions
(v) Other (specify): ____________________

19. In what way did these institutions help you? (Assistance given)

(i) Training in production
(ii) Provisionof input (specify)
(iii) Training in production
(iv) Credit
(v) Others

Government
Companies
Educational
Institution
Media
Others

20. What method and implements do you use for these various steps?

Steps	Method	Implement
	Manual	Mechanized
Landing clearing		
Ploughing		
Harrowing		
Ridging		
Heoing		
Planting		
Weeding		
Fertilizer application		
Pesticide application		
Harvesting		
Threshing		
Winnowing		
Storage		

21. Which other crops do you grow? (Actual measurement of the field should be got for the current season in respect of soybean)

Crops	'Hectarage'			Yield'		
	1991	1992	1993	1990	1992	1993
Soybean						
(List other major crops)						

22. Has soybean replaced any of the crops you were growing?

Yes/No

23. If yes, which crop? (specify): ______________________

24. What systems of cropping do you use?

(i) Monocropping
(ii) Intercropping
(iii) Both

25. If intercropped, indicate the crops?

(i) Cassava
(ii) Maize
(iii) Guinea corn
(iv) Yam
(v) Other crops (specify): ______________________

26. What Soybean varieties do you prefer and why?

(i) White
(ii) Yellow
(iii) Black (include agronomic varieties)
(iv) Other (specify): ______________________

27. Which of the soybean varieties do you prefer and why?

Types: (i) Black (ii) Yellow (iii) White
Reasons ______________________

28. What problems do you encounter in soybean production?

(i) Scarcity of seeds for planting;
(ii) High cost of land preparation;
(iii) Lack of tractors;
(iv) Pests, birds, rodents, domestic animals, insects;
(v) Tedious threshing step;
(vi) High cost of labour;
(vii) No market for disposal;
(viii) Low price of products;
(ix) Other (specify): ______________________

29. What solutions have you tried?

(i) Appealed to government
(ii) Bird scaring
(iii) Traps for rodents
(iv) Formed cooperatives to deal with input problem
(v) Approached government agencies
(vi) Other (specify): ______________________

30. How many bags of Soybean did you harvest?

YEAR:	1991	1992	1993
Quantity (50 kg) ______________________			

Soybean harvested
Less than 1 bag (specify): ____________
1 bag
2 bags
3 bags
4 bags
Over 4 bags (specify): ________________

31. Farmers disposal, by percentage %, of harvested soybean grains

(i) Used at home
(ii) Sold
(iii) Reserves (for Future planting)
(iv) Given out (freely)

32. If you market, how do you market your soybean?

	Within the State	Outside the State
(i) Open market		
(ii) Contractors (wholesale)		
(iii) Selling to industries		
(iv) Others (specify): ________________________		

33. At what price do you market your Soybean?

34. Indicate your storage method?

(i) Jute bags
(ii) Sealed containers
(iii) Polyethylene bags
(iv) Others (specify): ___________________________

SECTION 2

UTILIZATION OF SOYBEAN

35. Do you use soybean? Yes/No

36. If yes, what soybean products do you make?

(i) Soybean milk
(ii) Roasted Soybean beverage
(iii) Moin-moin
(iv) Akara
(v) Eba
(vi) Vegetable soup
(vii) Others (specify): ___________________________

37. Who taught you how to prepare the Soybean product?

(i) Nobody
(ii) Government agents
(iii) Extension workers
(iv) Health personnel
(v) Others (specify): ______________________

38. When did you get the training or information on soybean utilization?

(i) Less than a year ago
(ii) 1 year
(iii) 2 years
(iv) 3 years
(v) 4 years
(vi) Others (specify): ______________________

39. Rank these products in order of preference

(1)	(2)	(3)	(4)
(5)	(6)	(7)	(8)

40. How do you obtain your grains for utilization?

(i) From open market
(ii) Produce from farm
(iii) From other farmers
(iv) Gifts and source
(v) Others

41. Who eats Soybean in your household?

(i) Children only
(ii) Adolescent only
(iii) Adult males
(iv) Adult females
(v) All of the above
(vi) Others (specify): ______________________

42. How often do you consume soybean in a week?

(i) Daily
(ii) 5 times
iii) 4 times
(iv) 3 times
(v) Twice
(vi) Once
(vii) Others (specify): ______________________

43. Do you sell any soybean products? Yes/No

44. Who are your major customers?

(i) School children
(ii) Market women/men
(iii) Other agencies (specify): ______________________

45. How much does it cost to produce and how much do you realize from each sale?

Products	Cost of production ₦	Selling price

46. What problems do you encounter with soybean utilization?

(i) Scarcity of seeds
(ii) Tedious processing method
(iii) No market for products
(iv) Poor acceptability
(v) Poor storability
(vi) Others (specify): ______________________

47. List the most common traditional dishes in this area/city?

(i) Gari
(ii) Pap
(iii) Pounded yam
(iv) Pounded cassava
(v) Maize dishes
(vi) Rice dishes
(vii) Guinea corn
viii) Plantain
(ix) Beans
(x) Yam
(xi) Cocoa yam
(xii) Millet
(xiii) Others (specify): ______________________

48. In which of these dishes mentioned above do you incorporate soybeans?

1
2
3
4
5
6
Others (specify): ______________________

49. What is the quantity of soybean you consume in your home per week?

(i) 1.5kg
(ii) 1.5 3kg
(iii) 3-6kg 3 4.5
(iv) 6kg+ 4.5 6
(v) 6+

50. What equipment do you use in processing Soybean products?

(i)
(ii)
(iii)
(iv)
(v)

51. Are losses encountered during soybean processing? Yes/No

52. At what stage of processing do the losses occur?

(i) Dehulling
ii) Soaking
(iii) Milling
(iv) Packaging
(v) Any other reasons
(specify): __________

53. Are Soybean product readily available in your market? Yes/No.
List these markets and products:

54. If yes, list the markets, the products, unit sold and prices.

Markets	Products	Unit sold	Price
E.g. Soyflour	1kg	#6.00	

SECTION 3

NON-SOYBEAN CULTIVATING NOR PRODUCT PREPARING BUT CONSUMING INDIVIDUALS

55. What are the constraints for not preparing the Soy-products consumed?
(i)
(ii)
(iii)
(iv)
(v)

56. What are the constraints for not wanting to cultivate soybean?

(i)
(ii)
(iii)
(iv)
(v)

Socio-economic terminal/summative evaluation survey of IDRC/IAR&T Phase II soybean production processing and utilization impacts on nutritional intervention in human health within Nigerian State

Questionnaire No...................
Date...............................

1. Name of Health Institution ....

2. Town ....

3. Local Government Area ....

4. State ....

5 a. Name of Respondent ....
b. Rank (in the Institution) ....
c. Sex: Male/Female

6. When was this Health Institution established?

a. Over 4 years (ago)
b. 4 years
c. 3 years
d. 2 years
e. A year
f. This year

7. What necessitated this establishment to be utilizing Soybean?

a. Supplement for protein in food/feeds
b. To reduce cost of feed/food preparation
c. As a substitute for protein in melon/cowpea/groundnut/cow milk.

d. For medicinal (curative) purpose in diabetes/kwarshiokor/skin spot disease/Malnutrition
e. Hastening bodily growth.

8. Which Agency officials introduced Soybean utilization to this Health Institution?

a. Ford Foundation
b. IDRC
c. COWAN
d. COWAD
e. UNICEF
f. Indigenous Program (Better Life)

9. Since when has this Institution been utilizing Soybean?

a. Over 4 years (ago)
b. 4 years
c. 3 years
d. 2 years
e. A year
f. This year.

10. To which target group (patients) does this institution direct its Soybean utilization for amelioration treatment?

a. Diabetic adults
b. Malnourished babies/infants
c. Abandoned/Adopted babies
d. Breast feeding/Weaned Babies
e. Others (specify)

11. In what form is Soybean utilized in this institution?

a. Liquid/fluid
b. Solid wet paste
c. Solid dry paste

12. By what technique, procedure/method is Soybean intervention affected on the target group?

13. What are the achievement, since 4 years ago, of this health institution with regards to Soybean use in Nutritional intervention?infants

	Quantity of Number of	Number of		
Year	Soybean used	Patients	Successful	
(Kg)	Treated on	Treatment	Period	
	Soybean of Remarks			
Male	Female	Male	Female	Treatment

14. High-light, if any, other recently detected treatment area to which soybean utilization intervention could be directed:

15. What are the constraints of this Health Institution with regards to Soybean Utilization?

a. Scarcity/unavailability of soybean
b. Tedious processing method
c. Poor Soyproduct acceptability
d. Poor Soyproduct Storability
e. Others (specify)

16. What solutions can you prefer for the constraints detected? ....

Socio-economic terminal/summative evaluation survey of the impact of IDRC/IAR&T Phase II soybean production, processing and utilization in some soy industries within Nigerian State

Questionnaire No...............

Date...........................

1. Name of Industrial concern.................................

2. Town..

3. Local Government Area.......................................

4. State..

5a Name of Respondent...
b. Rank (in the Industrial Concern)............................
c. Sex: Male/Female

6. When was this industry established?.........................

a. Over 4 years (ago)
b. 4 years
c. 3 years
d. 2 years
e. A year
f. This year

7. Has this concern ever heard about IDRC/IAR&T soybean production, processing and utilization project? Yes/No

8. (If yes to 7); Since when has this concern learnt about IDRC/IAR&T Soybean Project?

a. Over 4 years
b. 4 years
c. 3 years
d. 2 years
e. A year
f. This year

9. Which set of Soyprocessing equipments are made use of in this industry?

a. Roaster
b. Dehauler
c. Miller/Grinder
d. Dryer
e. Extruder
f. Others (specify).

10. What are the characteristics of this industry with regard to Soybean utilization?

Year	Processing Capacity (Kg) Soybean (Kg)	Soybean Used Quantity Produced	% Units Source Unit	Customers Type	Units	Price #/
1991						
1992						
1993						

11. Which is the premium Soyproduct of this industry?

12. Which of your industrial soyproducts do the staff consume or like most

13. What are the constraints of this Industry on Soyprocessing?

a. Scarcity of Soybean
b. Spoilage/rapid wear of Soyprocessing machine
d. Poor sales
e. Other (specify)
f. Poor storability of products.

Socio-economic terminal/summative evaluation survey of the impact of IDRC/IAR&T Phase II soybean production, processing and utilization in some cells of ADP

Questionnaire No.................

Date.............................

1. Cell............................

2. Block...........................

3. Zone............................

4. Local Government Area.......................................

5. State...........................

6. Name of Village Extension Agent (V.E.A.)...................

7. Name of Office where the VEP can be located................

8. Venue of Meeting (of the farmers in the cell)

Street.................. Village......................
Town.................... L.G.A........................
State...................

SECTION I

1. Is Soybean cultivated in this cell? Yes/No

2. Since when did Soybean production start in the cell?

(a) Over 4 years
(b) 4 years
(c) 3 years
(d) 2 years
(e) A year
(f) This year

3. Who introduced soybean production to the Cell? ....

4. Which type (by colour) of Soybean (seeds) are grown in the cell?

(a) White
(b) Yellow/cream
(c) Black
(d) White and Black

5. What are the sources of Soybean seeds grown in the cell?

(a) Farmers reserves from harvest.
(b) Institutional Agencies: I.I.T.A & UNICEF/IAR&T and OYSADEP/COWAN
(c) Companies: PZ & NSA, FARINA & NSA
(d) Purchase from public markets
(e) Government Seed stores, NSS
(f) Others (specify).................................

6. How many farmers are presently in the cell?

(a) Women.................................
(b) Men..................................

7. Are there Soybean Growers Association in the cell? Yes/No

8 In which villages/towns within the cell are the Soybean Growers Association?

9. How many farmers cultivated soybean in the cell this season?

a. Women.............................
b. Men...................................

10. What was the total hectarage in the cell by this season?

a. Soybean as sole crop
b. Soybean as mixed crop.

11. How do farmers in the cell, generally dispose (in proportional percentage) of their harvested soybean grains?

a. Used at home............................
b. Sales to Contractors/local people/industries
c. Gifts.

12. What is presently the cost of 100 kg Soybean in the cell at peak of harvest?
₦..................................

13. What is the cost of 100 kg Soybean in the cell at this soybean planting season? ₦ ....

14. What is the average cost/Ha of Soybean produced in the cell this season?

15. What are the problems of Soybean Production in the cell?

a. Scarcity of arable land for growing soybean
b. Unavailability of soybean grains for planting
c. Rapid loss of viability of seeds kept-for planting
d. Vertebrate pests: rabbit/lizard
e. Damping off disease
f. Threshing.

SECTION 2

Level of adoption of soybean production, processing and utilization in Kaya, Kurmin Masara and Makera villages, Kaduna State (a terminal survey)

Introduction

This report is the documentation of findings of terminal survey conducted in three villages - Kaya, Kurmin Masara and Makera - Kaduna - where the phase II of the IDRC/IITA Soybean Utilization Project was carried out. These villages are located in Giwa, Zangon-kataf, and Kaduna South Local Government Areas respectively.

The phase II of the IDRC/IITA/NAERLS Soybean Project is a three year activity which started in February, 1991.

The Objectives

The broad objectives of the assessment of the project programme are to document the extent of achievement and problems encountered in the course of the execution of the project. More specifically the survey aimed at the following goals:

1. To assess the extent of soybean production after the project period and the effects of the project on soybean production efforts of farmers.

2. To assess the extent of soybean processing and utilization after the project period and the effects of the project activities on soybean utilization.

3. Identify problems associated with soybean production, processing and utilization in the project sites.

4. Recommend measures to improve soybean production, processing and utilization situation especially after the project period.

Methodology

The methods used in evaluating the project is a combination of Rapid Rural Appraisal Survey and the conventional Survey method. In the RRA all the project personnel comprising of Socio-Economist, Agronomist, Food Technologist and Home Economist jointly undertook a tour to the project sites and all techniques unique to RRA were adopted to obtain answers.

The conventional survey method adopted the use of structured questionnaires which were administered to farmers and soybean processors by trained enumerators.

Two types of questionnaires were administered. These are farmer/producer questionnaire and processor questionnaire. In all 256 questionnaires were used. Table 6.9 shows the types and breakdown of sample farmers and processors interviewed using RRA and conventional survey method.

At the end of questionnaire administration a total of 244 questionnaires were found analysable. The rest were either incorrectly completed or not completed at all.

The information obtained centres around findings on production, processing and utilization activities to reveal the effects of the project programmes and assess the impact of the project programme on the community. Thus, it is a "before" and "after" evaluation activity.

Table 6.11 Breakdown of sample farmers and processors interviewed

	Items	Kaya	Kurmin Masara	Makera	Kaduna State TOTAL
1.	Nos. of Household interviewed during RRA survey	52	63	25	140
2.	Sample Farmers	50	50	6	106
3.	Sample Processors	50	50	50	150

Results and discussions

The breakdown of sample farmers and processors interviewed is shown in table 6.11.

(A) Soybean production

(i) Kurmin Masara

Kurmin Masara is located in Zangon-Kataf Local Government Area (LGA). It is an agricultural village with about 4240 household nearly all dependent on farming for their livelihood. Out of this number the proportion of growing soybean crop remained at 30.8% and 47.8% for males and females respectively.

The structure of the household size did not change in 1993 compared to 1991 when a household size range from 2 to 30 while the average size was estimated at 8.2. Most of the respondents interviewed are mainly relatively elderly. The major tribes of Kurmin Masara are the Katafa who constituted over 80 percent, others are Kaje tribe, and Fulani settlers

Soybean production activities

The major crops grown in the area remain maize; guinea corn (Sorghum); Late Millet; Beans (*Achi Shins*) soybean; Yam; cocoyam; ginger; vegetables, groundnuts and so on.

The average farm size of each household was put at about 3.4 ha. Availability of family labour, and money are the major determinants on what proportion of the land is put into cultivation. The common varieties grown in Kurmin Masara remain mainly the local varieties and Sam-soy 1 and 11. However, TGX 579 variety was introduced to the farmers in the project area in 1992. Most of the farmers favour sole cropping but also intercrop soybean with cereals. The calendar of soybean production did not change greatly as rain fall and availability of vital inputs such as seeds, fertilizers and crop protection chemicals dictate timing.

Most of the farmers weeded their soybean farm in August while fertilizer was applied in June through August depending on when farmers obtained the commodity. Most of the farmers interviewed did not spray soybean crop to protect it from either pests and/or diseases. The size did not considerably change by 1993 when it was estimated at about 0.85 to about 1.0 ha. Most of the increase resulted mainly by the entry of a few large scale farmers into soybean production.

The number of farmers involved in soybean production in the project site remain at very high level and even higher than in 1991 when the percentage of households cultivating the crop in the area was put at about 90%. Using the RRA and conventional survey findings the production can now be put at about 95% of the households. The increase in number is attributable to many factors some of which included the knowledge gained on how to process and consume soybeans locally and the increased demand witnessed especially in 1991. These factors arose the interest of other farmers to start cultivating soybeans reports on insect pests attacking soybean farms.

Soybean was harvested and threshed in the months October and November. However, over 75% of respondents harvested soybean in October and threshed in November.

The average yield per hectare in the village was estimated at 850 kg/ha. This figure was found to be lower than the average reported in the Baseline survey which was 1500 kg/ha. There is no doubt that the baseline survey figure was an exaggerations made by the responding farmers at that time.

Production cost and returns

Farmers production costs and returns for 1993 were estimated and results show that the average cost of production per hectare was estimated at about ₦7,628 while the returns per hectare was found to be ₦5,737.50 about ₦1,890.50 lower than cost of production. Price of soybean has considerably fallen making it unprofitable for most farmers to now dispose soybeans.

The major production cost components for soybean is mainly the cost of land clearing and preparation which accounted for over 45 percent of the total cost. Thus, farmers who locally prepare land (use work bulls or manually) may save up to 60 percent the cost of land preparation compared with tractors. The cost of fertilizer application accounted for up to 25 percent of total cost per hectare even though only a few farmers do so. Given these situations most farmers spend less than the estimated production cost per hectare and as such afford to dispose soybean at the prevailing price levels of ₦6.75/kg in Kurmin Masara.

An estimate of the total soybean production in Kurmin Masara project site was about 825 tonnes in 1993 compared to 800 tonnes in 1992. The figures were arrived at considering the number of farmers growing the crop; the estimated yield and size of soybean farms.

Popularization of soybean production

The extent of soybean production popularization was assessed by investigating the number of neighbouring villages in which soybean producers can be found especially since the inception of the project. Soybean was produced in 12 villages initially but now about 10 more villages produce soybean (table 6.12).

