



## **Adoption of Soybean in Sub-Saharan Africa: A Comparative Analysis of Production and Utilization in Zaire and Nigeria**

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### *ABSTRACT*

*The issue of soybean adoption in sub-Saharan Africa is addressed. A survey was conducted of soybean [Glycine max (L.) Merr.] production and utilization in Gandajika, Zaire. Of 115 farmers sampled from nine villages, all cultivated soybean. Average production per farmer in the previous season was 73 kg. Almost all production was consumed by humans, primarily as full-fat flour mixed with maize (Zea mays L.) or maize and cassava [Manihot esculenta (L.) Crantz], or as roasted grain. Farmers ranked soybean second among grain legumes in area cultivated and fourth for total sales. Most farmers considered marketing the principal constraint to increased production. Survey results from Nigeria revealed similar adoption trends. Common elements were locally adapted foods in which soybean did not displace traditional legumes, promotion of soybean, diffusion, technological breakthroughs and response to local markets. The implications of these findings are discussed with respect to commonly held views on soybean in Africa.*

### INTRODUCTION

The potential for soybean cultivation in peasant agriculture in sub-Saharan Africa is a subject that has long been controversial. A commonly held

view is that sub-Saharan Africans will not eat soybean (Vanneste, 1986). Various reasons have been given, including slow cooking time and high energy requirement, unacceptable taste, or the belief by some that the crop is poisonous or causes sterility (Weingartner, 1987). Consequently, soybean cultivation is seen as appropriate only for commercial farming where the crop can be used for livestock feed or industrial processing. A corollary of the view that soybean is of little importance in the region is the opinion that research on soybean production and variety development will not benefit low-resource African farmers. Low-resource farmers account for 95% of food production in sub-Saharan countries (Mellor *et al.*, 1987) and thus should be the focus of research efforts.

Soybean production and consumption have already been documented in Africa. Commercial food products made with locally grown soybean have reportedly been marketed in Nigeria, Zaire, Zimbabwe and Benin (Weingartner, 1987; Weingartner *et al.*, 1987) as well as in Tanzania, Rwanda, Burundi and Uganda (W. Shurtleff, unpublished manuscript†). Household use of soybean has been documented in Nigeria, Zaire, Zimbabwe, Zambia, Ghana, Burkina Faso and Benin (Weingartner, 1987; Weingartner *et al.*, 1987). However, the extent to which soybean is grown and consumed in these countries is not well documented, and the view still persists that soybean is not a suitable crop for low-resource farmers in sub-Saharan Africa.

In this paper, a comparison of first-hand survey evidence from Zaire and secondary data from Nigeria is used to support the hypothesis that soybean has considerable potential for adoption in sub-Saharan Africa. Evidence is provided that demonstrates that soybean is grown and consumed by low-resource farmers in three distinctly different cultural environments and that adoption of the crop is spreading. Though the conditions of development of soybean production differed and the foods made from soybean also differed, the results were remarkably similar in the different case studies. Conclusions are drawn from the different case studies concerning the conditions favoring adoption.

## SOYBEAN ADOPTION IN GANDAJIKA, ZAIRE

### Background

Gandajika is a Zone (equivalent to a county in North America) in the Eastern Kasai Region of Zaire. The Kasai consists of two political regions

† History of soybeans and soyfoods in Africa. Unpublished manuscript. Soyfoods Center, P.O. Box 234, Lafayette, CA 94549, 14 pp.

spanning south central Zaire. They are united by a common language, Tshiluba, and have similar climates and agricultural systems. Maize and cassava are the principal crops grown. Cowpea [*Vigna unguiculata* (L.) Walp.] and peanut (*Arachis hypogaea* L.) are the primary legume crops.

Reports indicate that soybean was successfully tested in the Kasai in 1915 (Mestdagh, 1915, cited in Shurtleff and Aoyagi, 1990) and first grown at the agricultural experiment station at Gandajika in 1937 (Schoier, 1986). Active promotion of soybean cultivation began 300 km away from Gandajika, in Western Kasai, in 1960. Soybean for home consumption was introduced in pilot villages in 1962. Between 1964 and 1970, subsidized seed distribution and the guaranteed purchase of production led to the gradual adoption of soybean by farmers. Purchases of soybean grain by the agricultural school in Tshibashi increased from 0.25 tons in 1961 to 260 tons in 1971 (d'Heer, 1986; Vanneste, 1986). Most of this production was ground into flour and marketed through local channels.