Table 6.12 List of neighbouring villages where soybean producers were found in 1991 and 1993 in Kurmin Masara

	List of villages in 1991		List of additional villages by 1993
1.	Kurmin Masara	1.	Gora
2.	Unguwan Bahago	2.	Zon-Zon
3.	Unguwan Yohanna	3.	Sako
4.	Ungwan Adamu	4.	Kigudu
5.	Atisah	5.	Unguwan Musa
6.	Kibori	6.	Magamia
7.	Mai - chibi	7.	Kiffit
8.	Unguwan Dawaki	8.	Mabuhu
9.	Kan-Kurmi	9.	Zangon -Aman
10.	Unguwan Tabo	10.	Kurfi
11.	Samaru		
12.	Doka		

Thus the awareness of soybean crop among farmers has increased substantially either because of its increased production and or increased utilization among other reasons.

Table 6.13 Production constraints of soybean growers in Kurmin Masara

	Problems	Percentage of Respondents Reporting.
1.	High labour cost (e.g land Preparation, weeding	76
2.	Shortages of improved inputs (e.g seeds, fertilizers)	65
3.	Low producer prices	72
4.	Pests and Diseases	56
5.	Difficulties in Harvesting and Threshing.	65
6.	Inavailability of tractor and other farm machinery hire services	78

Production constraints

The production constraints reported by the farmers are presented in table 6.13. About 78% of the farmers reported inadequate tractor and other farm machineries hire services for farmers, while about 76% reported high labour charges especially for land preparation, weeding and harvesting operations. Other problems included shortages of improved seeds, Fertilizers and other inputs; difficulties of harvesting and threshing, Farmers have not done much to solve some of these problems mainly because these believe they are all beyond their control.

(ii) Kaya

Socio-economic background

Kaya village in Giwa Local Government Area of Kaduna State has over 6000 people, 95% of which are farmers. Majority of the people are Hausa tribe even though other settlers such as Igbos can be found.

The structure of the household size in Kaya remained unchanged compared to the situation in 1991 with an average family size of 10 (the range is from 2 to 35). The age distribution shows that the average farmers age is 41 years and the range is 17 to 67 years. The proportion of female farmers in the village is relatively very low compared to Kurmin-Masara but there are few women farmers.

Trend in soybean production

The major crops grown in Kaya and its environs other than soybean are maize, guinea corn, rice, beans, groundnut, and vegetables. Soybean crop was first introduced in the area in 1987 when 15 farmers volunteered to cultivate the crop on a trial basis. Since that period soybean production has been on the increase. The rate of farmers involvement in soybean production was estimated at over 25% per annum between 1987 to date. Similarly the spread of the cultivation of the crop to other neighbouring villages was considerably very fast. In 1987 soybean was grown in 3 villages, by 1991 ten villages and by 1993 the number has reached over 20 (table 6.15).

The average farm size of a family is estimated at about 5 hectares while the average soybean farm is estimated at 2.6 ha in 1993. This shows an increase of about 30% over the figures of 1991 and a substantial decrease over the reported figure. of 3 ha in 1992.

Most soybean farmers in Kaya appreciate the need for timely operations. However they are handicap in most cases by lack of adequate funds or farm implements such as tractors, animal power and fertilizers to carry out the farming operations on time Rainfall on the other hand, limit the time they prepare land, and carry out other operations.

The calendar operation of soybean farmers is represented in table 6.14.

Table 6.14 Calendar of soybean production operation in Kaya in 1993

Period /Time	Operation
May/July	Input procurements, land preparation planting.
July/August	Fertilizer application control measures.
Oct. November	Harvesting; threshing, marketing activities

Use of improved farm inputs

Only 9% of the farmers use tractor to clear and prepare land while majority (75%) use animal power in land preparation. The rest of the operations are carried out manually. Usually farmers prefer to harrow plots and later employ the services of work bulls to make ridges before planting soybeans. They claim that ridges prepared by work-bulls (ariana plough) gave more number of ridges than those made with a tractor. The popular soybean varieties planted by farmers are either Sam-soy 1 and Sam-soy 11. In 1992, the project distributed TGX 579 variety of soybean obtained from IITA, Ibadan free of charge for farmers to multiply and use in subsequent years. The variety performed very well and was found to yield better than the existing varieties in the locality.

In 1991 only a few farmer bothered to apply fertilizers to soybean crop. However, as a result of extension work by project personnel, it has increased to 45% in 1993. The popular brand of fertilizer most preferred by farmers in Kaya and its environs is 27:13:13 (NPK). However, this choice is often limited to the available brand in the market. Very recently farmers in Kaya started to employ the services of commercial crop protection agents to spray soybean farms against insects pests. A few farmer (about 7%) had their crop sprayed with cymbush to control leaf eating/sucking insects.

The use of herbicides is yet to gain any popularity. Many farmers said they were aware of such chemicals that can control weeds in farms but could not afford to use it because of the high cost and the risk of misuse. It is apparent that with escalating high cost of labour and improved extension services, farmers will start to use herbicides to control weeds.

Harvesting and threshing of soybean is mainly done manually. Farmers harvest soybean when matured and thresh it immediately after it has dried up using manual labour. Threshing machineries are not available in the area. Attempts to introduce a fabricated threshing machine by Institute for Agriculture, Zaria was not successful. In 1991, it was found that most of the farmers grew soybean in mixture with other crops. Over the years farmers have begun to appreciate the advantage of sole cropping even though the economics of sole cropping over mix cropping especially with sorghum was in favour of intercropping. Farmers who grew soybean as sole crop have increased to about 35 percent of the respondents compared to only 3% in 1991.

Production cost and returns

Table 6.16 shows the production cost and returns of soybean farmers in Kaya. The estimated cost of cultivating a hectare of soybean in 1993 is ₦7,940 while the gross returns is ₦5,000 for the average yield of 100 kg At the time of this survey the average price per kg was only ₦5.50 showing that gross return is lower than cost of production.

Price of soybean has generally remained at a very low level due to low demand on one hand and high cost of labour on the other hand. Farmers' are anticipating better prices towards the early parts of June through August 1994.

Popularization of soybean production

As was earlier mentioned the cultivation of soybean is on the increased in the project sites. In the case of Kaya, the crop has received a widespread prominence both in production and utilization at household levels.

Apart from the increase in number of farmers, total hectarage put to soybean in Kaya, neighbouring villages have also increased. The list of villages in which soybean is grown is shown in table 6.13.

Production constraints

Problems faced by farmers in cultivating soybeans are documented in table 6.16.

The major problems enumerated are inadequate supply of tractor and other implements for farmers to hire especially for land preparation and threshing; high labour charge For most of the farm operations; shortages of improved soybean seeds, fertilizers, pesticides etc., which make them very expensive. Other problems are low producer prices thus making soybean production no longer profitable. Farmers relate this problem to lack of assured market outlets, especially with the closure of the Funtua Cotton - seed Crushing Company which used to serve as an assured market outlet for farmers. To solve this problem, the Farmers' Association has made efforts to contact buyers in Kano and Makurdi but the responses were not encouraging.

Table 6.15 List of neighbouring villages where soybean farmers can be found in 1991 and 1993 in Kaya

	Villages as 1991 at		Additional villages as at 1993
1.	Kaya	1.	Fatika
2	Unguwar Sani	2.	Yakawada
3	Unguwar Fibim	3.	Nasarawa
4	Unguwar Dutse	4.	Gangara
5.	Unguwar Sarki	5.	Mujedawa
6.	Gadagau	6.	Gasawa
7	Kayawa	7.	Duya
8	Dako	8	Idasu
9.	Ruheya	9.	Unguwar Pa
10	Layin Taki	10.	Dankuturu
		11.	Gazari
		12.	Marke
		13.	Unguwar Namama

Table 6.16 Soybean production constraints

	Problem	Percentage of Farmers reporting
1.	High labour costs (e.g. land preparation and weeding)	84
2.	Shortages of improved inputs (e.g. seeds; fertilizers etc.)	75
3.	Low producer prices	90
4.	Pests and Diseases	54
5.	Difficulties in harvesting & Threshing.	68
6.	Inadequate tractor & other farm machinery line services.	86

(iii) Makera (Kaduna)

Socio - economic background

Makera is the headquarters of Kaduna South Local Government Area, the most populated LGA in Kaduna State. The majority of the people are civil servants, traders, craftsmen and workers in the factories. There are several factories in Makera with a few of them being agro allied Unlike the rural areas the family size in Makera is only 4 while the range is between from 2 to 8 per family.

Only the low income people in the outskirts of the town are involved in farming generally on a small scale. There are a few large scale farmers which farms are mostly located outside Kaduna town. Some of the farmers are engaged in soybean production.

The major tribes in Makera are Hausa, Kaje, Kataf, Igbos, and Yoruba.

Soybeans production activities

Soybean Production activities in Makera is limited to only a small number of people. Out of the people interviewed only 12% of the respondents (6 people) claimed to have cultivated soybeans. Out of this number four of them are women while the remaining two are men. The production practices of these farmers were found to be similar to those of farmers in Kurmin Masara. In fact, it was found that these farmers are from southern parts of Kaduna State.

The average soybean farm in Makera is only 0.3 ha and the production pattern is mix-cropping system. There were no sure source of planting materials therefore in 1992, TGX 579 seeds were distributed to group of women to multiply for seeds in 1993.

The average yield was estimated at 700 kg per hectare for sole cropped farms and less than 400 kg per hectare for most intercropped plots. The calendar of soybean production operations in Kaduna in 1993 is shown in table 6.17.

Table 6.17 Calendar of soybean production operations in Makera-Kaduna, 1993

	Period /Time	Operations
1.	April/June	Procurement of Inputs land clearing
2.	June/July	Land preparations, planting
3.	July/August	Weed control, fertilizer application and earthening up.
4.	Oct. /November	Harvesting/threshing.

The estimated production costs for soybean producers in urban Makera was estimated as ₦814 per hectare and the gross returns at prevailing price of ₦8.00 per kilogram for a yield of 700 kg/ha was estimated at ₦5,600 (table 6.18). The shortfall of return to cost of production was due to the general low price levels of soybean in the market and of-course the high labour cost. It is hoped that when price increases over the season farmers will be able to make profit.

Production constraints

The major constraints of soybean production in Makera among others are inadequates land for expansion of farms shortage of farm inputs and land preparing machineries, high labour cost, low producer prices and so on.

Table 6.18 Estimated production cost and returns of soybean in project sites in Kaduna state 1993

		Kurmin	Kaya	Makera
1.	Land clearing and Preparation	3500	3000	3200
2.	Seeds	700	800	900
3.	Planting	270	350	400
4.	Weeding and Earthening up	890	1060	950
5.	Fertilizer and Application	1200	1400	1400
6.	Harvesting	350	500	400
7.	Threshing and Bagging	468	530	364
8.	Transportation	250	300	200
	Total Cost ₦	7,628	7940	7814
Yield		850 kg/ha	1000 kg/ha	700 kg/ha
Price		6.75	5.50	800.00
Value		₦5737.50	₦5500.00	₦5600.00

(B) Soybean utilization

The extent of Soybean utilization in Kaduna Sate just four years ago was rated as low and generally limited to areas of production in the southern parts of the state. Soybean consumption in the northern parts was not common. Today, in 1994 at the expiration period of the IDRC/IITA soybean utilization project soybean is consumed in large quantities in most parts of the state. Developed soybeans recipes by the project and other recipes learnt outside the project are very familiar to households in the state.

An assessment of the extent of adoptions of processing and utilization of soybean products carried out is reported below.

(i) Kurmin Masara

The major traditional dishes (food) of the people of Kurmin Masara are 'pate', 'tuwo', 'kunu', boiled beans and vegetables boiled cocoyam, pounded yam with vegetable soup, boiled yam with stew, akamu (pap), and gari and soup. Other confectioneries include, Kosai (akara) moinmoin, boiled cassava etc. These dishes can be eaten either as breakfast, Lunch or dinner depending of the preference of the household. But in general tuwo, boiled yam with soup and gari are mainly taken during dinner while pounded yam pate, boiled cocoyam and boiled beans are taken during lunch. During breakfast akamu (pap) and kosai or moinmoin is eaten. It was realized right from the onset that soybean can be incorporated into nearly all of these dishes. As such, most of these dishes are selected for fortification with soybeans by the project. The selected dishes from Kurmin Masara included tuwo, kunu, akamu (pap) moinmoin, akara pate and the soup with which tuwo, boiled yam, rice, beans etc., are eaten.

Extent of soybean processing and utilization

The extent to which soybean is processed and used in Kurmin Masara is relatively high and in fact higher than the rest of the 2 other project sites. In nearly all the households in the village soybean is eaten daily in the form of daddawa, used in preparing soup. Other families knew how to in corporate soybean akamu (pap) to feed children. Processors (men and women) were exposed to different processing techniques and various soybean recipes.

Daddawa (a soup condiment) is processed in this village in commercial quantities for a long time ago. The area is popular with this commodity. Inter state trade in daddawa is a booming business in the southern parts of Kaduna State. The various methods used in the processing of daddawa has been fully explained in the baseline survey report of 1991. The four basic soybean processing techniques is shown in table 6.19. The table also shows the most acceptable techniques for different products in the three project sites. However, it is clear from the table 6.17 that method 2 and 3 are more popular in Kurmin Masara. Method 1 and 4 are regarded as slow by most of the participating women. Method 2 which is roasting/dry milling into flour is used if soybean is to be incorporated into akamu (pap), pate, and soup, and if tasty and nice smelling daddawa is to be prepared the soybean is roasted.

In all these cases the test (skin) of the grain is removed before milling. An assessment of which methods are more popular among women in the village shows that depending on the final products desired the women can use all the methods. If they can get the taste of the final product right.

Out of the fifty women processors interviewed, 68 percent of them learnt to process soybean in the last 3 years which coincided with the project period. Unlike the other project sites high number of respondent appear to know how to process soybean before the commencement of this project in Kurmin Masara (table 6.19).

Recipes developed and disseminated

The recipes developed by the project personnels and disseminated in the project sites for adoption are based on the local traditional dishes and a few others found to be useful for weaning babies and those that can be used as snacks. In all, 17 types of soybean incorporated products were disseminated and adopted majority of which are called in local names to ensure easy communication. Table 6.21 carries the list of these adopted products. In table 6.22, the commercially prepared products in each project site are listed.

Categorizing the adopted product in order of preferences from number one to five as shown in table 6.223, daddawa, soy-milk, soy-soup, soy cheese and kunu is the order of preference in Kurmin Masara.

The problems associated with soybeans utilization

The major problems identified as enumerated are shown in table 6.23. From the tables new problems that have emerged over 1991 are the problem of inadequate funds to undertake commercial processing of soybean, there is also the complaint of lack of improved machineries to aid processing at household levels more specifically the processors were referring to wet- milling machines.

(ii) Kaya

The extent of soybean utilization in Kaya at the beginning of the project (1991) was very minimal, despite the relatively high awareness level of the nutritive value of the crop. At that time only 6 percent of the respondent interviewed claimed to know how to prepare soybean based foods. The average consumption level was only 0.44 kg per week and consumption was limited to only younger people.

The common traditional dishes in Kaya are tuwo (prepared with either rice, guinea corn, or maize and eaten with soup); gauda (prepared with any of the above cereals plus beans and cassava and eaten with vegetable soup); koko (pap made from millet or sorghum or maize eaten with Kosai or moinmoin); Danwake (made from cereals and eaten with pepper and vegetable oil); Taliya (locally made); Fura de nono prepared from millet and drunk with milk yoghurt; Waina (made from cereals and eaten with vegetable soup); and Pate (prepared from grit of cereals and vegetables).

Other snack foods include Kosai, Dakuwa, Chin-chin, Alele, and Kunu, Zaki, Tuwo, Waina and gauda. Heavy foods are eaten during lunch and dinner while higher one during breakfast or in between meals.

Extent of soybean processing and utilization

The consumption of soybeans in Kaya before the commencement of the project (1991) was on the average very low (0.44 kg week). The popular products then was only daddawa and to some extent soy-milk. Only a few women could process soybeans and this problem was regarded as the major bottle-neck to soybeans consumption in the area.

The methods of soybean processing disseminated to the women in Kaya were similar to those taught in Kurmin Masara. The most popular methods among women in Kaya are methods 4 and method 2 Women in Kaya claimed that soaking overnight saves them the cost of firewood than to blanch while roasted soybean give better flavour. The preference of methods of processing of soybean among women in Kaya is shown in Table 6.21.

The distribution of processors over the time they knew how to process soybean reveals that 88 percent of respondent learnt how to process soybeans between 1991 and 1993This is within the last 3 years as shown in table 6.18.

Recipes development and dissemination

Table 12 shows the list of soybeans products developed and disseminated in Kaya during the project life. A number of these products are currently prepared at commercial levels. They include soy nama; gauda, kosai, moinmoin, daddawa, danwake and dakuwa. In fact Kaya village has the largest number of commercial processors of soybean product compared to Kurmin Masara and Makera.

The extent to which the developed products are adopted is shown in Table 6.21. From the table, soy nama (soy cheeses); gauda, soy - milk, soy - soup, daddawa; danwake and soy hatsi were the most adopted products in the village. The least adopted are chin chin and soy yoghurt. Of the soybean products developed, soy nama (soy cheese) soy milk, gauda, soy soup, and daddawa are the most adopted.

MAKERA - Kaduna (Urban center)

The RRA conducted in 1991 as a baseline information reveals that the extent of soybean utilization in Makera is very low. The situation after the project period improved significantly. Soybean consumption is widespread in Makera.

The type of food dishes processed and consumed in Makera include: boiled rice with stew/jollof rice; tuwo/soup; "Pate"; pounded yam with vegetable soup or boiled yam with stew; akamu (pap) with kosai/moinmoin; and gari with vegetable soup.

As usual lighter dishes are eaten as breakfast while the heavy ones are for lunch and dinner. Nearly all of these foods were improved by fortifying them with soybeans.

Extent of soybean processing and utilization

Before the commencement of this project in Makera the existing soybean fortified food products are vegetable soup in which soybean flour is added and or in which soybean daddawa is added. Soybean milk was also processed by a few women, Akamu (pap) is also fortified with soybean but mainly to feed small children.

On the time they learnt to process soybean, findings confirmed that participating women have learnt the methods during the project period. It was estimated that 92 percent of the respondents interviewed learnt the method of processing in the last 3 years while only 8 percent knew how to process soybeans before the project was started (table 6.18).

Recipes developed and disseminated

The soybean recipes developed and disseminated Makera are shown in table 6.19. The methods of dissemination used were similar to those used in Kaya and Kurmin Masara. In Makera participating women were trained to prepare the products at the training centre and were provided with essential ingredients to process similar products at home. Women were also encouraged to train other non - participating women.

The most adopted products in Makera are soy-milk/soy - cheese (soy-nama); soy hatsi; chin-chin; daddawa and soy soup. Others that were fairly adopted are moinmoin; kunun zaki and kosia. Products with zero adoption are waina, soy yoghurt, danwake and gauda. Soy flour, daddawa and moinmoin are processed on commercial basis.

Problems of soybean processing and utilization

The major problems associated with soybean processing and utilization in Makera are inadequate supply of soybeans; laborious nature of processing method. Low level of acceptance especially among adults in the household and the relative availability of alternative products that are more acceptable to the family are also problems associated with soybean utilization.

(C) The economics of commercial soybean processing

The economics of processing soybean products in the project sites is shown on table 6.25 where it can be seen that the total investment of soybean processors is fairly low except for a few large scale. The total investment range from ₦100.00 to ₦5000. The average per product is also shown in the table.

The average gross return varies from ₦250.00 for kosai ₦500.00 for daddawa in Kaya. In Kurmin Masara it was estimated at ₦125 for kosai to ₦6,500 for daddawa. In Makera it was ₦130 for kosai and ₦300 for daddawa. The low level of investment can be associated with low demand level and poor financial background of the processors.

Profits are made in commercial soybean processing and the amount varies from product to product and location to location. Daddawa processing gave the highest profit per unit of production. But the most profitable product per naira invested was soymilk in Kurmin Masara, gauda in Kaya and daddawa in Makera. This is followed by daddawa in Kurmin Masara and Kaya.

(D) Recommendations

Based on the findings of this survey in areas of production, processing and utilization the following recommendations are made.

1. As production of soybeans has started gaining popularity among farmers especially among the small and large scale farmers in Kaduna state there is the need for government to encourage the entrepreneurs to establish soybean processing industries with a view of stimulating demand so as to boost soybean production.

2. Extension services need to be intensified in the state to train farmers on the importance of optimum plant population, fertilizer use, weed control and crop protection measures.

3 Farm inputs such as tractor hire services and the provision of threshing implements, fertilizer distributor and agro-chemicals should be made available to farmer at right time, places and prices.

4 There is the need to organize farmers into viable groups and association so that they can provide themselves with the needed services and resources to increase their output.

5. Government Extension Workers especially those under the local Government Authorities, Agricultural Development projects (ADPs) and other women groups should formulate means to work jointly to train rural women on how to process and use soybeans at household levels. In this regards the proposed phase III of this project should work hand in hand with the staff of the above organizations.

6. There is the need to emphasize the engineering aspect of processing soybeans so that simple and affordable processing implements can be developed for rural processors. Local fabricators therefore need to be fully involved in future promotional efforts.

7. Subsequent project of this nature should ensure that participating processors represent a cross section of the community. There is the tendency of involving a particular section of the community if care is not taken. This could easily have a negative effect in the adoption of the technologies being disseminated.

8 Budgets of similar project in the future should be strictly adhere to. It has been observed that agreed programme of activities jointly planned with beneficiaries once disrupted affect the smooth running of the other activities in the future. The experience of this project is that poor funding could easily disrupt planned programmes.

(E) Conclusions

To conclude the socio-economic assessment of this project reveals interesting development as follows:

1. Soybean crop exhibits great potentials in the savannah areas especially in Kaduna State for its increased production processing and utilization at both household and industrial levels. The readiness of farmers to cultivate the crop is guarranteed given the necessary encouragement especially in area of farm input supplies provision of land preparation facilities; assured market outlets and so on. On the part of the processors women have shown their readiness to learn to process the crop and use it for home consumption and for commercialization.

2. Improved approach to the dissemination of processing and utilization techniques especially the type adopted by the project has proved very effective and resulted in accomplishment of the project set goals. Thus, future efforts should take lessons from this project.

3. NGOs and other public agencies in the country should strengthen their coordinated approach towards rural development. The experience of the IDRC/IITA/NAERLS Soybean Utilization project has proved to be the most effective development effort ever undertaken in the rural areas of Kaduna state. Thus future soybean programme should be expanded to involve as many agencies as possible and as many rural areas as is feasible.

Table 6.19 Popular methods of soybean processing techniques and products

Methods	% Respondents preferring each method			Soy-product associate with methods
	Kurmin Masara	Kaya	Makera	
1. Blanching/Drying/ Milling into flour	24	4	28	Tuwo, Yam, Akamu, Kunu, Taliya, Waina
2. Roasting/Milling/ into flour	60	52	24	Daddawa, gauda, Soup Moin-moin Akara, Pate Danwake, gauda Chin-chin Dakuwa.
3 Blanchin/ Wet Milling	48	0	24	Soy-milk, gauda, Soy-cheese Kunu- Zaki, Moin-moin
4. Soaking/ Wet Milling	24	76	24	Same as above.

Table 6.20 Distribution of soybean processors by the time they learnt to process soybean in the project sites, 1993

	Time	% Respondents in the Project sites		
		Kurmin Masara	Kaya	Makera
1.	Less than a year ago	8	16	12
2.	1 year ago	16	12	-
3.	2 years ago	16	44	68
4.	3 years ago	16	16	12
5.	4 years and above	32	12	8

Table 6.21 Adoption of soybean products in the project sites

	Time	% Respondents adopting soybean products		
		Kurmin Masara	Kaya	Makera
1.	Soy-cheese	56	80	60
2.	'Daddawa'	84	76	40
3.	'Gauda'	0	80	0
4.	Soy-milk	72	64	64
5.	Soy-soup	56	56	40
6.	'Kunun-Zaki'	64	32	32
7.	'Danwake'	0	48	0
8.	'Taliya'	32	32	8
9.	Dakuwa	8	8	12
10.	Pate	8	20	0
11.	Soy-Yoghurt	8	20	0
12.	Waina	0	4	0
13.	'Kosai'	32	20	20
14.	Moin-moin	8	40	32
15.	Chin-chin	0	8	44
16.	Tuwo	20	32	4
17.	Soy-hatsi	56	48	44

Table 6.22 Commercially processed soybean products in the project sites

Kurmin Masara	Kaya	Makera
'Daddawa'	Soy-cheese 'Gauda' 'Kosai'	Chin-chin 'Daddawa' Soy-flour
Soy-cheese	Moin-Moin 'Daddawa' 'Danwake' 'Dakuwa'	Moin-moin

Table 6.23 Expressed preference of soybean products in the project sites

	Kaya	Kurmin Masara	Makera
1st Preference	Soy-cheese	Daddawa	Milk
2nd "	Milk	Milk	Soy-soup
3rd "	Gauda	Soy-soup	Soy-cheese
4th "	Soy-soup	Soy-cheese	Chin-chin
5th "	Daddawa	Akamu	Daddawa

Table 6.24 Problem associated with soybean processing in project site Kaduna State

Problems	% Respondents		
	Kurmin Masara	Kaya	Makera
1. Tedious processing methods	42	60	72
2. Poor acceptability of products	32	40	72
3. Poor storability of products	80	76	80
4. Lack of market for commercial processors	42	32	60
6. Lack of adequate milling malchines and other facilities	60	60	64

Table 6.25 The economics of commercial soybean processing in project sites

Item		Kurmin Masara	Kaya	Makera (Kaduna)
1.	Average investment per product			
1.	Daddawa	5,500.00	300.00	200.00
2.	Soy-cheese	-	250.00	-
3.	Gauda	-	150.00	-
4.	Soy-milk	100.00	150.00	150.00
5.	Kosai	100.00	100.00	100.00
6.	Moinmoin	100.00	150.00	100.00
7.	Chin-chin	-	-	450.00
8.	Dakuwa	-	150.00	-
2.	Variable cost per unit production			
1.	Daddawa	4,500.00	250.00	150.00
2.	Soy-cheese	-	200.00	-
3.	Soy-milk	85.00	120.00	120.00
4.	Kosai	85.00	85.00	85.00
5.	Moinmoin	85.00	130.00	85.00
3.	Cross revenue per unit production			
1.	Daddawa	6,500.00	500.00	300.00
2.	Soy-cheese	-	350.00	-
3.	Soy-milk	150.00	300.00	250.00
4.	Gauda	-	350.00	-
5.	Kosai	125.00	250.00	130.00
4.	Margin per unit production			
1.	Daddawa	1,500.00	200.00	100.00
2.	Soy-cheese	-	100.00	-
3.	Soy-milk	30.00	50.00	50.00
4.	Gauda	-	100.00	-
5.	Kosai	25.00	500.00	30.00

SECTION 3

Level of adoption of soybean production, processing and utilization in Okutu, Ozalla and Enugu urban of Enugu State (a terminal survey)

Introduction

Soybean production, processing and utilization activities were demonstrated and promoted in two rural communities - Ozalla and Okutu - and one urban area - Enugu - in Enugu State from 1991 to 1994. An evaluation of these activities in these areas for the three years' period was carried out as a terminal survey. Information obtained showed that in Okutu, both men and women in the community were now very much aware of the technologies involved in the production, processing and utilization of soybean. They had done soybean cropping and their acreage and yield consistently increased in the second but not in the third year. Processing in these two areas increased slightly because they depended on the tedious mortar and pestle or grinding stone method to grind the soybean seeds into flour or paste, because milling machine was not available in Ozalla and the one in Okutu had long broken down. Due to their increased awareness, the people in these two communities supplemented the soybean ground at home with processed soybean flour bought from their local markets or from markets in Nsukka and Enugu towns. They used the soybean flour to fortify children and adult foods which are derived mainly form cereals, roots and tubers. In Enugu urban, soybean processing in Ogbete market and New Market showed an appreciable increase in New Haven, Kenyata Market and Onu-Asata locations. The general observation was that soybean utilization had increased in Enugu Urban due to the increase in the number of processors and marketers of processed soybean products, especially flour.

Methodology

In Ozalla, Okutu and Enugu, the Soybean Utilization Project started its promotion in 1991 by conducting a baseline survey to obtain information on the status of soybean production, processing and utilization in these locations. The rapid rural appraisal technique was used for this purpose. Thereafter men, women and children in Ozalla and Okutu were taught technologies used for soybean production, processing and utilization between 1991 and 1993. Soybean processing and utilization was taught to processors in Enugu and utilization demonstrated to users. Conventional survey was used in conjunction with rapid rural appraisal to monitor the progress of adoption. For the final survey, both RRA and conventional survey methods were used to assess the impact of the project.

(A) RRA findings

(i) <u>Soybean production in Okutu and Ozalla</u>

Soybean production in Okutu project site as assessed by the activities of the 1993 growing season was very encouraging. There was a general increase in soybean production in this site. In Ozalla however, there was a general decrease in soybean production when compared to 1992.

During the 1993 growing season, a total of nine farmers produced soybean in Okutu while a total of 3 farmers planted in Ozalla. There were six new entrants (farmers) to soybean production, three of them came from outside the target village. This is an indication of a high degree of awareness in this site. The location of the first demonstration plot generated a lot of interest as well as other ways of communication such that new farmers were requesting for seeds to plant. Four farmers bought their seeds from other farmers. No farmer was given any free seed yet there was an increase in the number of farmers. Some of the farmers received seeds from their relatives. These are indications that the community had adopted the crop to a high degree.

Cropping system

Both sole cropping and mixed cropping were practiced. Some farmers planted sole soybean in one location and mixed crop in another location. The associated crops in this site included *Manihot esculenta* (cassava), *Cajanus cajan* (Pigeon pea), *Xanthosoma saggitifolium* (cocoyam), *Vigna unguiculata* (vegetable cowpea) and *Arachis hypogea* (groundnut).

Soybean production was late during the year of survey in the sites because of the rain that started very late. Although land was cleared in March and April, hoeing and planting had to be done much later. Most farmers planted from middle of August to late September. Weeding was done two or three depending on the associated crop with soybean. Only one farmer used fertilizer while insecticide was not used at all. The mature crop was harvested in December 1993. The method of harvesting was cutting the plant at the ground level with a matchet. The harvested crop in small bundles were brought home and kept for drying before threshing. There was a rainfall in December and most of the unthreshed crop were beaten by the rain. Unfortunately, the farmers did not quickly thresh them but still left them for more drying. The bundles started growing mouldy so that when it was threshed later some of the seeds were already infected with mould. One farmer at Okutu reported that after threshing he got $2\frac{1}{2}$fertilizer bags (about 150 kg) but after picking out the mouldy seeds he had about 2 bags (about 100 kg). This problem of mouldy seeds was reported by all farmers except three, two harvested and threshed earlier before the rain, while one farmer lost most of his crop due to very late harvesting and the resulting shattering losses. Most farmers stored their seeds well in bags or plastic containers on a platform. The farmer who planted sole at Ozalla had a good yield estimated at 450 kg/ha.

Sources of labour

Hired labour was utilized for clearing and hoeing supplemented by family labour of able bodied men. Planting, harvesting and threshing were done by family labour. Women were very prominent in these, as well as weeding which also was accomplished by hired labour in some cases. For the 1993 cropping season, the cost of labour rose to unprecedented levels which limited seriously the hectarage that could be cultivated.

Farm size

The largest soybean plot in Okutu was 0.2 ha by one farmer, the rest of the farmers' plot averaged 0.1 ha. In Ozalla, the average farm size was less than 0.1 ha even for the intercropped soybean.

Yield

The average yield for Okutu was 600 kg/ha while 450 kg/ha was the highest yield recorded for farmers at Ozalla.

Problems

The problems encountered in Okutu were: Mouldy seed due to a rain that occurred in December, before most of the farmers threshed their harvest, labour cost, resulting in limited hectarage that could be planted, lack of tractor hiring and the lack of fertilizers at reasonable prices. A problem of crop failure that was reported earlier in this project site could not be further pursued because of limited funds. Table 6.26 summarizes the soybean production from 1991 to 1993 in Okutu. The farmers at Ozalla were faced with the problem of limited land, lack of funds, and lack of input such as fertilizer.

Future prospects

There is indication that soybean production will continue to increase in Okutu despite the limitations especially that of labour. Most of the farmers indicated they will plant again next year. The farmers at Ozalla shows unwillingness to increase production of soybean.

A request has been made by some interested farmers from a nearby town, Ugwuroko, to come to their town to teach them how to grow and use soybeans. It is also hoped that the result of the agronomic trials (Mbah, 1993a, 1993b, 1993c) involving soybean and common cropping systems of the project site will further enhance soybean production in the area.

Although Ozalla community has the potential to benefit from soybean production in terms of its soil building capacity for their poor sandy soil and utilization to improve their protein in take, yet continued work in this location may be unadvisable under the present level of funding. A more aggressive involvement than has been the case is more likely to bring a better result.

Finally, the knowledge acquired by the people on processing and utilization of soybean will further ensure that demand for soybean will continue to increase in the future. Steps taken to encourage continued and increased soybean production in this area will therefore be worthwhile.

Table 6.26 Summary data on the status of soybean production in Okutu project site, 1991-1993

Year	No of Soybean farmers	Farm size ha	Yield kg/ha	Cropping system sole	mixed	Companion crops	Soybean variety planted	Soybean farmers outside village	Problems
1991	3	0.1	350	3	0	None	TGx	0	-
1992	5	0.1	600	2	3	Cassava pigeon pea cowpea	TGM 579	0	• One farmer had unfilled pods High cost of labour • No mechanization •No fertilizer
1993	8	0.1	600	3	5	Cassava pigeon pea Cowpea Groundnut Cocoyam	TGM 579	3	• High cost of labour • No mechaation • No fertilizer • Moudly seed due to untimely threshing

(i) <u>Soybean processing and utilization</u>

Ozalla

The women in Ozalla know how to prepare soybean foods or use it to fortify different traditional foods. However, only two of them prepared soybean foods very occasionally. The major reason for not processing soybeans is the unavailability of machines for grinding the beans. The two engines in the town had broken down and people have to walk to Opi, a town about 20km away from Ozalla. Grinding with mortar and pestle or stone is efficient but very tedious and they can only grind the soaked or blanched soybean by this method. More women use soybean products than process it because many of them buy roasted soybean flour from the local market, Nsukka and Urban markets for fortification of their children's foods. Two of the women like buying and eating the roasted bean themselves.

One other problem the women complained of was the fact that soybean cannot be cooked and eaten as such but must be processed into paste or flour before using it with other foods. They would prefer being taught how to plant cowpeas which they can cook and eat since the quantity of soybean processed for household use is not worth the trouble of going down to Opi to grind.

The soybean used came as gifts from the UNN team and limited quantity from their farms. Many of them expressed willingness to increase consumption of soybean if they are given a mill for grinding. They were not willing to buy soybean which was sent to the community because of the problem of milling it.

Okutu

Soybean processing and utilization were more enthusiastically welcomed in Okutu than Ozalla. One advantage Okutu has is that they have more farm lands and so production is going on very well. Therefore, they have more positive attitude to soybean. However, although the people, particularly the women know how to process soybean and use it for processing various foods, utilization has remained very low because of lack of grinding machines. The few who use soybean grind it with stone. Only one women uses soybean on a very regular base and others buy soybean vegetable soup from her.

As in Ozalla, the people buy roasted soybean flour for fortifying their children's foods and for soybean tea/bournvita for the family. They lamented that although they know how to produce the roasted soybean they have to buy it at a higher price because of lack of milling machines. All those interviewed were willing to eat soybean on regular basis if a mill can be provided for them.

Enugu

In Enugu, three large markets and one very large milling spot and small millers using engine powdered mills in the New Haven area of Enugu were interviewed.

The small miller said business varied. There were weeks when they milled a lot and others in which they milled very little. On the average, they grind for about four people in a week. The roasted soybean was the product mainly brought to them. They dehull and mill this 3-4 times to produce very fine flour. The clients informed them that they add it to weaning foods or adults can add it to gari, or tea for drinking or use water to make it into a beverage. They also wet-mill soaked soybean but this is not as common as dry milling. It costs about ₦5-₦10 to grind the roasted soybean and #5 to grind the same quantity if it is wet. They mill a lot of other food such as cowpeas, corn, "egusi", tomatoes, sorghum, millet, pepper, water yam etc.