The government enforced the cultivation of soybean in one sub-region in 1969, and distributed soybean seed in five zones of a second sub-region. Health workers of the Ministry of Agriculture used household visits to promote soy foods as a low-cost source of protein for children (Kabadi, 1986). Hospitals and dispensaries promoted soy foods to fight protein malnutrition and reduce death among young children (Miller, 1986). These institutions required mothers of malnourished children to purchase soy flour as a precondition of treatment (G. Vanneste, personal communication). Because of these efforts over the years, the local population had come to regard soybean as a medicinal crop.

Research on methods of soybean preparation was conducted in Western Kasai by d'Heer (1986) to find a suitable weaning food for infants and to counter protein deficiency. Cooking soybean as one would common bean (*Phaseolus vulgaris* L.) or cowpea was found to be time-consuming and required much fuel. Recipes used in Asia were unsuitable because soy milk deteriorated rapidly and preparation methods were unfamiliar to the local population. Foods made with toasted full-fat soy flour were found to be the most acceptable. It was a simple process to add soy flour to staple foods made with cassava and maize flour. A ratio of one measure of soy flour to three measures of maize flour was used. No additional food processing equipment was needed; costs were low and soy flour did not significantly modify the taste of the staple foods.

The promotion of soybean recipes based on soy flour began in 1966 through the efforts of health and agricultural extension services (d'Heer,

1986). Soybean variety testing took place at Gandajika, and some seed was multiplied for sale to farmers (D. A. Shannon, unpublished document‡).

In 1985, a national grain legume research program, Programme National Légumineuses (PNL), was established with headquarters at Gandajika. As research priorities were being elaborated, questions were raised about the merits of conducting research on soybean relative to other grain legume crops. The questions echoed the view of some that soybean was not an important crop in the region and had little potential. Accordingly, a survey was designed and implemented to evaluate the importance of soybean and other legume crops at Gandajika.

## Methods

Farmers in nine *groupements* or village groups within the Gandajika Zone were interviewed in April 1987 to obtain information on the production and utilization of soybean and farmer attitudes toward soybean. The survey was carried out by technicians trained in agronomy and rural sociology at the secondary and university level. A questionnaire was drawn up in French for recording responses. The actual interviews were open-ended and conducted in the Tshiluba language. During these conversations, additional, related issues arose, and the information was recorded. Because reliable census data were not available, formal sampling procedures commonly used for social surveys in industrialized settings were impractical. Interviewers circulated in the fields and interviewed farmers as they found them. An area of several square kilometers was covered, representing a population greater than 100 000. The 115 farmers interviewed belonged to three tribal groups, the Kaniok, Luba and Nsonge, and reflect variations in the cropping practices observed in the area. Originally, we sought a simple quota sample with equal proportions of farmers who grew soybean and those who did not grow the crop. All of the 115 farmers interviewed, however, were found to be soybean growers. Production and amounts sold or consumed were reported by farmers in *meca*, the local market measure of volume, estimated to weigh 3 kg for soybean.

## Results

Three farmers in our sample first began cultivating soybean during the 1950s (Fig. 1). Most (72%) began growing soybean between 1984 and the

‡ Grain legume research in Zaire: A review of past research from 1979 to 1985 and suggestions for the future. Report submitted to United States Agency for International Development, Kinshasa, Zaire, 1986, 37 pp.

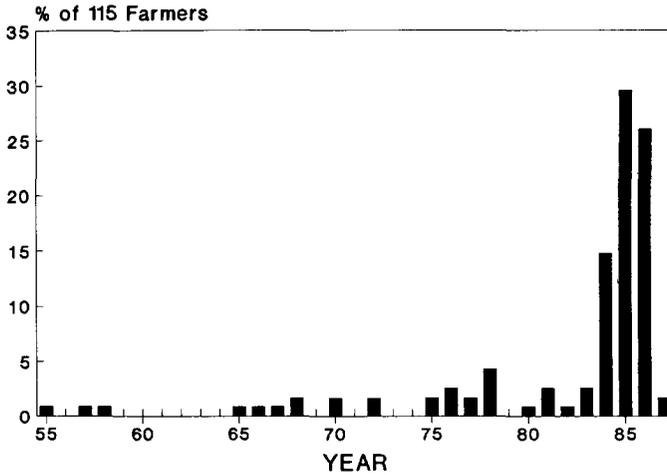


Fig. 1. Year farmers began growing soybean.

date of the survey, April 1987. The increase in new soybean farmers in the previous 3 years appears to be related to increased seed multiplication at the experiment station. The increase in new soybean planters in the late 1970s might be attributed to the release of an adapted variety, SJ 127.

According to the farmers sampled, the principal agents by which soybean was introduced into the villages were church groups (some of which ran nutrition centers and clinics), other villagers, the experiment station, and agricultural development projects (Fig. 2). The extension efforts carried out in Western Kasai to promote soybean production and utilization undoubtedly played a major role in encouraging the adoption of soybean in Gandajika. As in Western Kasai, the hospital and clinics at Gandajika frequently recommended soybean for malnourished children.

% of 115 Farmers

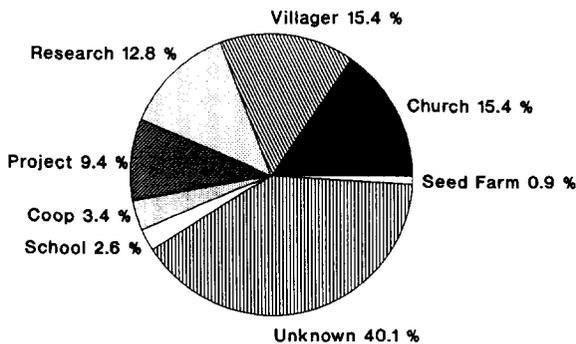
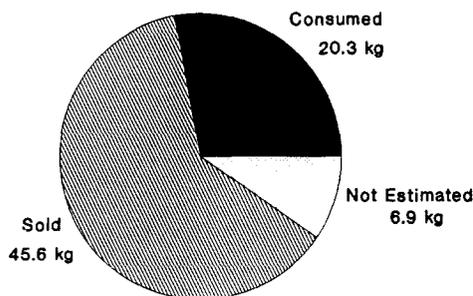


Fig. 2. Person or group who introduced soybean to the village.



Average Production in Season A = 72.7 kg/Farmer

Fig. 3. Use of soybean harvested in previous season (average of 85 farmers).

The average production per farmer in the previous season was 73 kg (Fig. 3), of which 63% was reportedly sold and 28% was consumed by the household. Forty-three percent of farmers consumed all their production, another third consumed part and sold the rest, while the remainder sold all that they produced (Fig. 4). Among those who sold all or part of their soybean production, nearly half sold their produce in the local market, 40% sold to nutrition centers and smaller numbers sold to neighbors, a hospital, development projects, etc. (Fig. 5). It is significant that only 10% of farmers sold directly to the only farmer in the area known to feed soybean to livestock. Though exact figures were not available, it is evident that the vast majority of soybean grown in the Gandajika area was used as human food and not for livestock.

Soybean was eaten as roasted whole grain, or the flour was used as an additive to a maize porridge, to *nshima*, also called *bidia* (the staple paste made from maize and cassava flour), as a substitute for milk in tea or coffee, or mixed with the vegetable eaten with *nshima*. The most frequently

% of 115 Farmers

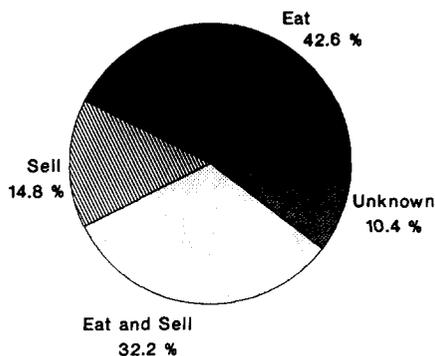


Fig. 4. Use of soybean by farmer.