Kenyatta market

Soybeans were processed dry and wet as in the streets in new Haven. Roasted soybean was ground at the cost of ₦20 per 10 cups and ₦10 per 10 cups of the wet soybean. The processors complained that the level of grinding soybean as for other foodstuffs have declined from what it was last year because of the general high cost of food items. People do not consider soybean a priority so there is a tendency to buy the more essential foodstuffs. The other reason which had also been mentioned in an earlier report was that the major consumers are people from other states and these had been forced to leave Enugu when new states were created. They did not consider that the high cost of milling was a problem since the high milling price applied to other foodstuffs as well.

Onu-Asata

All the machines were large milling machines powered by diesel engines or electric motors. Intensive wet milling goes on in this location although they also do dry milling. The grains milled there are maize, sorghum, groundnut, bambara groundnuts, and occasionally, soybean. The cost of grinding one bag of dry maize was ₦35-₦40, one bag of Okpa, ₦85 and one bag of cowpeas, ₦60. They have not processed soybean in bags this year but would be willing to do so if given the beans. The cost of grinding roasted soybean was higher than that of wet soybean because the roasted ones caused more problems for the engines.

Ogbete market

Wet and dry milling of soybean are also done in this location. Commodities milled include beans, soybeans, maize, cassava, tomato, pepper, onions, crayfish, etc. There are two groups of millers - large and small millers. Apart from these two organized groups, there are also small millers located in the section of the market where grains are sold. While the others mill mainly roasted soybean, the group in the grain selling section of the market mill raw soybean and sell to consumers. In fact, raw milling of soybean for vegetable soup is more common than roasting or soaking/blanching before milling. Roasted or raw soybean brought to these millers are dehulled, winnowed and ground 3-4 times to produce fine powder.

One of the large processors grind 1-3 bags of soybean about twice a month for a customer who uses it for formulating animal feed. Other millers (both large and small) process 2-20 cups weekly for about 4-5 people. The minimum charge is ₦3 for about 2 cups or less, ₦5 for 10 cups and ₦8 for 20 cups.

Dry milling is very common and wet milling is done occasionally. This is because dry flour is easier to store and has better shelf life. They said that wet milled paste spoils within 12 hours while the powder can store for more than one month.

Crayfish is sometimes added to the roasted flour. The number of people processing soybean in this location has increased in the last year.

New market

New Market also has small and large millers. The small millers mill roasted, raw, soaked or blanched soybean. Soybean processing has substantially increased in this location. Some of the small millers who also sell Soybean seeds mill the raw seeds and sell them to consumers and other vendors so that within the market so many women sell packets of milled raw soybean. Women also come to these people to buy a cup or two and have these milled for them. The cost of milling when they buy from the sellers is less. Each small scale processor processes for 10-20 people per week. Some of the small scale processors in Ogbete and New Market also sell soybean which they buy form warehouses in Ogbete Market. At the time of the survey, one bag cost ₦1,200. The soybean sold are very clean because they take time to remove stones etc., before displaying them.

The large processors grind raw undehulled soybean for those that formulate animal feeds. They grind for about 2 people per week and each of these two people grind about 2 bags. Other items processed by the large millers are maize, yam and cassava chips, bambara groundnuts, sorghum, groundnut cake, millet, cowpeas etc. Small millers grind food items like "egusi", pepper, tomatoes, cowpeas for akara, "Ukpo" (*Mucuna urens*), "akparata" (*Afzelia africana*), "achi" (*Brachystegia eurycoma*) and "ofo" (*Delarium microcarpum*).

Two small scale processors were identified in Enugu town this year. One of them Ziknis Hunger Fighters, could be a large processor if he has the finance. According to him, he started research (the man is not highly educated) on food processing in 1984 and by 1990, he started food processing. He has a large roasting drum fabricated by Projects Development Agency (PRODA), Enugu, with which he roasts soybean. He has his own grinders quite unlike the others who depend on commercial grinders. The other processor is a woman.

Mr. Nwajah says his customers include the army, retail stores and besides, he has his own stores where he sells his products. His organization goes by the name "Ziknis Hunger Fighters". In 1992, he milled about 60 bags of soybean, in 1993, he milled about 100 bags. He roasts soybean as well as blanches, dries in this his big drum drier and mills these into what he calls "Ziknis Soya Milk".

Another small scale industry identified is the Abia State Health Foods Limited. This project was incorporated in 1988 and was conceptualized as a gigantic project. A Brazilian team purchased, installed, did test run on the machines but abandoned it. Since 1989, they have been producing soybean milk. The residue is sold to animal feeders particularly, piggier owners. Their products include soybean milk flavoured with banana, chocolate and pineapple flavours which is pasteurized before packaging.

Ownership of mills

Majority of the small scale processors own their mills which they had purchased from their personal effort or with the assistance of the family. The large scale processors in most cases were running the mill for an absentee owner. The price of the mills have gone up tremendously. For example, Bentei Attrition Mills which cost ₦2,000 about 15 years ago now sells for ₦160,000 - ₦200,000. Small 7 Horse Power Yamaha petrol engine and the mill (imported or locally fabricated) which cost about ₦6,000 and ₦5,000 respectively in 1990 now cost ₦16,000 and ₦15,000 respectively. The cost of spare parts have risen in the same proportion. There have been no changes in capital investments.

Processing

All processors use similar methods (Fig 1) for the raw flour, the soybean is split after all stones and debris are removed, winnowed and milled into flour. For the other flour, soaking/blanching and drying or roasting is done before cracking, winnowing and milling.

Almost all the soybean processed is for human consumption either for soup, pap making, for enrichment of traditional foods or as beverage. There have been no new products developed.

Packaging materials

Apart from Ziknis Hunger Fighters, other small scale processor package their soybean products in small polytene bags which they seal by stapling the two open ends together. Zikn's foods uses stronger plastic and does double bagging before finally sealing the products. The use of polytene bags make their products not very durable as weevils eat through these bags easily. Abia Health Foods Lts., packages its milk in polyethylene film after pasteurization.

The processes involved are the same as that of last year. The only additional new product in the market is the Zikin's foods which are blanched, dried and milled rather than roasted and milled and the soybean milk in Abia State.

Storage

The products are rarely stored because the level of production is still low and targeted. The processors know exactly how much they need to supply to super-markets or retailers and how much they can sell and aim at producing this. Zikin's Hunger Fighters produce a lot and store. At the time of visit most of his last year's products which he said he processed in February were weevil infested. However, he explained that it was because he used another person's warehouse to store. Apart from this weevil problem, his products, according to him, store for over a year without any problems. Some of his products like dried egusi are packaged in aluminum foil.

Marketing channels

The small scale processors sell their products to the super markets, retailers in the markets, hawkers and directly to consumers. All the processors process and sell soybean flour either roasted, dry and in very few cases, blanched before roasting or drying.

Equipment

Very simple pieces of equipment are used for processing. This include baskets for removing sand, trays for winnowing, frying pans for roasting and the attrition mills for grinding. Other equipment include basins, pots, spoons etc. However, these are household equipment used for processing other foods as well.

Problems of the processors

The problem encountered by the processors in all the locations seem to cut across small and large processors. One of the problems is that the cost of purchasing a new milling machine and its motor is high and most processors cannot afford to replace their old engines. Therefore they resort to repairing them and replacing worn out parts. The cost of repair and spare parts are also high. This adds to the cost of grinding which may sometimes scare their customers.

Some parts of the engine such as the hopper are corroded after long use, and have to be replaced. The attrition plates also wear out and get blunt and have to be sharpened and eventually replaced after sometime. Since the increase in the price of petrol, water, engine oil, diesel and electricity, this has become a problem for them. Milling price has increase. In some locations such as Onu-Asata, the water bill is very high and they find it difficult to pay.

Sometimes there is power failure and water scarcity which militates against processing operations. During the fuel crisis of 1993, it was difficult for the processors who use diesel or petrol engines to obtain these fuels. Even when they were available, they were very expensive. Thus the running cost of their machines was high, thus, reducing their profit. Some of the broken machines have not been repaired because of the high cost of repairs.

There are no post processing problems as processors have ready market for the what they produce. The only processor with problem is the Zikin's foods. Part of his problem is connected with the general economic hardship which makes it difficult for him to enjoy as much patronage form his major customers as before.

Conclusion

In Okutu and Ozalla, processing of soybean was at a very low level because the milling machines are non-existent. The people were not too willing to grind their soybean with the mortar and pestle or grinding stone because it s difficult. However, utilization of the commercial roasted soybean products for enrichment of family foods, particularly weaning foods has increased in both places. Most often, the men who visit Nsukka and other urban areas buy these for their families.

In Enugu, it can be concluded that soybean utilization has substantially increased despite the fact that in some locations, the processors felt there was a decline. Milling and selling raw soybean for vegetable soup is on the increase. In fact, this product can be seen wrapped up and sold alongside other soup condiments in Ogbete and New Market. This may partially explain the apparent decline in number of people milling soybean reported in some parts of Enugu. Rather than waste their time on processing small quantities, the women may prefer to buy already milled ones for their soup.

Another interesting finding which augurs well for consumers is the massive adulteration of "moin-moin", "okpa", soup thickeners and other powdered products with soybean to increased the gain on these items. Last year, we reported adulteration for one product -"akparata" but this seems to be gaining ground and would imply that more soybean is being consumed than is actually reported in Enugu.

It can be concluded generally that over the three years in which we have had the soybean project, the awareness and utilization of the soybean has increased. Everybody including children in the project villages know that soybean is also the products that can be produced from soybean. Some housewives have even started using soybean products (roasted) for fortifying almost every food consumed in the family. In Enugu, consumption has increased and a group that cultivated soybean under the auspices of the BLP was identified. Small scale processors that we can collaborate with to further promote soybean utilization have also been identified.

Convetional result

A total of 298 respondents were interviewed. Two hundred (67.12%) were from Enugu, 58 (19.5%) were from Okutu and the rest (13.4%) were from Ozalla. Thirty-one percent, 37.5% and 11% of the respondents from Okutu, Ozalla and Enugu respectively were females and the rest were males. The age distribution of the respondents is summarized in table 6.27.

Table 6.27 Age distribution of respondents

Age (Years)	Enugu (%)	Okutu (%)	Ozalla (%)
20-25	11	50	-
26-30	36	25.9	10
31-35	39	15.5	2.5
36-40	2.5	5.2	7.5
41-45	3.0	-	2.5
46-50	2.5	1.7	5.0
51-55	1.0	1.7	2.5
Over 55	-	-	57.5

The ages of the respondents ranged from 20 to 62. Many (86%) of the Enugu respondents were aged 20-35 years, 75.9% of the Okutu respondents were aged 20-30 years while 57.5% of Ozalla respondents were aged over 55 years.

In Enugu, 81% of the respondents were married, 9% were single and 6% and 4% were widowed or divorced.

In Okutu, 65.5% were married, 32.8% were single and 1.7% were divorced. None was widowed. In Ozalla, 87.5% were married and 17.5% were single.

The number of wives and children in the three locations are shown n tables 6.28 and 6.29 respectively.

Table 6.28 Number of wives (%) in surveyed families

Number of wives	Enugu	Okutu	Ozalla
1	66.7	83.3	57.5
2	11.1	16.7	5
3	22.2	-	5.0
	-	-	-

Table 6.29 Number of children (%) in surveyed families

Number of children	Enugu	Okutu	Ozalla
1-2	18	25.6	12.5
3-4	17.5	28.9	15
5-6	51.0	28.2	27.5
6	12.5	15.4	27.5

Over half of the respondents in Enugu (63.5%) and Ozalla (55%) had 5 or more children and 43.6% of Okutu respondents were in this category.

All respondents in Okutu and Ozalla claimed to be farmers. However, 6.9% in Okutu and 2.5% in Ozalla combined farming with petty trading or teaching. Enugu respondents had more varied occupations such as trading (43%), working in the civil service (9%), big business (4%), teaching (4%). nursing (2.5%), sewing (3%). Some (16.0) said they were full time housewives and none was a farmer although they had small farms and gardens around their houses. Majority (98%) of Enugu respondents were christians and 2% belonged to non-traditional sects. In Okutu, 63% were christians, 5.2% were moslems and 31% were adhering to traditonal religion. In Ozalla, 22.5% were christians and 77.5% said they adhered to traditional religion solely or combined traditional religion and christianity. All respondents in Okutu and Ozalla were Ibos but 96% of respondents in Enugu were Ibos, 0.5% were Hausas, 1.0% were Tivis and 2.5% were Ibibios.

Educational level varied in the three locations as shown in Table 6.30.

Table 6.30 Educational level (%) of the respondents

Educational level	Enugu	Okutu	Ozalla
No formal education	12.5	27.6	65.5
Primary school completed	1	60.3	19.5
Secondary school	27.5	12.1	5.0
Nursing school	2.5		
Teacher Training College (TTC)	16.6		-
Vocational training	12.5		

Majority (65.5%) of the respondents in Ozalla were not educated and 60.3% of those from Okutu had only primary education. In Enugu, 27.5% had completed secondary school education and 16.0% had been trained as teachers (table 6.30).

Soybean production

Majority of the respondents in Enugu (85.5%), and all the respondents in Okutu and Ozalla know what soybean is. Their sources of information are summarized in Table 6.31.

Table 6.31 Sources of information on soybean (%)

Sources	Enugu	Okutu	Ozalla
Mass media	7.5	1.7	10
Friends	7.5	12.1	-
Government agencies	2.5	43.1	-
Better Life Program (BLP)	5	1.7	-
UNN team	48.5	63.8	90
Others (church, village meetings etc)	42.5	-	-

Some of the respondents got information from several sources with UNN team featuring as 48.5% and 90% in Enugu, Okutu and Ozalla respectively.

The date of introduction varied in the different locations (Table 6.32). However, many people in Enugu (53.5%), Okutu (70%) and Ozalla (87.5%) claimed it was introduced to them about 2 years ago.

Table 6.32 Time of introduction of soybean (%)

Time (years)	Enugu	Okutu	Ozalla
1	27.5	6.9	7.5
2	53.5	70	87.5
3	5.0	12.1	5.0
4	-	3.9	-
5	-	7.2	-

All the farmers in Enugu said soybean was introduced to them by the Better Life Program. In Okutu, 1.7%, 12.1%, 29.3%, 1.7% and 55.2% mentioned mass media, friends, government agencies, BLP and UNN team as having introduced soybean to them. All respondents in Ozalla said the UNN team introduced soybean to them. Only the respondents grew soybean in Enugu and Ozalla but in Okutu, the responses were every adult (1.7%), 1-2 people in the family (20.6%) and 3-4 people in the family (1.7%). The respondents in Enugu and Ozalla started growing soybean only 2 years ago. In Okutu, 1.7%, 17.2%, 1.7% and 3.4% started growing soybean 1, 2, 3 and 4 years ago, respectively. Growers in Enugu could not estimate the size of their farms but described them as very large BLP farms. In Ozalla and Okutu, the farms were less than one hectare when they started and have remained the same since then. Respondents in Enugu know only fellow cooperators as soybean farmers and those in Ozalla mentioned only 1 or 2 other farmers. In Okutu, the soybean farmers knew as many as 7 other farmers from within and outside their village.

Institutional assistance to Enugu farmers had come from government through the Better Life Programma and the University of Nigeria team. Okutu respondents had also been assisted by government agents - extension workers from Anambra ADP (24.1%) and UNN team (100%). Ozalla had got help only from the UNN team. The BLP provided inputs and some training in production to Enugu farmers, while the UNN team trained them on utilization. Ozalla farmers claimed that the UNN team provided them with seeds, training in production and utilization. The Okutu farmers said the ADP personnel provided them with seeds, training in production while the UNN team provided them with seeds, training in production and utilization.

The Enugu respondents could not actually describe the timing in months of their production. However, the Okutu and Ozalla respondents gave the timing of months of production as summarized in Table 6.33. Production generally carried out by adolescents and adults although children took part in collecting harvested soybean. Participation in soybean production activity is summarized in Table 6.34. The more strenuous activities of land clearing, ploughing, harrowing and ridging were exclusively done by males. Many adult males (57.1%) in Okutu participated in planting but no adult male did so in Ozalla. All females in Ozalla and 35.7% females in Okutu participated in planting.

Harvesting was done mainly by males (100%) in Okutu and females in Ozalla. In both locations, threshing was done mainly by men, winnowing by females and storage by both males and females. All cropping activities were manually done in Ozalla and Okutu but land clearing, ploughing, harrowing, ridging and hoeing were mechanically done in Enugu.

Other crops grown by Enugu farmers were cassava, corn and vegetables. Okutu and Ozalla farmers planted a wide variety of the same crops. This include cowpeas (Vigna unguiculata), pigeon pea (Cajanus cajan), bambara groundnut (Voendzeia subterranea), yams (Dioscorea spp), cocoyams (Colocasia esculenta), cassava (Maninot esculenta) and Melon seeds. Other foods grown were vegetables, groundnut, corn (Zea maize), sorghum (Sorghum spp), sweet potatoes (Ipoemia batatas), pepper and tomatoes. They could not estimate the hectarage and yield since the farms are widely scattered on plots of various sizes and a lot of intercropping is done. Soybean yield ranged from about 2-10 kg. Intercropping is generally done and soybean has not replaced any crops. Soybean is intercropped with okra, cassava, corn and black beans. They also said they could plant soybean in their yam plots if the foliage is not too much particularly at the edges of the farm.

They plant the cream coloured soybean variety which is the only one they know. Enugu farmers did not complain of any problems with soybean production but in Okutu and Ozalla the problems were the same and included high cost of labour. Lack of tractors, pests, tedious threshing steps, and in Ozalla in particular, lack of suitable land where chickens cannot molest their farms. Okutu farmers have tried to solve their problems by appealing to government and the UNN team tractors (100%), bird scaring (100%), and setting traps for rodents (42.9%). In Ozalla, they have tried bird scaring (62.5%) and 37.5% have done nothing about the problems.

Enugu farmers said they harvested four jute bags (400 kg) of soybean when they planted it. In Ozalla and Okutu, harvested soybean has remained below half a bag. Enugu farmers invited interested members to take what they wanted to eat and marketed more than $3^3/_4$ bags as members did not take up to 1/4 bad. The cooperators invited wholesalers in Enugu to buy and got #800 per bag. In Okutu, 28.6% ate all they produced, 21.4% sold all their crop, 37.2% sold some and reserved some for planting and 14.3% reserved all for planting. Ozalla, 75% ate all their yield and 25% marketed all their crop. Majority of those in Okutu (75%) and the two persons who marketed theirs in Ozalla sold soybean in open market. The other 25% in Okutu sold their crop to the UNN team. Selling price in both cases was #2 per milk cup (about 180 grams).