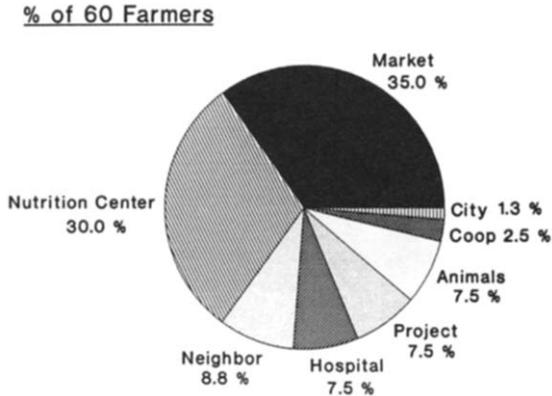


Fig. 5. Where soybean was sold.

mentioned foods were roasted, porridge and *nshima* (Fig. 6); the preferred food of more than half the respondents was porridge (Fig. 7).

Almost equal numbers of farmers planted cowpea and soybean (Fig. 8), with smaller numbers planting peanut, mung bean [*Vigna radiata* (L.) Wilczek var. *radiata*] and bambara groundnut [*Vigna subterranea* (L.) Verdc.]. Farmers ranked soybean second to cowpea by land area, ahead of peanut and mung bean (Fig. 9). For sales in the market, cowpea and peanut were classified as important by almost all farmers (Fig. 10). However, soybean ranked fourth in position after mung bean, with peanut being ranked most important (Fig. 11). 'Slow sales in the market' was the constraint to production most frequently cited by farmers.

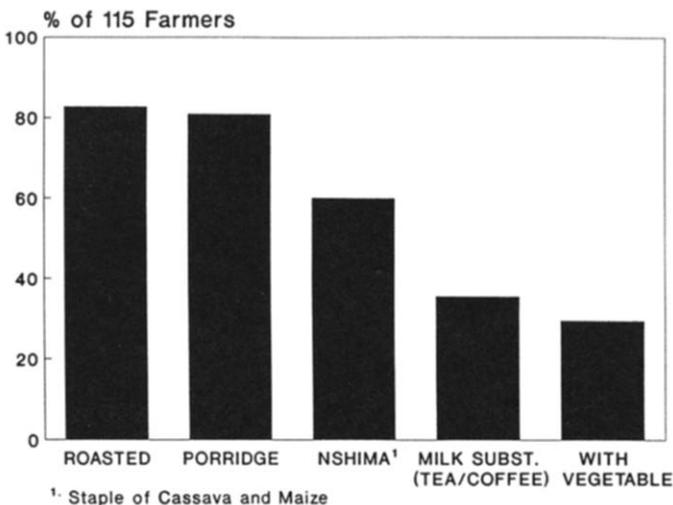
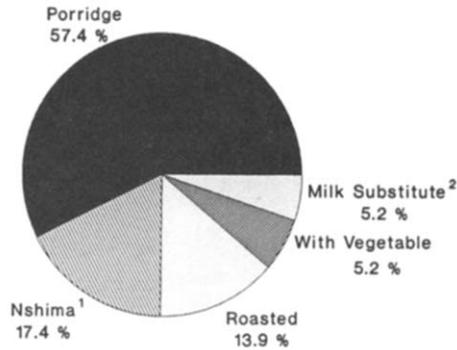


Fig. 6. Ways to eat soybean.