Enugu farmers stored their seeds in jute bags until they were sold but in Ozalla, 25% stored in sealed containers, 25% in polytene bags and 50% in pots. In Okutu, 57.1% stored in sealed containers, 14.3% stored in polytene bags and 28.6% stored in pots.

The only constraints to production according to Enugu farmers of was the creation of state which forced more vibrant members of the cooperative to leave the state and the uncertainty of BLP. In Okutu and Ozalla, the constraints mentioned are summarized in Table 6.35.

The major constraint in Okutu are lack of tractors (64.3%), no engine for grinding soybean (28.6%), tedious and time consuming processing steps (42.9%) and lack of seeds (85.7%). In Ozalla, the major constraints are lack of capital (100%), inability to cook and eat soybean like other crops (62.5%) and unavailability of engine to grind soybean.

Soybean utilization

Many (76%) of the Enugu respondents now use soybean. In Ozalla and Okutu, all of them use soybean but only when they are given processed products after demonstrations. On their own, 43.1% and 10.3% of the respondents from Okutu and Ozalla respectively use soybean. The products they make are shown in Table 6.36.

The most popular product in all areas is soy vegetable soup. In Enugu, 40.1%, 34.2%, and 30.9% prepare soymilk, roasted soy beverage and soy moin-moin. Apart from these production, the respondents were aware that soybean could be used for other products such as akara and pottage of all types. All respondents in Okutu and Ozalla were taught how to prepared soybean dishes by the UNN team. In Enugu, 53.9% said they had been taught by the UNN team, 41.4% had been taught by friends and others mentioned extension workers or other minor sources. Training in soybean had been acquired at different times as shown in Table 6.37.

All respondents in Okutu and Ozalla got their information on soybean production about 2 years ago. In Enugu, many (47.4%) of the respondents got their training about 1 year ago and 2.6%, over 3 years ago.

Soybean products used were ranked differently in the three locations. In Enugu, the order of preference (highest to lowest) was soybean vegetable soup, roasted soybean, soybean milk, soybean jollof rice, soy-akamu, soybean enrichment of almost all family foods. In Okutu, the order was roasted soybean, soybean milk. In Ozalla, the ranking was roasted soybean, soy vegetable soup, soy-yam pottage, soy-alibo, soy-akpu and soymilk (Table 6.38).

Grains used were almost always obtained from the UNN team by respondents in Okutu and Ozalla. In Enugu, sources of grains were open market (56%), farm (3.3%), gifts (2.0%) and UNN team (25%). Others did not have any particular source. In all locations, every member of the family eat soybean but roasted soybean is reserved particularly for children. Respondents in Enugu said they consume soybean almost daily. In Okutu, they reported consuming soybean on the average of once a week and in Ozalla, they consume it whenever it is available. Nobody in Ozalla sells soybean products but 2 people in Okutu and 16 people in Enugu were doing so. These people have no special customers and have never estimated the production cost.

Problems associated with soybean utilization in Okutu and Ozalla were similar. These include lack of engine for milling their soybean (100%), tedious processing procedures (100%) and scarcity of seeds (20.7%). Respondents in Ozalla also complained of production difficulties (5%). In Enugu tedious processing methods (16.4%) and poor storability (11.8%) were the only complaints.

Soybean has been used to fortify a wide range of traditional dishes as shown in table 6.39.

The traditional foods most often fortified with soybean were gari, pap, maize dishes, rice dishes, plantain dishes and cassava dishes.

The quantity of soybean consumed in a week was less than 1.5kg in Okutu and Ozalla. In Enugu, many (86.8%) consume 3-6kg per week, 8.6% consume 1.5-3 kg, 3.9% consume 1.5 kg and 2.6% consume more than 6kg per week. Apart from Enugu. Where owner operated mills were mentioned as processing equipment, only household wares like spoons, pots, basins, trays, pots are used for processing. Little or no losses were encountered during processing.

The only soybean product available in Nkwo market, Ozalla, is roasted soybean. In Okutu, roasted soybean were said to be available in Nkwo Okutu, Eke Avurugo, Oye Okpuje and soy vegetable soup is available at Nkwo Okutu. In Enugu, soybean products are available in the markets as shown in Table 6.40.

Table 6.33 Production times (months) (%)

Activity	January Ok oz	February Ok oz	March Ok oz	April Ok oz	May Ok oz	June Ok oz	July Ok oz	August Ok oz	September Ok oz	October Ok oz	November Ok oz	December Ok oz
Land clreaing					78.6	21.4 25	50	25				
Ploughing					78.6	21.4 25	50	25				
Harrowing					78.6	21.4 25	50	25				
Ridging					85.7	14.3 25	50	25				
Hoeing					85.7	14.3 25	50	25				
Planting						85.7	12.5 50	25				
Weeding								78.6	21.4	50	50	
Fertilizer application												
Pesticide application												
Harvesting									14.3	78.6	7.1 25	75
Threshing												64.3 50
Winnowing												64.3 50
Storage												

OK = Okutu; OZ = Ozalla

Table 6.34 Family members who participate in soybean production activities

Actvity	Children		Adolescents				Adults			
			Boys		Girls		Males		Females	
	OK	Oz	OK	Oz	OK	Oz	OK	Oz	OK	Oz
Land clearing	-	-	21.4	12.5	-	-	100	100	-	-
Ploughing	-	12.5	14.3	50	-	-	100	100	-	-
Harrowing	-	-	7.1	-	-	-	100	100	-	-
Ridging	21.4	50	42.8	25	-	-	100	100	-	-
Planting	-	-	-	-	7.1	25	57.1	-	35.7	100
Weeding	-	-	-	-	-	-	57.1	-	28.6	100
Fertilizer application	-	-	-	-	-	-	-	-	-	-
Pesticide application	-	-	-	-	-	-	-	-	-	-
Harvesting	14.3	25	42.8	-	-	-	100	25	28.6	100
Threshing	-	-	42.8	25	-	-	100	75	-	25
Winnowing	64.2	50	-	-	57.1	50	14.3	-	71.4	100
Storage	-	-	-	-	-	-	100	-	21.4	100

Table 6.35 Constraints to soybean production

Constraints	Okutu		Ozalla	
	No	%	No	%
Lack of tractors	9	64.3	2	25
High cost of labour	2	14.3	3	37.5
Lack of capital	2	14.3	7	7.5
High cost of seeds	2	14.3		-
No engine to grind it	10	71.4	8	100
Cannot be eaten whole like other crops	4	28.6	7	87.5
Ways of preparing it are time consuming	8	57.1	5	62.5
Not easy to cultivate	6	42.9	3	37.5
Lack of seeds	12	85.7	-	-

Table 6.36 Soybean Products prepared by respondents (%)

Products	Enugu	Okutu	Ozalla
Soymilk	40.1	-	-
Roasted soy beverage	34.2	3.5	-
Moin-moin	30.9	-	-
Akara	-	-	-
Soy-gari	9.9	8.8	7.5
Soy-alibo	-	17.5	10
Vegetable soup	100	100	77.5
Soy stew	6.6	5.2	
Soy ayaraya	-	3.5	-

Table 6.37 When respondents were trained on soybean utilization

Time (years)	Enugu	Okutu	Ozalla
1 year	47.4	-	-
2 year	26.3	100	100
3 year	2.6	-	-
Over 3 years	2.6	-	-
Don't remember	21.1	-	-

Table 6.38 Ranking of soybean products in the three locations

Enugu	Okutu	Ozalla
Soy-Vegetable soup	Soy-alibo	Roasted soybean
Roasted soybean	Soy yam pottage	Soy-vegetable soup
Soybean milk	Soy-vegetable soup	Soy-yam pottage
Soy jollof rice	Roasted soybean	Soy-alibo
Soy-akamu	Soybean milk	Soy-akpu
Soy enrichment of all foods		Soy-milk

Table 6.39 Traditional dishes fortified with soybean (%)

Traditional dishes	Enugu	Okutu	Ozalla
Gari	89	100	100
Pap	60	31	10
Pounded yam	10	5.3	-
Maize dishes	85	100	100
Rice dishes	100	100	100
Guinea corn dishes	26	29.3	27.3
Plantain dishes	65.8	72.9	30
Bean (cowpeas)	9.9	20.7	40
Yams	38.2	100	100
Cocoyam	23.7	15	5.0
Okpa	7.5	35.1	25
Achicha	5.3	36.8	22.5
Sweet potatoes	33.6	60.3	12.5
Cassava dishes	27.6	100	100
Pigeon pea	49.3	11.8	50

Table 6.40 Soybean products available in Enugu markets

Market	Products
Kenya market	Roasted flour
Ogbete	Roasted flour, raw flour
Gariki	Roasted flour
Afia Nine	Roasted flour, raw flour
Awkunanaw	Roasted flour, raw flour
Relief (new)	Roasted flour, raw flour
Abakpa	Roasted and raw flour.

Roasted and raw flour were available in all the markets (table 6.40). Commercial products available were cerelac, golden morn etc. Soup thickeners, moin-moin and `Okpa', `Egusi' soup and other products were highly adulterated with soybean even though the vendors would not admit this to their clients.

Soybean processing

Methods used for soybean processing are shown in table 6.41.

Table 6.41 Method of soybean processing (%)

Methods	Enugu	Okutu	Ozalla
Roast and mill into flour	40.8	-	-
Soak and mill	67.1	-	-
Mill dry, no soaking	93.4	-	-
Blanch and mill	55.9	100	100

Enugu respondents used a wide variety of methods for processing. In Okutu and Ozalla, all respondents claimed they blanched and milled. However, only one person in Okutu and 2 people in Ozalla had actually used this method. Adult females carry out all processing activities in Okutu and Ozalla. In Enugu, roasting could be done by househelps (14.5%), adolescent children (42.3%) or adult females (110%). Soaking and blanching are always done by adult females and milling almost always by school children or adolescent females. Milling was said to be the most difficult step followed by blanching and milling (Roasting > blanching > milling). In Enugu, respondents do not know what to do about the difficult steps. Some (42.6%) did not think it was more difficult to roast soybean than groundnut. Respondents from Okutu and Ozalla said they have appealed to the UNN team to bring the problems they have to the attention of the government.

All methods of processing were said to be efficient. Enugu respondents said roasting could be improved but that individuals must find a way of making the processes easier for their families. In Ozalla and Okutu, the emphasis was on provision of machines to make processing very easy.

In general, price of finished products vary. One packet of roasted soybean flour sells from ₦5 (75gms) and ₦2 (30gms) and a cup of moin-moin costs ₦1 or ₦2 per milk cup.

Table 6.42 Constraints to soybean products production (%)

Constraint	Enugu	Okutu	Ozalla
No milling machine	-	100	100
Processes too many	16	63.5	50
Processes too long	16	63.5	50
Soybean cannot be used on its own to produce a filling meal	-	94.8	100
It is difficult to produce good crop for family use	-	39.7	60
Seeds are becoming expensive	43	-	-
We are not sure people will buy some of the products	-	-	-

Constraints to soybean production are summarized in Table 6.42.

The major constraints to processing are lack of milling machines in Ozalla and Okutu and too many processing steps for safe soybean product.

Respondents in Enugu complained that the seeds were becoming expensive (43%) and that they were not sure people would buy the products if they prepare them.

Discussion

Different methods were used for soybean processing. The major problem remains lack of milling machines in Okutu and Ozalla. Unless this problem is addressed, soybean utilization in these communities will not actually make much progress.

Conclusion

Soybean production and utilization were almost non-existent at the beginning of the project (Uwaegbute et al., 1991). In Ozalla, for example, nobody knew what soybean was and in Okutu, only one person knew how to use it. In this present work, all respondents knew what it was and could prepare products from soybean. Processing and utilization were low in all areas. While these have improved substantially in all areas, there is still room for improvement particularly in Okutu and Ozalla. In Enugu, the indications are that more people are consuming soybean than reported because of the massive `adulteration' of foods with soybean that is practiced in Enugu Urban.

Production has also been adopted in the three areas. The Enugu farmers were very happy with the yield of the soybean they produced. However, none of them could produce soybean on their own because they did not eventually learn how to do this. Moreover, the dispersal of some of their most enthusiastic members following creation of states has dampened their enthusiasm. However, they were advised to get together again and find a pieces of land so that the soybean utilization group in Nsukka can teach them how to produce soybean on their own. For the other areas, soybean production has taken off. In Ozalla, in particular, women were more involved than men. This implies that soybean production could be successfully done. However, the pattern of residence of the farmers who prefer to live in their farms and consequently move to farming areas with their livestock create problems since their chickens destroyed even the crops planted on demonstration plots. If this community can find chicken-free zone, production would be more successful. In Okutu, the team is making more effort to involve women since the young men who are very keen on production are also looking for white collar jobs in the urban area. In fact, the most enthusiastic soybean farmer who also was our contact person has left the village to look for white collar job in the area inspite of this satisfaction with the yield of his crops. At the moment, young men are more involved in soybean farming than the older farmers who are more conservative. The major constraints to utilization and production could not be addressed by the project in Phase II. It is concluded that although a great deal of success has been achieved in all areas, unless the major constraints are addressed, it is doubtful that any more improvements can be achieved in the two rural areas.

SECTION 4

Level of adoption of soybean production, processing and utilization in Diko, Mungorota and Bida villages in Niger State (a terminal survey)

Introduction

Recently, soybean research in these countries has solved most of these production problems and paved the way for soybean as a primary source of protein in these protein deficient countries including Nigeria. However, there is a need to promote an increased and sustained production of soybean by creating a demand for its utilization both at the household and commercial levels. The realization of this need led to the initiation and funding of soybean utilization project by International Research Centre (IDRC) Canada in collaboration with International Institute of Tropical Agriculture (IITA), Ibadan and Institute of Agricultural Research and Training (IAR&T), Ibadan in Oyo State in 1987. After successful completion of this first phase in 1990, the project was extended to other zones of the country. The second phase of the project commenced in 1991. The National Cereals Research Institute (NCRI) is one of the participating Institutes, and it is responsible for the middle belt zone of Nigeria.

The broad objective of the project is to develop and promote the use of soybean utilization technologies which are suitable for rural and urban households and small scale processing enterprises in Nigeria in order to stimulate production and to improve the social and economic well being of the people (Osho and Dashiell, 1992). One of the specific objectives is to document the status of soybean production and utilization in three project sites in Niger State. To achieve this specific objective, a baseline survey was carried out in May 1991. Between 1991 and 1993, production, processing and utilization technologies were developed and introduced to the project sites. And a monitoring survey was carried out in April 1993 (Ikejimba, et al). Finally in December 1993 a terminal survey was conducted to evaluate the impact of the project in the sites. The results of the terminal survey are presented in this report.

Methodology

The sites of the projects are Diko (production site) Mungorota (non production site) and Bida (urban site) in Niger State. The sites were selected on the basis of production level. Both primary and secondary sources of data collection were used. The primary data were collected by using a set of questionnaire. Information were collected on socio-economics, soybean production, processing and utilization. The secondary data were collected from NCRI library and the project's documents. Thirty two, 15 and 23 copies of the questionnaires from Diko, Mungorota and Bida respectively, that were properly completed, were analysed. Descriptive statistics were used for the analysis.

The checklist in the Rapid Rural Appraisal method were also used. The survey was carried out by a multidisciplinary team of four scientists; Agricultural economist, Food technologist, Agronomist and Home economist.

Results and discussion

The results obtained from the three sites (Diko, Mungorota and Bida, urban) are presented individually under the topics: awareness, soybean production, soybean processing and soybean utilization.

Awareness

Diko village has been noted for its long history of soybean production which dated back to 1930, but the level of production was not consistently sustained due to lack of demand.

During the period of 1991 to 1993 the introduction of the NCRI/IDRC/IITA project stimulated the interest of more of the villagers in soybean production, processing and utilization. The result of this survey showed that 97% of the respondents know what soybean is Table 1. Their main sources of information include the NCRI/IDRC/IITA project, friends, others (Ministries, the extension agents of Agriculture Development Projects), news media and the better life programme as indicated by 40%, 22%, 19%, 10% and 6% of the respondents respectively (Table 1). Information gathered from respondents indicated that soybean was introduced to 63, 13, 9 and 3% of the respondents over 5 years ago, 3 - 4 years ago 1 - 2 years ago and less than one year ago respectively. In 1993, 84% of respondents in Diko (data not presented) claimed to have grown soybean as against 59% and 25% in 1992 and 1991 respectively (Ikejimba, et al, 1993). The NCRI/IDRC/IITA project has had the greatest impact in creating awareness about soybean (Table 1). Twenty-two per cent of the respondents indicated that soybean was first introduced to them through the project staff as against 10% that made similar claims in 1992 (data not presented).

Production

Prior to the advent of the NCRI/IDRC/IITA project, the level of soybean production in Diko area had always fluctuated with the yearly market prices with demand influencing production in the succeeding year. But with the introduction of the project production stabilized, and yearly more hectarages were put into soybean cultivation. By 1992, 41% as against 55% pre-project years and 9% as against 0% of farmers interviewed had less than 1 hectare and over 4 hectares under soybean respectively (Table 6.44). Similar trends were observed at Mungorota. The urban nature of Bida, makes it difficult to have large contiguous expanse of land for farming. However, the survey still revealed that more and bigger fragments of land were put into soybean cultivation.

In all, 34% of respondents claimed that groundnut, cowpea and cassava have been substantially substituted for by soybean in their cropping systems. The survey also revealed that soybean was being grown either as a sole crop or in intercrops. Thirty-four percent of the respondents grew soybean as a sole crop, 31% intercrop, while 19% indicated that they grow the crop either sole or in intercrops on circumstances. Soybean is intercropped with cassava, maize, guinea corn by 13, 16 and 22% respectively. About 72% of the respondents have grown the yellow variety TGM 923-2E and 19 have grown the white variety (TGX in 85 - ID). About 65% preferred the yellow variety while none of the respondents planted the black variety.

Lack of market is the greatest production problem encountered by the Diko farmers, followed by lack of tractor, high cost of land preparation, high labour cost and low-prices of soybean. Efforts have been made to solve these problems by appealing to government, and by organizing farmers cooperatives to cut down on labour and tractor hiring costs.

Twenty eight percent of the respondents sell their harvested soybean while 31% sell part and use part for household processing and utilization. 72% of those that cell, do so in the open market.

There is no standardized price for soybean in Diko. The price of soybean per mudu (1 mudu is approximately = 1.25 kg) as stated by the respondents varies from ₦5 to ₦20. The average price in 1993 is ₦10 per mudu. This price is said to be low and discouraged production. The threshed soybean is stored in jute bags by 65% of the respondents while 13% store it in polythene bags. The low price of soybean may be as a result of the increase in production without a corresponding increase in demand for soybean.

Processing

In Diko village soybean is processed or incorporated into the following products as soy daddawa, soymilk, soy kosai, soy egusi soup. Though, soy kulikuli was found among the villagers; it was bought from another villages. The processing methods used vary among the respondents and also according to the product. The first method of blanching, drying and milling into flour is used by 28%; the second method of roasting and milling to flour by 16%; the third method of blanching and wet milling by 31%; soaking and milling by 19% of the respondents.

All the steps (soaking, blanching, roasting, milling and dehulling are done by male and female adolescents and adult females. The processing steps ranked in decreasing order of cumbersomeness are dehulling, roasting, milling, blanching and soaking.

Reasons for ranking dehulling as the most cumbersome are:

1. Problems of removing the husk.
2. Problems of separating the husk from the soybean without loss.

Roasting is said to be difficult because of the direct heat on the processes and length of time required to roast the soybeans. Milling of soybean with grinding stone is stated to be difficult by 25% of the respondents. On the other hand, 31 percent claimed that they have no problem with milling soybean with grinding stone. Blanching and soaking are ranked as not being difficult. About 73% have done nothing to improve the difficult processing steps but 27% have tried easier methods. About 72% feel that dehulling methods should be improved upon. No suggestion was, however, given on how the soybean processing steps can be improved upon.

Utilization

Home consumption or utilization of soybean can be an incentive to soybean production. In Diko 84% utilize soybean. The percentages of the respondents who produce soybean milk, soy vegetable soup, soy akara, roasted soybean beverage, moinmoin, and daddawa are 75, 55, 9, 13, 10 and 79 respectively. In addition, they are also aware of soy ogi. Soybean daddawa is well utilized in this village. Seventy eight percent of the respondents claimed to have been taught how to prepare soybean products. The various agents that have taught them are NCRI/IDRC/IITA project, extension workers, health personnel and others. Thirty seven percent were taught soybean utilization under 3 years ago while 53% had their training over 3 years ago. The preference for soybean products is daddawa, soymilk, soy egusi soup, soy akara in that order of likeness. The soybeans utilized is obtained from the open market, personal farms and other farmers. Thirty four percent, 41 and 6% of the respondents utilize these sources respectively.

In Diko village, 88% of the respondents asserted that everybody in their household eat soybeans. Of this, 34% said it is consumed daily.

The females are mostly responsible for soybean processing in Diko village. Twenty five percent sell soybean product and this is sold mostly to market women and men.

The problems encountered with soybean utilization are tedious processing methods and poor storability, especially, of soymilk. The most common traditional dishes in Diko area are pounded yam, yam, guinea corn dishes, millet, maize dishes and sweet potatoes. Soybean has not been incorporated into the dishes per se except in ogi (pap) but it is used to make egusi soup with which these dishes are consumed.

Fifty nine percent and 19% of the respondents claimed to consume in the homes, about 1.5 kg and 1.6 kg to 3 kg of soybean per week respectively.

Most of the grinding for household utilization is done with the traditional grinding stone. But it is expected that more people will use the electrical grinder as electricity has now been installed in the village. In fact, about five grinding machines were seen in operation in the village during the survey.

The adoption of the use of grinding machine for grinding soybean may ease some of the processing constraints expressed earlier.

About 25% of the respondents have small scale soybean processing industries.

Mungorota village (non production site)

Awareness

The staff of the Ministry of Agriculture initially introduced soybean to this village but lack of market for the disposal of the produce and lack of production, processing and utilization technology discouraged subsequent soybean production in the village. The initiation of NCRI/IDRC/IITA project in this village has resuscitated their interest in soybean. Eighty percent of the people interviewed know about soybean (Table 1). About 53% heard about soybean through the NCRI/IDRC/IITA while 7, and 20 knew it through friends and other sources respectively (Table 1).

About 60%, 20, 7 and 13% of these said soybean was introduced to them 1 - 2 years, 3 - 4 years, 4 - 5 and over 5 years ago respectively.

Production

About 80% of the respondents grow soybean (Table 1). About 60%, 20 and 20% of these respondents said soybean was introduced to them 1 - 2 years, 3 - 4 years, 5 years and above ago respectively. When soybean was first introduced to the people, 74, 13 and 13% farmed less than one hectare, 1 hectare and 2 hectares respectively (Table 2). Forty six percent started growing soybean about 1 - 3 years ago. This falls within the period the NCRI/IDRC/IITA project was started in the village. In 1992, 61% had soybean farm sizes less than one hectare, 26% had about 1 hectare and 13% had about 2 hectares. Investigations revealed that most of the soybean seeds given to them were sold out and only a few quantity was planted.

About 40% claimed that the NCRI/IDRC/IITA project has helped them with soybean production. The assistance rendered are in the form of input provision, training in production, processing and utilization. Land preparation starts in June while planting is done between June and July.

Thirty three percent of the respondents prefer to plant the white (TGX in 85-ID) variety while 67% like the yellow variety (TGX 923-2E). The black variety is not grown. The yellow is preferred because it has a higher yield than the white. The adolescent and adult males are involved in operations such as land clearing, ploughing, ridging and hoeing. Both males and females are involved in weeding. Threshing is done by both sexes and winnowing is done by females.

The other crops grown in Mungorota are cassava (the main cash crop in this village), maize, guinea corn, rice and sweet potatoes. Only 20% of the respondents said soybean has replaced other crops grown. About 66% while intercropped, 13% used the monocropping system while 7% practice both mono and intercropping systems. Soybean is intercropped with maize, guinea corn and cassava.

At Mungorota the respondents have problems with rodents, tedious threshing steps and high cost of labour. They have attempted to solve the production problems by appealing to the government and approaching other government agencies. Setting of traps is used to control rodents.

About 72, 18 and 10% of those who planted soybean harvested 100, 200, 300 kgs of soybean respectively in 1993. Forty six percent of those who grew soybean sold all the harvested soybeans sold all the harvested soybeans, 40% ate part and sold part and 13% stored for future use, marketing and planting. Out of those who sold their soybean, 86% sold them at the open market at prices ranging from ₦8 to ₦20 per mudu. The average price, however, was ₦9 per mudu. In 1993 soybean was stored mainly in jute bags.

Processing and utilization

In Mungorota, it was not easy reaching the females because they were busy with gari processing at the time of survey. Only 33% of the respondents were women. It is the women who are involved in soybean processing. 60% of these women claimed that they use soybean. The products made are soymilk, roasted soybean beverage and daddawa. The soybean product they are aware of include soy akara, soy ogi, soy moinmoin, soy egusi, soy cheese. They had only recently adopted soy daddawa.

Eighty percent said they were taught soybean utilization by the NCRI/IDRC/IITA project team and 13% by the extension agents of the Ministry of Agriculture. Seventy three percent got their training in the past three years. The soybean product they prefer are daddawa, soymilk and soy beverage. The soybean seeds used were obtained from the open market, produce from personal farms and other farmers by 13, 40, 13% of the respondents respectively. 67% of the respondents said soybean is eaten by everybody in the house. Soybean is said to be consumed daily by 20%, 4 times/week by 67% 3 time/week by 33%, 2 times/week by 26 %, once/week by

13%. Only one respondent sell soybean daddawa to the market women. The rest of the respondents consume the products made.

The most common traditional dishes in Mungorota are Tuwonrice, Tuwondawa, pap, beans and potatoes. The villagers have not incorporated soybean in any of the dishes but soybean, daddawa is added to their soup. About 60%, 33%, 6(1) B% consume 1.5 kg, 1.6 - 3 kg and 3.1 - 6 kgs of soybean per week. The grinding machine is used for grinding large quantities of soybean while grinding stone is used for small quantities.

Bida urban

In the Bida urban site questionnaire were administered at two locations. They are the maternity health care, and the Gwadabe market. Seventy eight percent of the respondents were women while 22% were men. None of the respondents is a full time farmer.

Awareness

Eight seven percent of the respondent know what soybean is (Table 6.43). They knew soybean through news media, friends, NCRI/IDRC/IITA project and other sources (Table 1).

Production

Thirty percent of those interviewed stated that they grow soybean (Table 1). About 65% of the respondents were introduced to soybean in the past 2 years which falls within the project period. Thirty four percent were introduced to it through the NCRI/IDRC/IITA project, while 35% were introduced to it by friends and 31% through other agencies. Sixty percent said nobody grows soybeans in their household. Only 9% said they grow soybean in their household. About 17% and 4% of the respondents started soybean production 1 year and 3 years ago respectively. The farm sizes for those who claim to grow soybean were not up to 0.4 hectare.

Their farm sizes in 1993, was also less than 0.4 hectare. The soybean is grown intercropped or using both systems by the respodents. The yellow variety is preferred. 28% of those who grow soybean indicated lack of tractor as a production problem and they havee appealed to grovernment for help. The soybean harvested was sold to friends and neighbours. The average price in 1993 was ₦15 per mudu. Soy ean is stored in jute bags.

Processing

The soybean processing methods used are:

(1) Blanching, drying and milling into flour. (23% of respondents).

(2) Roasting and milling into flour. (48% of respondents)

(3) Blancing and wet milling. (17% of respondents).

(4) Soaking and milling. (31% of respondents).

(5) Any other. (9% of respondents).

The adolescent and adult females are resonsible for processing soybeans. The ranking of the processing steps in order of how difficult is dehulling, roasting and milling. They have tried easier methods. Roasting and milling into flour is ranked to be the most efficient processing method because large quantities can be processed at once, stored and used when needed. They also stated it is easier to dehul the roasted soybean. Blancing, drying and milling into flour is said to be efficient except for the dehulling and separation of the husk which are said to be tedious and requires a lot of water. Blanching and wet milling is slightly efficient, but the milk produced from it does not store well. The steps that should be improved upon are blanching, roasting, dehulling and milling according to 22%, 26, 39 and 13% of the respondents respectively. 87% feel that the soybean products are cheap while 13 feel they are expensive.

Over 64% stated that processing of soybean to its products is time consuming and tedious.

Utilization

About 78% of the respondents use soybean to make soybean milk, roasted soybean beverage, moinmoin, vegetable soup and other products according to 30, 30, 18, 8 and 13% respondents respectively. The other product, the respondents are aware of is daddawa. About 56% were taught how to make soybean products by the NCRI/IDRC/IITA team while 22% were taught by health workers. About 9, 30, 17, 17 and 9% of the respondents were taught soybean utilization less than 1 year, 1 year, 2 3 and 4 years, ago respectively. The soybean product in order to preference are soymlk, moinmoin, daddawa and soy beverage. About 74% obtained their soybean from the open market. About 50, 26, and 75 said everybody, children only and adult females eat soybean in their household. 9% were not specific as to those who consume soybean products, market women and government workers are the main customers of 34% of the respondents who sell soybean products.

Problems encountered are tedious processing methods and poor storability of soy milk. The most common traditional dishes are rice, guinea corn, maize, pa, sweet potatoes and millet. About 48, 44 and 9% consume about 1.5 kg, 1.6 - 3 kgs and 3.1 to 6 kgs of soybean per week. The equipment used for soybean processing are grinding machines and grinding stone. Losses occur mostly during dehulling. Soybean and soy products are readily available in the market as affirmed by 73% of the respondents. The markets are located in Gwadabe, post office area and Masaga. The forth one is referred to as the small market.

Table 6.43 Percentage distribution on awareness and sources of information about the soybean crop at Diko, Mungorota and Bida in Niger State, Nigeria, December 1993

Awareness/ soruce of information	% Respondents		
	Diko	Mungorota	Bida
Awareness			
Yes	97	80	87
No	3	20	13
Cultivation			
Yes	84	80	30
No	16	30	70
Source			
NCRI/IDRC/IITA project	40	53	30
News media	10	0	9
Friends	22	7	31
Better life programme	6	0	0
Others (Ministry, ADP)	19	20	17
Not specific	3	20	13

Table 6.44 Trends in percentage hecterages under soybean production in Diko, Mungorota and Bida in Niger State, Nigeria, December, 1993

Period and size of farm	% Respondents		
	Diko	Mungorota	Bida
Pre NCRI/IDRC/IITA project			
Less than 1 hectare	55	74	100
1 hectare	22	13	0
2 hectares	19	13	0
3 hectares	4	0	0
4 hectares	0	0	0
Above 4 hectares	0	0	0
Post NCRI/IDRC/IITA project			
1991			
Less than 1 hectare	37	92	100
1 hectare	33	8	0
2 hectares	18	0	0
3 hectares	12	0	0
4 hectares	0	0	0
Above 4 hectares	0	0	0
1992			
Less than 1 hectare	41	61	100
1 hecatare	18	26	0
2 hecatares	26	13	0
3 hecatares	3	0	0
4 hecatares	2	0	0
Above 4 hecatares	9	0	0

Conclusion

The NCRI/IDRC/IITA Soybean Project Phase II in Niger State has been a succes as indicated by increased production, processing and utilization. In Diko, the percentage of the respondents who grow soybean increased from 25% in 1991 to 59% in 1992 and 84% in 1993. At Mungorota, the percentage increased from 46% in 1991 to 96% in 1992 but dropped to 80% in 1993. The reason for the drop in 1993 production at Mungorota may be as a result of low yield experienced the previous year (Olowe, et al, 1993). At Bida urban the percentage increase in production rose from 8% in 1991 to 30% in 1993.

Before the initiation of the project in Niger State, the soybean products known and processed were mainly soy daddawa and soymilk. But presently, the soy products known and processed are soy daddawa, soymilk, soy kosai, soy egusi soup, soy kulikuli, soy beverages soup, soy ogi, soy moinmoin, soy cheese and soy vegetable soup. In other words, soybean is now used in completing the nutritional status of most staple food and snacks. This observation has good health and nutritional implications.

Small scale processeing enterprenuers visited during the survey claimed that soymilk business is very profitable. Net profits of ₦15 to ₦25 per 1.25 kg of soybean processed were reported by some processors. Consumers of soymilk interviewed supported the fact that demand outweighs supply. In fact, requests for soymilk had to be made well in advance. For instance, people drop containers in the morning with one Madam Hawa Aturbuku, in Diko area, to guarantee their supply of soymilk. Another soybean product that sells fast is the soy daddawa. A small scale processor, madam Damisa, in Bida area, processes about 5 mudus of soybean on each market day and makes a profit of about ₦100.

In fact, the impact on the adoption of the NCRI/IDRC/IITA soybean technologies were noticeable during the project terminal survey. In addition, a large scale soymilk processing company is being established at Suleja near Diko. When the company is fully operational, the price and demand for soybean will increase in this area. This may in turn stimulate local soybean production.

Soybean processing at the household level has increased and the people's taste for its products established in the NCRI/IDRC/IITA soybean production, processing and utilization project sites. However, more needs to be done to remove the drudgery associated with post harvest processing methods. This is why the recent development of a soybean thresher also funded by IDRC through the co-ordinator, National Co-ordinated Research Projects on soybean is a welcome idea. But the current levels of household consumption and utilization are low. To sustain production for houshold and future indistrial usuage in Niger State, good marketing outlets have to be sought to absorb present production increases. A glut would be a dis-incentive to soybean production.

Soybean as a cheap source of plant protein is more than ever before needed in the diets of the low income people because of the exorbitant prices of animal protein sources. There is, therefore, the need to organize train-the-trainer courses where the experiences gained throught the NCRI/IDRC/IITA are passed on to participants. This will have a multiplier effect on information and experiences derived by the project team as to the benefits of soybean production, processing and utilization.

CHAPTER SEVEN

Impact of the project on soybean production and utilization in Nigeria

Soybean and soy based foods are now house-hold names in many parts of Nigeria. Thanks to the awareness drive of IDRC through the Soybean Utilization Unit of IITA; and the participating national institutions. The results from the baseline survey were used to develop a research agenda for improving traditional foods with soybean and also use to assess the impact of the project. Some of the research activities undertaken included the following:

Fortification of traditional root and tuber crops (yam, cassava, sweet potatoes), white potatoes and cereals (maize, sorghum and rice) with soybeans;

Fortification of indigenous Nigerian foods using soybeans; development of soybean based weaning foods;

Development of food uses for various soy flours, (defatted cake, extruded flour, raw soy flour, milk residue flour);

The utilization of soybean in the production of dairy-like products (yoghurt, flavoured soymilk, cheese and ice cream);

Development of low-cost, simple soybean oil refining processes that will remove foam, improve colour, improve frying characteristics and maintain oil stability;

Testing consumer acceptability of texturized vegetable protein products.

Formulation of various breakfast foods, snacks and weaning foods, using extrusion cooking;

Development of low cost soybean processing equipment (filter press of soybean milk and cheese cleaners);

Evaluation of processing on nutritional characteristics and lipoxygenase effect on soymilk and the coagulated product, tofu.

Soybean had been incorporated into traditional foods of Nigerians like soy vegetable soup, soy Kunuzaki, soy-tuwo, soy opa, soy alibo, soy akpu, soy hatsi, soy cheese and there were also new products like soybean milk, soy ice cream and soy-yoghurt. These soybean fortified products have more protein and minerals than the non-fortified counterpart products and the level of acceptance was quite high. Anti-nutritional factors (phytic acid, tannin, trypsin inhibitor) were found to have been effectively eliminated by traditional processing. Most of the developed technologies have been transferred to home users and some to small scale industries. Some of the reasons household users gave for incorporating soybean into their foods were that is is nutritious, tastes nice, is a good substitute for expensive protein and is versatile.

IAR&T in South Western Nigeria developed food products like soybean eggs, soybean ogbono and soy tortillas. NCRI ("Middle Belt" Nigeria) developed weaning foods with soybeans and traditional beverages like kunuzaki were fortified with soybean. Local foods and snacks e.g gari, zanbu, masa, bambara, dankwa, chinkafa, etc were all fortified with soybean. At UNN, in South Eastern Nigeria, studies on enriching traditional foods like okpa, ora, akpu, alibo etc with soybeans were carried out. Weaning foods and breakfast cereals were developed from local cereals and extruded full fat and defatted soybean flours. NEARLS in Northern Nigeria conducted nutritional studies on traditional foods fortified with soybean e.g soy tuwo, soy wara, soy talia, soy paten masara, soy paten acha, soy ganda, soy danwake, soy nakiya. The fortified foods had increased protein content and the sensory evaluation revealed that there was no significant difference in the level of acceptance when compared with the conventional foods. In most cases, panelist and villagers were not able to detect any differences. The costing of the products developed also revealed that the inclusion of soybean reduces the total cost of many products by at least 25%.