% of 115 Farmers

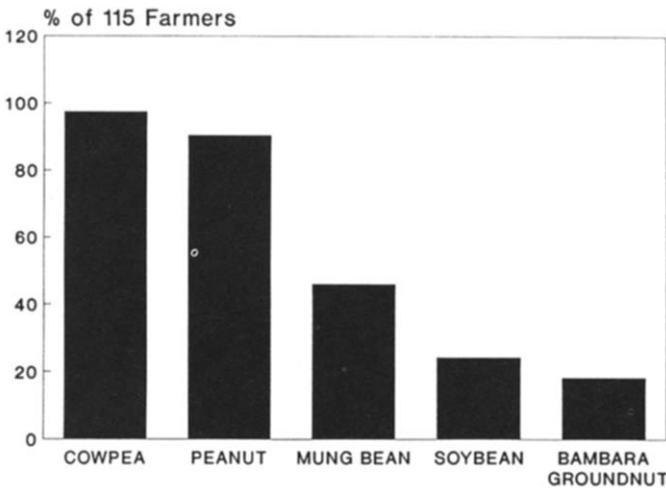


- 1. Staple of Cassava and Maize
- 2. for Tea and Coffee

**Fig. 7.** Preferred way to eat soybean.

**Discussion**

The results presented here clearly indicate that soybean production had increased and was integrated into the diet. Though marketing remained a constraint, the recent increases in the number of producers in the absence of a commercial outlet for soybean show that home consumption of soybean, and thus demand for the crop, was increasing. Soybean remained a secondary crop, but its importance had increased.



**Fig. 8.** Grain legume crops grown.

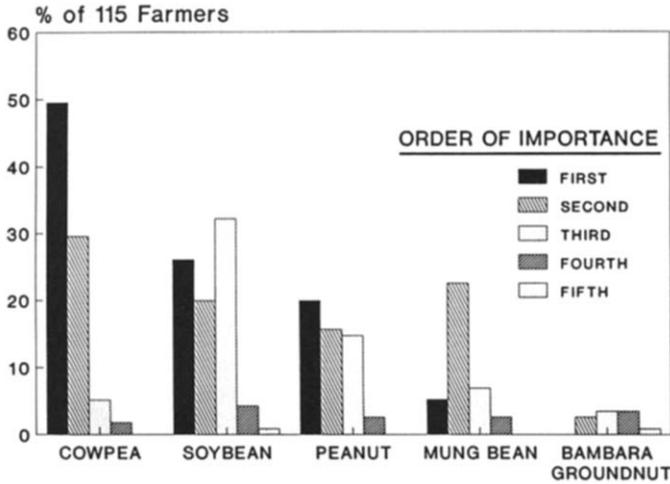


Fig. 9. Importance of legumes by area, ranked by farmers.

### SOYBEAN ADOPTION IN NIGERIA

Surveys conducted in two geographically and culturally distinct areas of Nigeria provide a basis for comparison with soybean adoption trends in Zaire. Benue State is located in the eastern part of the 'Middle Belt' of Nigeria, in Southern Guinea Savanna (Keay, 1959). Ayepe and Igangan are villages in the transition between rainforest and derived savanna in south-western Nigeria. The studies in Benue were conducted among the Tiv and neighboring tribes, while Ayepe and Igangan are Yoruba villages.

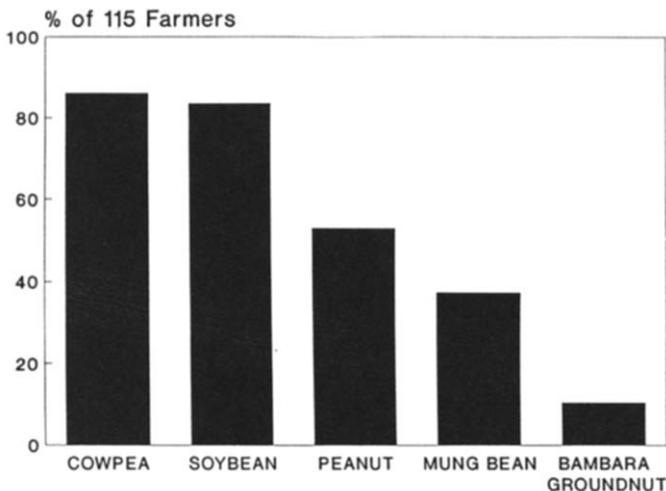


Fig. 10. Important grain legumes in the market.