Apart from conducting research into the utilization technologies appropriate for household and small scale processing enterprises, the project also engage themselves in popularizing its findings. For instance, they had on many occasion demonstrated to large audience in Trade Fairs, farmers shows and village demonstrations nation wide, simple ways of using soybean to fortify the carbohydrate rich foods of the people. The relatively easy ways of making house hold soybean foods has greatly contributed to the impact of the crop in many homes.

The developed technologies were transferred to the rural and urban people in the selected soybean project sites. Example of such technologies is soy gari processing as shown in picture 16. The training usually encompassed production and utilization with particular reference to incorporation into particular diets. The training programs were conducted in local Nigerian languages - Yoruba, Igbo, Hausa, Nupe, English and Pigin English. Other important training programs were held for hospitals, family planning groups, nutrition rehabilitation centres, secondary schools, primary schools, Obas (traditional rulers) and in some instances for Agricultural Development Programs (ADPs), Better Life for Rural People and some international organizations and small scale industries. The total number of people trained was over 47,000 out of which about 30,000 were women. To facilitate training, the IITA publication "Soybean for Good Health" was translated into Yoruba, Hausas, and Igbo.

Datas kept by the project revealed that before the onset of the project (1987), only a few products made from soybean were known to be available in Nigeria which were confined to the traditional soybean growing areas of Benue state included seasoning for soups and stews. However, one can easily count not less than 30 products in 1990 and less than 51 in 1994, made from soybean nation wide, particularly at small scale level. At the industrial level, the number of indigenous soy-processing companies in Nigeria has increased from only 2 to about 20 in 1991 and 51 in 1994 (Fig. 7.1). Several new soybean products which were directly or indirectly linked to the research effort of the IITA/IDRC Soybean Utilization Unit are now available in the market. Picture 17 shows some of soybean products being hawked in the market while picture 18 shows some of the industrial soybean products in Nigeria markets.

As a result of the dissemination and sensitization activities associated with this Phase II project, an increasing number of food processors have incorporated soybean into their products. About 60 industries are currently processing soybeans (table 7.1). These products are now available in markets. The production of several new soybean products are directly or indirectly linked to research efforts in Phase II. Examples of some of the processed products include soybean flours, soybean oil, high protein cake, soybean milk, soybean yoghurt, soybean based weaning foods (Nutrend, Soy ogi, Babeena, Golden Morn) chocolate candies, texturized vegetable protein, soy biscuit, livestock feed (Picture 18).

The 1991 findings of the baseline survey and the situation in the following year showed an increased production from 1991 to 1993. Table 7.2 shows the trend of soybean in production in project sites from the inception of 1st Phase of the project. In addition, it was found that the availability of a reliable market was very crucial to soybean production as farmers did not want to plant if there was not market in or close to their location. Soybean processing and utilization increased significantly in all the areas where the projects were carried out. This has led to increase in demand for soybean and thus creating more avenue for farmers to dispose their gains. Fig 7.2 shows the number of markets selling soybean in Ibadan markets. There was increase in household utilizing of soybeans from 1991 to 1994 (Table 7.3).

This project has also had an effect on the number of retailers selling soybean. In Ibadan markets, for example, the number of retailers increased from 539 in 1991 up to 1020 in 1994 (Fig. 7.3) while the price per kg also increased from ₦5.70 to ₦19.50 between January 1991 to January 1994. Soybean is sold as seed and flour in the markets. This finding is based on a survey of 42 Ibadan main markets a city of about 4 million people. In Enugu, the number of retailers also increased from 4 retailers to 107 in Ogbete main market where soybean has been retailed as raw flour and toasted flour for two years.

The awareness drive of the unit coupled with the fact that consumers derive direct benefit from soybean products especially as ideal weaning food for babies and as a source of balanced diet for malnourished children have made hospital authorities to embrace soybean products to alleviate these problems (kwarshiokor and marasmus). An increase in number of hospital was noticed in all the states where the project is implemented. In 1994 the number of hospitals has increased tremendously to more than 69 nation wide (Fig. 7.4).

Imported and locally produced equipment were studied to assess their efficiencies and suitability for processing soybeans. These equipment were: an extruder (INSTA-Pro Model 600 Jr), a screw press (AUII) and a soybean milk filter press (designed in Japan), which were all installed at IITA; an imported seed destoner (gravity separator for seed cleaning prior to processing) and a soybean oil filtering machine installed at Orman Industry in Ibadan; and, a locally designed soybean milk filter press which was installed at Nigerdock in Lagos.

IITA has used the extruder to process a variety of soybean flours e.g full fat soy flour, and defatted soy flour which can be used in traditional foods like egusi and used at the industrial level for baby foods and breakfast cereals manufacture.

Soybean is now a way of life for many Nigerians that knew next to nothing about the crop and its products before 1987. Now voluntary organizations and other government agencies like the Ministry of Health, Youth and Sports and Social Development; the prisons, army, schools, have incorporated soybean utilization into their activities. Moreover, food technology students, nutrition and agriculture students have become more keen and interested in exploring the benefits of soybean to the consumer. The students are interested in studying processing technologies, fabrication of suitable processing machines, etc appropriate for the home level, small scale and industrial preparation of soybean products.

There is evidence to suggest that governments level, there is a growing and significant support for soybean production and utilization. Government is giving more support to research institutes involved in soybean research and to the Nigerian Soybean Association.

Results from this project conclusively show that people will adopt new technologies and recipes once they are carefully prepared, recognizing the people's cultural habits and as long as these new technologies and recipes do not increase equipment cost, processing cost, or cooking time; in addition, the new technologies and recipes also enhance nutrition.

We are confident that success achieved here in Nigeria will soon spread through the West Africa coast.

Fig. 7.1 Number of indigenous soy processing companies in Nigeria (1987-94)

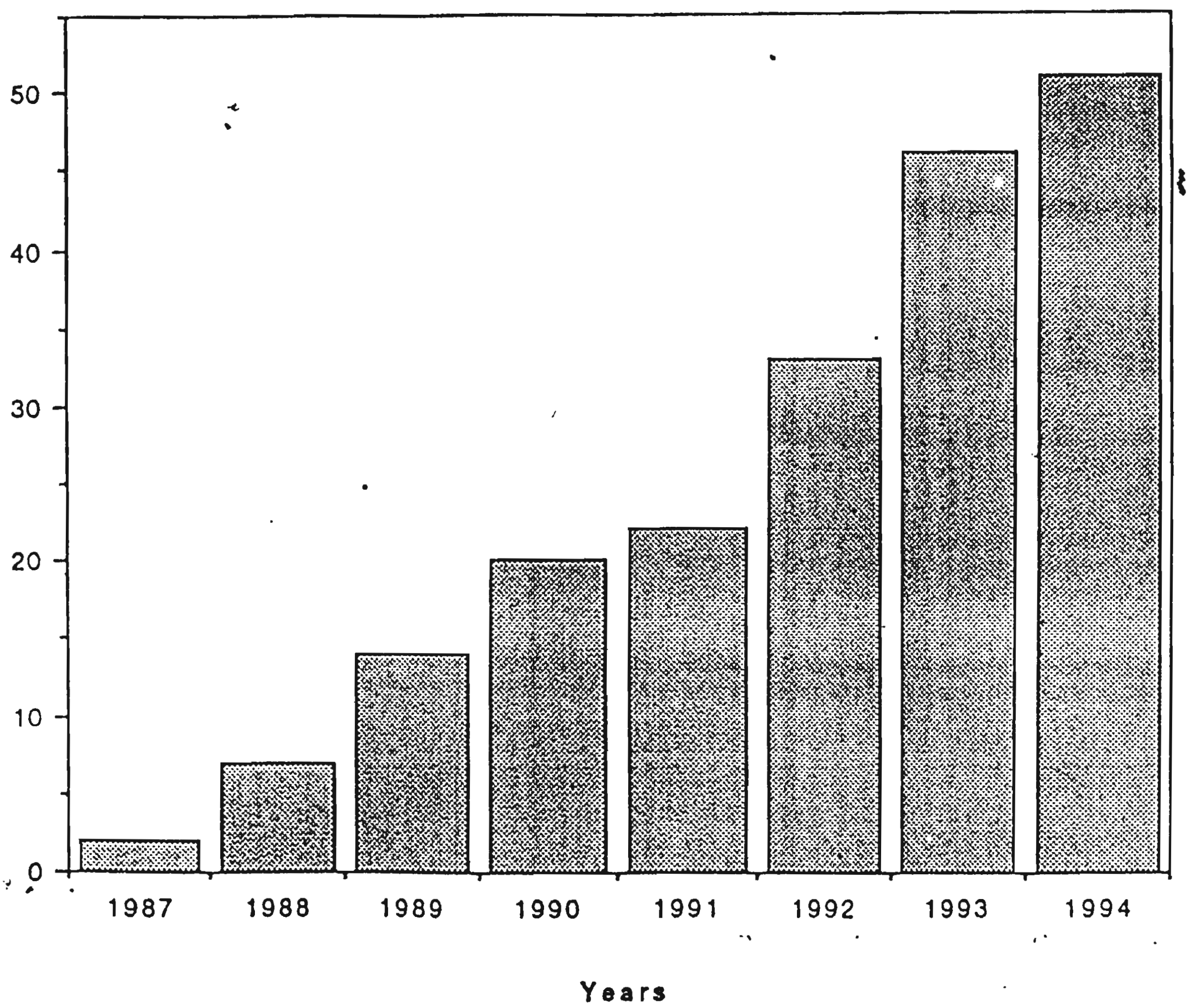


Fig 7.1 Number of Indigenous soy-processing companies in Nigeria (1987-94)

Fig. 7.2 Number of markets selling soybean in Ibadan, Nigeria

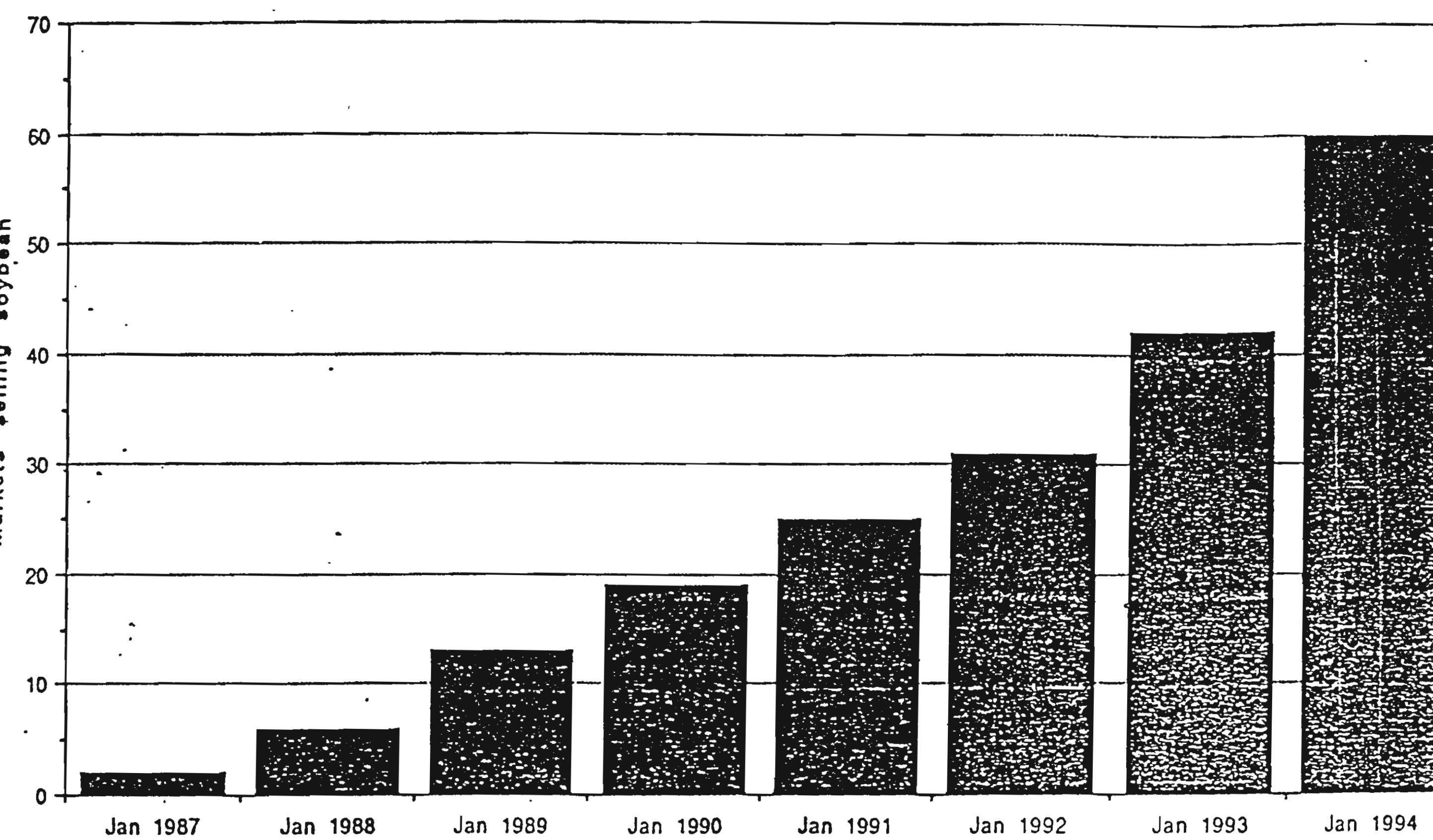


Fig. 7.3 **Number of Retailers selling Soybean in Ibadan, Nigeria.**

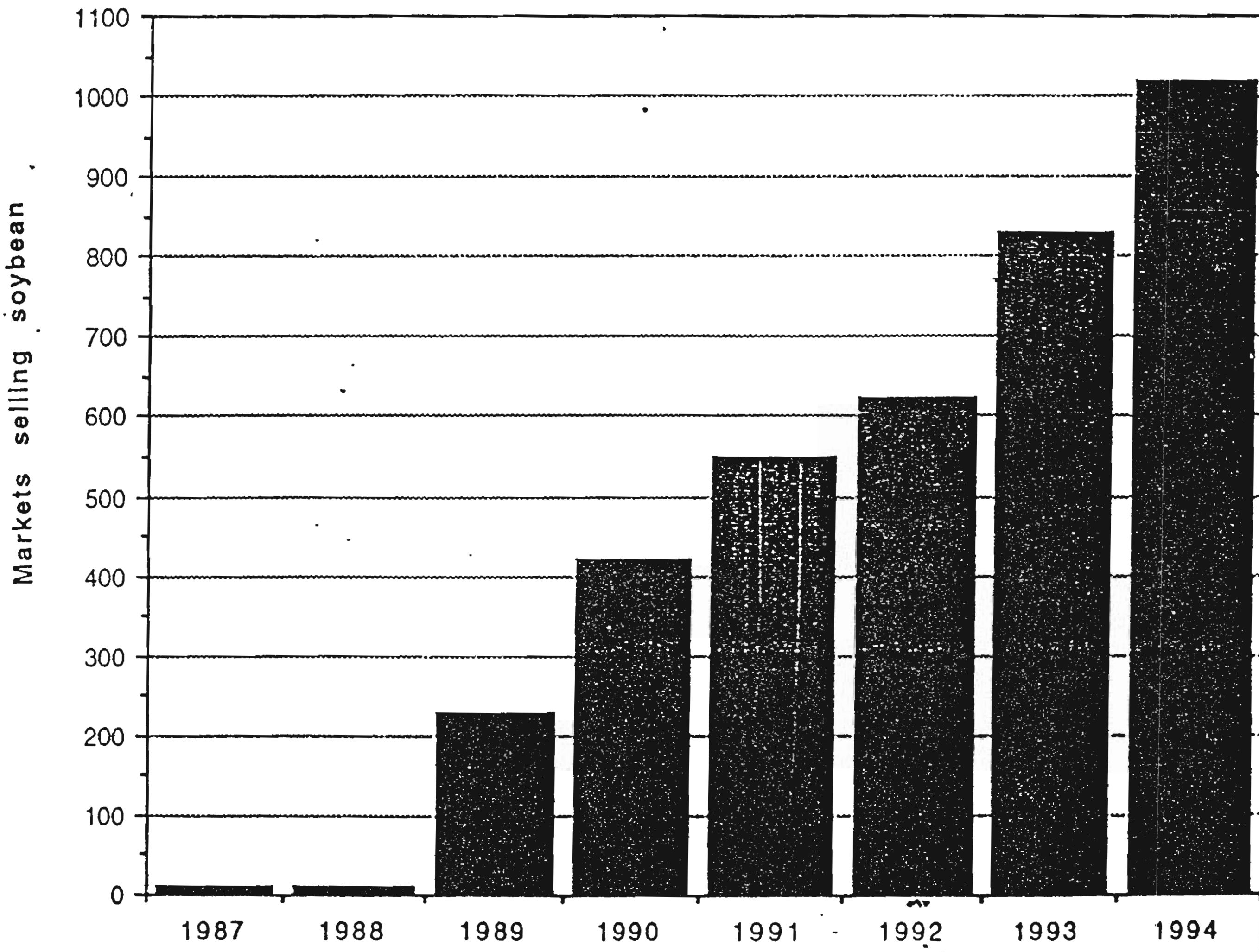


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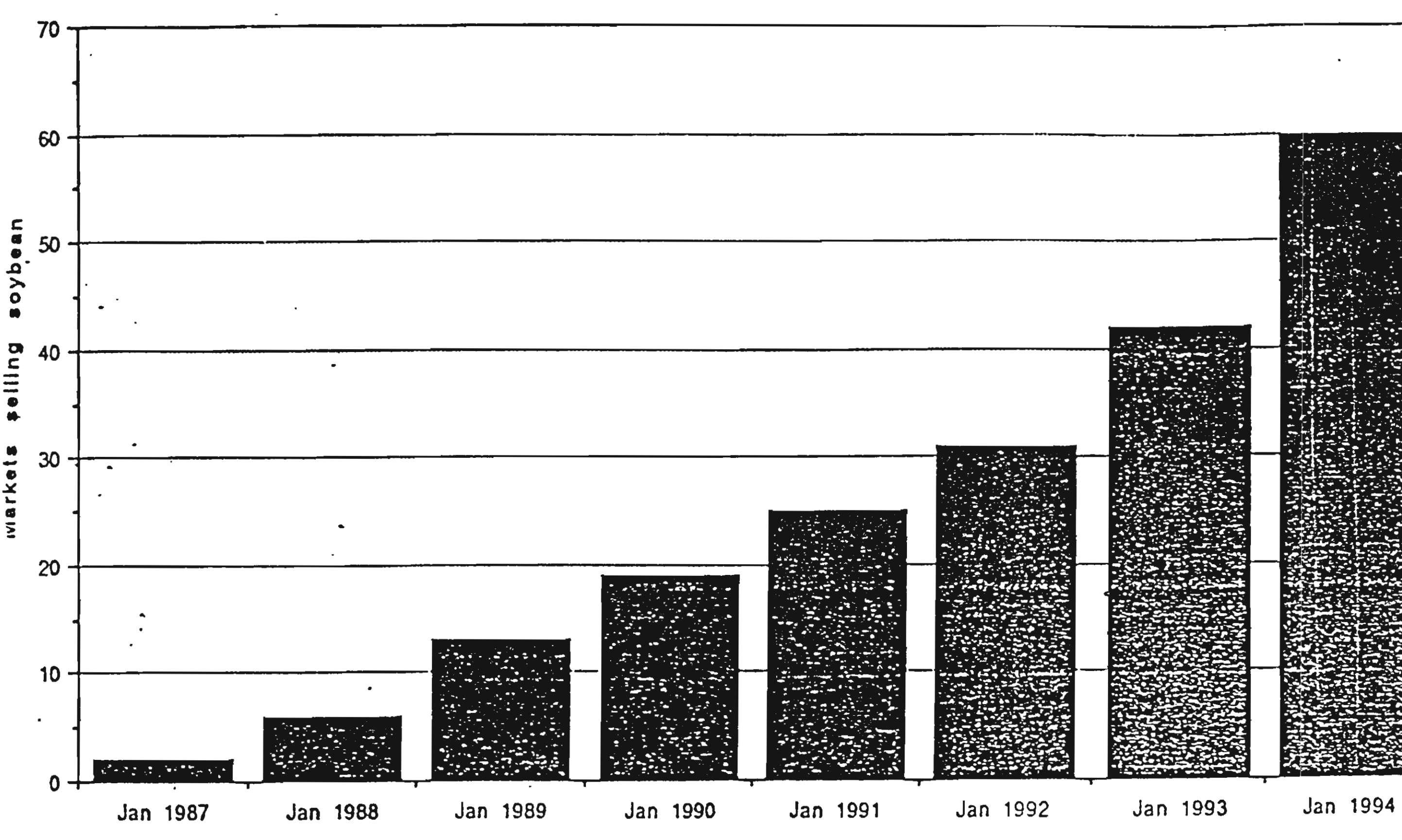
Fig. 7.2 Number of markets selling soybean in Ibadan, Nigeria



Picture 39:

Peeled cassava for soy-gari processing

Picture 40:

Grated cassava and soybean paste mixed together before pressing in soy-gari processing.

Picture 41:

Women sieving and frying soy-gari

Picture 42: A handing testing one of the soybean product.

Picture 43: Dried soybean daddawa as marketed in the Northern part of the country.

Picture 44: Children hawking soy-akara

Picture 45: Some industrial soybean products in Nigerian markets.

Table 7.1 Some soybean products that are being processed and marketed by companies in Nigeria (July 1994)

	Company	Location (State)	Product	% soybean used in the product
1.	Betamarks	Lagos	Soybean flours	100
2.	DLOB	Oyo	Soy Oil/High Protein Cake	100
3.	Farina	Lagos	Soy beverages	100
4.	Kofa Agric. Venture	Kwara	Soy Oil/High Protein Cake	100
5.	Milkman	Oyo	Soy milk	100
6.	Oja Farms	Oyo	Soy Oil/High Protein Cake/Casasoy	30
7.	Taraku Oil Mills	Benue	Soy Oil/High Protein Flake	100
8.	Uncle Segun Food Proc. & Oreserv. Co	Oyo	Soy Powder	100
9.	Jomartex	Oyo	Soy milk	100
10.	Lisabi Foods	Lagos	Soy Custard	30
11.	Smallette	Lagos	Sogi	30
12.	Funta Oil Mills	Kaduna	Soy Oil/High Protein Cake	100
13.	Glaxo Nigeria	Lagos	"Babeena" baby food	30
14.	Nestle Foods	Lagos	"Nutrend" baby food	30
			"Golden Morn" Breakfast food	30
15.	Imo Health Foods	Imo	Soy beverages	100
16.	Cadbury Nigeria	Lagos	"Dash" candies	10
17.	Tuns Oil	Osun	Soy Oil/High Protein Cake	100
			Extruded Products	
18.	Marrison Ltd	Lagos	Extruded Products	100
19.	Akiibiti Farms	Ondo	Extruded Products	100
20.	Deagbo Industries	Oyo	Soyvita (beverages)	100
21.	Tella Food Industries	Oyo	Soymilk	100
22.	Goodings Health Goods	Lagos	Texturized vegetable protein (Nutrela)	100
23.	Niger Dock	Lagos	Soymilk	100
24.	Jof Ideal Family Farm	Ondo	Vegetable oil	100
25.	Temitope Biscuit Indus. Ltd	Ogun	Soybiscuit, Baby food	10, 30
26.	Orman Industries Comp. Ltd	Oyo	Extruded soy full-fat defatted soycake	100
27.	Al-Bahamas	Lagos	Baba Ogi	30
28.	Odichie Bakery	Lagos	Soybread	10
29.	Morgan	Oyo	Soyflour	100
30.	Pfizer Nigeria Ltd	Lagos	Livestock feed	30
31.	Buckingham Ltd	Lagos	Mama Joy baby food	30
32.	Alphatec	Oyo	Soyoil/Livestock	100
33.	Cocoa Industries	Lagos	Chocolate bar	10
34.	Rainbow Manufac. Industries	Ogun	Soyflour/High protein cake	100

Table 7.1 continued

	Company	Location (State) soybean used in the product	Product	%
35.	Florets Ltd	Oyo	Soyflour/Babyfood	100
36.	Vita soy	Oyo	Soymilk	100
37.	Green Source Nigeria Ltd	Lagos	High protein cake	100
38.	Dare foods	Oyo	Soyflour	100
39.	Babs Ventures	Ondo	Soymilk/cassory	100
40.	Golden Compass Foundation	Lagos	Babyfood	100
41.	CAPL	Lagos	High Protein Cake	10
42.	NAINTO Ltd	Lagos	Soymilk	10
43.	Parakletos Co. Ltd	Osun	Soyflour/Baby food	100
44.	Sarah Farms	Oyo	Soyflour	10
45.	Benny Commercial Co. Ltd	Oyo	High Protein Cake	100
46.	IBOL	Osun	High Protein Cake	10
47.	Olayemi Farm	Ondo	Soy Vegetable Oil	10
48.	Women's Group	Jos	Soyflour	10
49.	Golden Oil Indus.	Anambra	Soybean oil/Cake	100

Table 7.2 **Percentage of farmers cultivating soybean in IITA/IDRC Soybean Utilization Project sites**

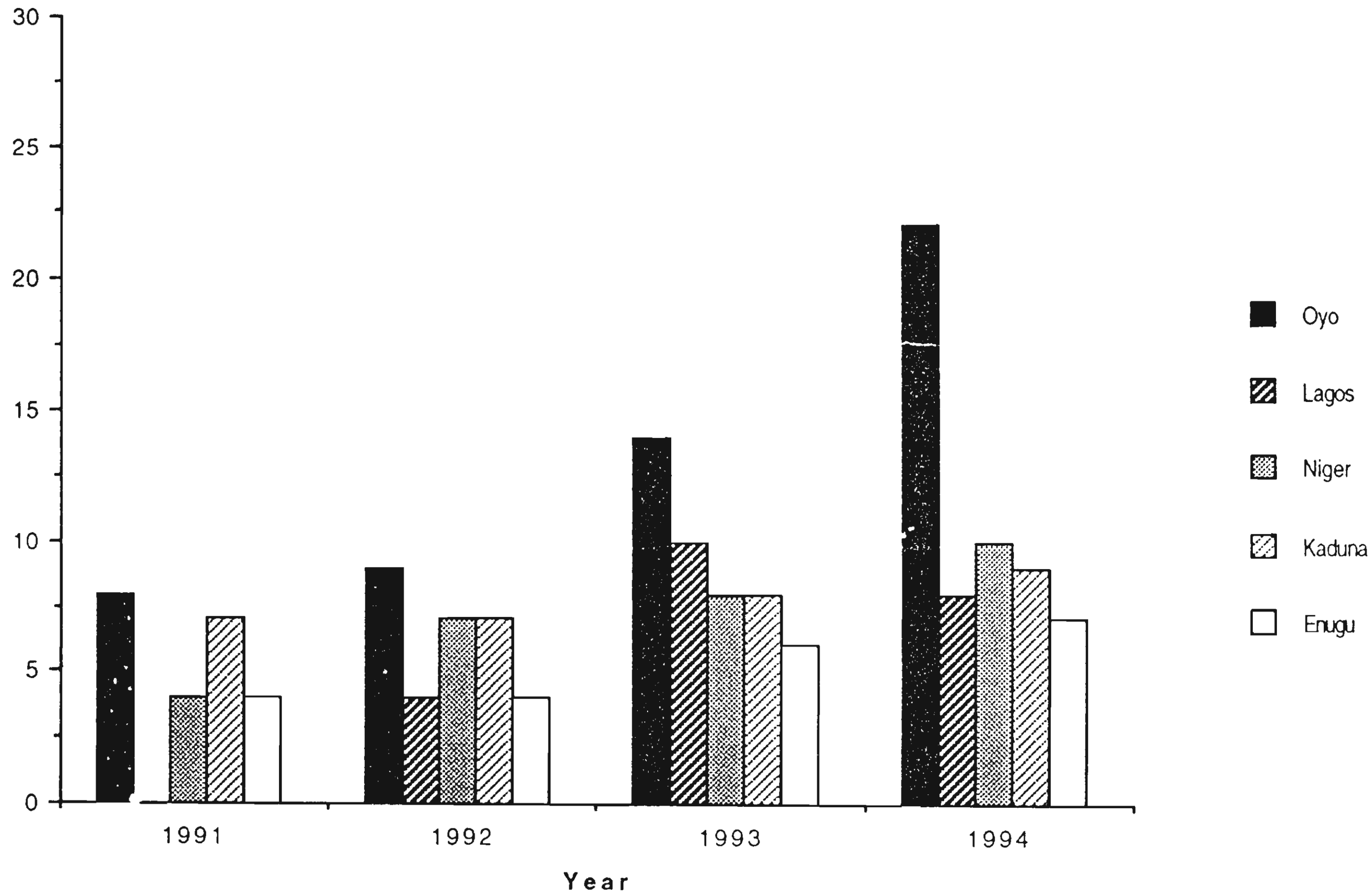
	YEARS					
Location	1987	1989	1991	1992	1993	1994
IAR&T, Oyo State						
Ijaiye	-	-	10	20.4	65.3	70.5
Igangan	-	26	30	35.6	45.6	50.8
Ikoyo, Ogbomoso	20	42	52.5	58.7	66.2	72.8
IAR&T, Lagos State						
Imota	X	X	-	12.5	46.88	50.8
Idimu	X	X	4.5	8.2	20.41	25.6
NCRI, Niger State						
Diko	X	X	67.0	80.0	X	X
Mungorota	X	X	3.8	20.8	X	X
Bida	X	X	28.0	27.8	X	X
NAERLS, Kaduna						
Kurmin Masara	X	X	70.9	80.9	86.4	70.0
Makera village	X	X	50.0	42.6	50.54	82.4
Kaya	X	X	48.0	60.8	72.8	70.0
UNN, Enugu State						
Okutu	X	X	10.7	20.7	23.4	25.6
Ozalla	X	X	-	10.5	15.4	12.8
Enugu	X	X	-	2.1	10.3	40.0

Table 7.3 Percentage of households utilizing soybean in IITA/IDRC Soybean Utilization Project sites from 1987 to 1994

	YEARS					
Location	1987	1989	1991	1992	1993	1994
IAR&T, Oyo State						
Ijaiye	-	10	35.0	45.1	65.3	70.5
Igangan	20	28	35.1	70.2	80.5	85.2
Ikoyo, Ogbomoso	40	66	74.5	80.5	86.2	86.3
IAR&T, Lagos State						
Imota	X	X	15.0	25.1	46.88	68.0
Idimu	X	X	10.5	20.5	20.41	45.6
NCRI, Niger State						
Diko	X	X	70.3	82.4	X	X
Mingorota	X	X	1.3	14.5	X	X
Bida	X	X	11.2	22.3	X	X
NAERLS, Kaduna						
Kurmin Masara	X	X	72.5	82.7	90.0	95.4
Makera village	X	X	26.0	36.8	12.60	30.45
Kaya	X	X	19.1	29.8	25.0	38.62
UNN, Enugu State						
Okutu	X	X	10.7	38.2	44.2	10.3
Ozalla	X	X	1.2	12.8	26.8	43.1
Enugu	X	X	11.1	22.5	52.0	76.0

X - No survey was carried out in the area for that year

Fig. 7.4 **Number of hospitals in selected areas of Nigeria using soybean to treat malnutrition**



CHAPTER EIGHT

The general objective of the project is to develop and encourage the use of soybean processing technologies appropriate for rural and urban households and small-scale processing enterprises in Nigeria. During the period of three years, the project conclusively established the following.

(1) In 1991, at the onset of the Phase II of the project, the baseline survey showed that soybean production was relatively unimportant in the farming systems of the states (Niger, Kaduna, Lagos and Enugu States) where the participating institutions were located except Oyo State. Soybean production was also found to be important in some part of Kaduna State where it is being used for daddawa production on commercial level.

According to the farmers the motivation factors in the cultivations of soybeans are ready market, multipurpose uses, profitability, nutritive value and knowledge of cultivation. About 31% of the farmers cultivated soybeans in Oyo State. 2% in Lagos State, about 33% in Niger State, 56.3% in Kaduna State and about 4% in Enugu State cultivated soybean during the baseline survey.

(2) In 1992, there was a small increase in both the number of soybean farmers and total hectare under soybean cultivation. By 1994, soybean farmers have increase to 64% in Oyo State, 38.2% in Lagos State, 74.1% in Kaduna State and 36.43% in Enugu State. The positive effect of training resulted in higher consumption level of soybean products locally.

(3) Soybean was being gradually integrated into the farming systems of these communities. The consumption level has increased over the three years period, especially in Lagos and Enugu States where little or nothing was known about soybeans utilization at the start of the Phase of this project.

(4) Soybean has been accepted not only at the rural level but also at the urban level. It is now found in all the major markets in Ibadan. The marketing data show that the number of retailers have increased in Lagos, Kaduna and Enugu during the 3 year project. The price of soybeans also showed an increased from ₦4.50 in 1991 to ₦19.00 per kilogram in January 1994. Soybeans is now being sold in form of grains and flour in most of the local markets.

(5) There has been an increase in commercial products of soybeans found in the Nigerian market. The products now range from soy flour, soy ogi, Nutrend as baby foods, soy milk, soy biscuits and soy bread. These products are now available as a result of popularizing soybeans; for human food. Table 7.1 shows that about 50 industries now use soybean as one of their raw materials.

(6) A baseline investigation into the nutrient composition of some selected Nigerian traditional dishes and foods, show that they are quite low in protein, hence the need for fortification. When soybean was incorporated into these foods, the protein contents and mineral contents of the foods increased tremendously with no significant difference in the level of acceptance of these soybean fortified foods.

(7) When soybeans was incorporated into traditional dishes, using household level processing techniques, the levels of antinutritional factors where effectively eliminated by processing. The TIA, phytic acid, tanin reduced to acceptable levels.

(8) About 140 food products were developed with satisfactory nutritive value and acceptability. Some of these products have been scaled up to industrial level. Examples of products developed for industrial processing include weaning and convalescence foods, soybean beverage and novel foods like soybean ice-cream, soybean cheese and soybean chocolate bars.

(9) Extrusion technology is new in Nigeria and its capabilities have been positively demonstrated during the project. The products of the extruder i.e full fat soy flour,

defatted soy flour, extruded defatted soy flour, soy/cereal blends have been shown to be nutritionally superior to other soybean foods because of it high quality protein. The products were formulated to local recipes and has proved highly acceptable when compared to other conventional foods. The extruder have also being used to develop a cereal/cocoa/soybean product referred to as soybean crunch. it is eaten as a snack.

(10) Soybean milk, is one of the major products of soybean developed, tested and transferred to project sites. Soy milk can now be processed from full fat soybean flour, as opposed to processing it only from the grains processing soy milk from soy flour was developed to reduce processing time.

Soybean milk is accepted as plain milk or as flavoured chocolate or vanilla flavoured milk. local flavours, like mango, banana, and pawpaw also hold good promises show a lot for acceptability. Soy milk is now being processed in some of the project sites.

In general, soy milk has shown high acceptability among all classes of people and has done well. When compared to leading milk brands in the Nigerian markets.

(11) As far as assessment and transfer of soybean processing technologies are concerned; adoption of soy foods at rural level is high, adoption of extruded products, shows potentials of extrusion cooking to be a rural level technology. Soybeans has been introduced into school lunch program to improve nutrition of children in public schools. Soybeans oil has proved to be highly acceptable for cooking oil among all the class income groups in the Nigerian society.

(12) Training activities were used to educate people on soybean processing and utilization. Programs were conducted in Yoruba (local language) or English depending on the level of audience. 14,098 people have been trained during the 3 year project, out of which 10,633 are women and 3,465 are men. Majority of these trainees are expected to trained others. To facilitate training various recipes were developed. These include national institutions recipe book in English and IAR&T recipe book Yoruba. Soybean for Good Health in all the national languages Yoruba, Hausa, Ibo and English, Soybeans in Nigerian Foods which contains over 50 recipes compiled as a result of fortifying our local foods with soybeans.

A national training program for the Agricultural Development Project (ADP) officials across the country was used to disseminate information on developed soybean technologies during the project.

(13) Rapid Rural Appraisal (RRA) is a relatively new and quite difference approach for conducting research. This methodology is usually applied to rural setting. It was however found to be very useful in gathering information at both industrial level, and rural level; especially on the uses of soybean.

(14) The project also conclusively show that soybean is the cheapest source of protein when compared with other protein sources (Fig. 8.1).

The same positive attitude is observed in Ghana and Côte d'Ivoire where a similar project is expected to take off during the 3rd Phase of the project. The Ministry of Agriculture has also formed a National Committee on soybean production and utilization.

In conclusion the collaboration link established with Nigerian National institutions should be used as a model in future works with national institutions of other countries. When this is accomplished we are very confident that the impact will be very good just as it has been in Nigeria.

Fig 8.1 Comparative cost of selected sources of protein in Nigeria.