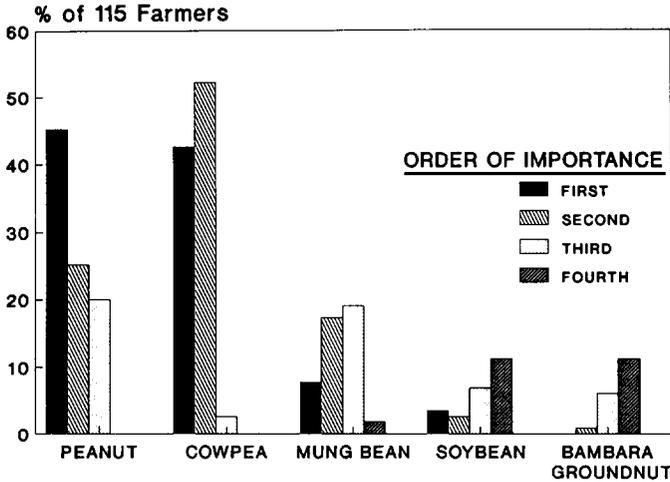


Fig. 11. Grain legumes which sell best in the market as ranked by farmers.

## Benue State

The Tiv tribe began growing soybean approximately half a century ago (Root *et al.*, 1987). The crop was exported until the Nigerian Civil War in 1967 cut the area off from foreign markets. Production continued at a reduced rate despite the commonly-held local belief that soybean was poisonous. Benue production was sold to women in southern Kaduna State, who processed the crop into *daddawa*, a fermented condiment traditionally made from locust bean. *Daddawa* from soybean was marketed across Nigeria and even exported to Niger and Chad (Knipscheer *et al.*, 1985). Around 1986, soybean production expanded into non-Tiv areas of Benue State (Smith *et al.*, 1993).

Soybean production increased between 1984 and 1989 in most Tiv villages and half the non-Tiv villages surveyed by Woodworth *et al.* (1992). Over half of 70 Tiv farmers interviewed began growing soybean between 1986 and 1988 (J.B. Woodworth, personal communication). Average production per Tiv farmer increased from 20 kg in 1975 to 434 kg in 1989 (Smith *et al.*, 1993).

Smith *et al.* (1993) attributed the increase in soybean growers primarily to increased demand created by devaluation of the Nigerian currency. Other factors included a temporary ban on imports of soybean meal and edible oils, the opening of an oil mill in the state and the introduction of new commercial foods. However, promotion of home consumption of soybean by hospitals, religious missions and the government also played a part (J.B. Woodworth, unpublished document§).

Among Tiv villages surveyed, 96% grew soybean (Smith *et al.*, 1993).

It was an important cash crop in half of these. Although soybean was grown primarily for sale, some villages grew soybean only for home consumption. Among individual farmers interviewed, 83% grew soybean for profit, but 78% also considered consumption to be important (J. B. Woodworth, unpublished document§). Soybean was used to make *daddawa* and as a partial substitute for cowpea in *akara* and *moin moin* (fried and steamed cowpea paste, respectively).

Soybean was grown by half of the non-Tiv villages surveyed, but was not a major cash crop (Smith *et al.*, 1993). Home consumption was the primary reason for growing soybean in 30% of villages. An additional 40% of villages consumed some of their production. Soybean was used in cowpea dishes, and sometimes used for *daddawa*.

### Ayepe, Oyo State

In Ayepe, diffusion of soybean was observed within 2 years of its introduction in on-farm trials (J. Smith, unpublished document¶). Plots were small, averaging 0.03 ha, with the soybean being grown primarily as household food. The high rate of soybean adoption was attributed by Pfeiffer (unpublished document||) to instruction provided in semi-annual workshops on production, cooking methods and the nutritional benefits of soybean.

The primary uses of soybean in Ayepe were as substitutes for melon seed in sauces and for locust bean in *daddawa* (J. M. Pfeiffer, unpublished document||). It was also prepared as soy milk and porridge, and as a supplement to maize, cowpea, rice, cassava and yam. Pfeiffer concluded that soybean was easily incorporated into dietary habits. Advantages over melon and cowpea included price, ease of preparation and freedom from storage insects. Knipscheer *et al.* (1985) reported that soybean was a cheaper and acceptable substitute for melon seed in *egusi* sauce. Ay *et al.* (unpublished manuscript††) reported that soybean was cheaper and required less work in *daddawa* preparation than did locust bean.

§ Paper presented at National Meeting of Nigerian Soybean Scientists Association, March 1990.

¶ Improvement of maize-based cropping systems. Annual Report for 1989. Resource and Crop Management Program. International Institute of Tropical Agriculture, Ibadan, Nigeria.

|| Factors affecting adoption of soybeans into cropping systems and diets by small farmers, rural households and petty traders. Presented at a Symposium on Sustainable Agriculture in Africa: Socio-Cultural, Political, and Economic Considerations held at the Ohio State University Center for African Studies, 25–26 May 1990. Proceedings forthcoming.

†† Ay, P., Weber, M. & Yusuf, I. (1984). Soybean and locustbean as substitutes in Ilorin Agricultural Development Project area. Draft manuscript. Resource and Crop Management Program. International Institute of Tropical Agriculture, Ibadan, Nigeria, 11 pp.

### Igangan, Oyo State

In Igangan, soybean was introduced together with training in production (Pfeiffer, unpublished document||). A commercial buyer provided seed in return for a contract to later purchase soybean at a fixed price. After 2 years, the crop was mainly grown for cash. Pfeiffer attributed the lack of household use to the absence of training in soy food preparation and the male orientation of the introduction program. Notwithstanding, home use had already begun on a small scale and may be expected to increase.

## COMPARISON OF SOYBEAN ADOPTION IN ZAIRE AND NIGERIA

Certain elements are common in the four case studies.

(1) Adoption was tied to locally-accepted ways to process and consume the crop. Most farmers in Ayepe (Pfeiffer, unpublished document||) and over 40% in Gandajika (Fig. 4) grew soybean only for home consumption, while the soybean that was sold also was used almost entirely for home consumption. In both cases, the introduction of soybean recipes compatible with local food preparations played a major role in adoption of soybean cultivation. Local foods with soybean also played a role in the spread of soybean in the non-Tiv areas of Benue (Smith *et al.*, 1993). In Tiv areas, where soybean was originally grown uniquely as a cash crop, village-level processing of soybean into *daddawa*, though not done by the farmers themselves, enabled farmers to continue cultivating soybean after the disappearance of the export market. The high proportion of those farmers who presently consume soybean (farmers in 96% of Tiv villages) suggests that longstanding misconceptions are being overcome. In Igangan, some contract growers had begun reserving part of their production for food and seed (Pfeiffer, unpublished document||).

In both Nigeria and Zaire, considerable effort went into the selection of soy foods similar to or compatible with traditional foods and preparation methods. Compatible preparation methods are a necessary condition for adoption of soy foods, according to Weingartner *et al.* (1987).

(2) In the initial phase of soybean introduction, some expense and effort were employed to entice farmers to adopt soybean. Free or subsidized seed was supplied to farmers in Western Kasai (Vanneste, 1986),

Ayepe and Igangan (Pfeiffer, unpublished document||). Arrangements to purchase production were made in Western Kasai, Igangan and most certainly in colonial Benue State. At Ayepe, in Western Kasai, and more recently in Benue State, training in food production was provided. In Zaire, demand was enhanced by making soy food part of medical treatment. Undoubtedly these factors played an important role in the adoption of soybean.

(3) Soybean cultivation was later also adopted by people who did not receive material assistance from external sources. The fact that most soybean growers in Gandajika had not benefited directly from the promotional efforts in Western Kasai is evidence of diffusion of soybean technology. Diffusion of soybean cultivation and consumption happened very quickly in Ayepe (Smith, unpublished document¶), where homemakers were provided with several methods of preparing soybean. Improved market prospects for soybean also played a major role in Igangan and villages in Benue State that have recently begun growing soybean. Government price and import policies in Nigeria increased the demand for locally grown soybean and fueled the spread of soybean as a cash crop (Smith *et al.*, 1993).

(4) Technological breakthroughs created new markets or facilitated home consumption. In Benue State, the undocumented discovery that soybean can be substituted for locust bean created a new domestic market for soybean, eliminating the total dependence on export markets. The discovery that soy flour can be made in the village mills used to grind cassava and maize enabled Gandajika farmers, who are located far from the soybean processing plants in Western Kasai, to directly consume their own soybean production. Many of the soy foods adopted in Nigeria and Zaire were the result of food technology research. The creation of new commercial soy foods increased market demand for soybean and the introduction of improved soybean varieties stimulated production (Smith *et al.*, 1993).

A parallel may be drawn with the adoption of cassava in Africa. Like soybean, cassava also requires processing. Cassava was introduced into Africa in the 16th century, but the introduction of processing of cassava into the meal, *gari*, by settlers from Brazil in the 17th and 18th centuries facilitated the spread of cassava in West Africa (Jones, 1959).

(5) Local markets played a role in soybean adoption. The number and size of soybean fields and total production per farmer increased with market demand in Tiv areas of Benue State (Smith *et al.*, 1993). At Gandajika, farmers expressed concern over the perceived inadequate demand, implying that production would increase with expanded demand. The difference in field size between Igangan and Ayepe farmers reflected the

difference between commercial and home markets. Traders at Ayepe responded to consumer demand by importing soybean to supplement local production (Pfeiffer, unpublished document||).

(6) As a food, soybean competed only minimally with other grain legumes. Many of those who doubt the suitability of soybean in sub-Saharan Africa assume that it will compete with grain legume crops that already play an important role in the culture and diet. Of the soy foods consumed in Zaire, only roasted soybean grain is, however, in any way similar to a traditional legume food, roasted peanut. In Nigeria, soybean competes with seed of the locust tree and with melon seed. In both cases, however, use of soybean saves time and money. In most other preparations, soybean enhances the nutritional quality of foods made with high-energy staple crops. The exception pertains to foods made from cowpea, where the partial substitution of soybean enhances its nutritional value while reducing cost (Smith *et al.*, 1993).

## CONCLUSIONS

The results of our survey in Gandajika and the review of research completed elsewhere provide evidence that refutes the common misconception that soybean is not appropriate for sub-Saharan Africa. Although the area we surveyed was not extensive, soybean is grown and consumed in each region of Zaire. Similar methods of cultivation and food preparation are found throughout the country. The soybean adoption trends found in Gandajika are consistent with those reported at three locations in Nigeria, despite differences in introduction methods and histories, foods and cropping systems, and the six or more ethnic cultures represented. When presented with an opportunity to improve family nutrition or family income, farmers readily adopted soybean.

Farmers who not only grow soybean but also process and use the crop are independent of elements external to the local economy that might eliminate the demand for a strictly cash crop. The research reported here provides evidence from farmers in Zaire that the independent production, processing and consumption of soybean is an important feature of its continued cultivation. The same conditions prevailed in Ayepe and some villages in Benue State (Pfeiffer, unpublished document||; Smith *et al.*, 1993). The village-level processing of soy food, though not by the farmers themselves, was critical to the survival of soybean as a crop in Benue State during the 1970s and early 1980s. Household use of soybean has already been documented in seven countries in Sub-Saharan Africa (Weingartner, 1987; Weingartner *et al.*, 1987). The integration of soy-

bean production and consumption into local economies may be feasible throughout much of the region.

The introduction of soybean cultivation should be accompanied by the provision of information concerning food preparations and incentives for farmers to grow the crop. Technical developments, particularly in food processing, may be necessary to render the crop attractive to local consumers. The presence of markets for the sale of excess production were not found to be necessary for adoption in these studies, but such arenas accelerated the spread of the crop and are probably necessary for soybean to become a major crop.

As shown in this paper, efforts to introduce the home consumption of soybean were successful. It is reasonable to conclude that the introduction of soybean into new areas of sub-Saharan Africa can succeed provided that information on soy food preparations that are compatible with local foods and preparation methods are provided at the same time. Appropriate introduction methods could lead to the increased production and use of soybean, and the alleviation of protein malnutrition. Research on soybean in sub-Saharan Africa can be justified based on the potential for continued adoption and the crop's nutritional merits.

#### ACKNOWLEDGEMENTS

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#### REFERENCES

- d'Heer, A. (1986). Utilization du soja. In *Séminaire National sur le Soja*. Proceedings of a conference held at Kananga, Zaire, 3–10 May 1972. Comité de Coordination pour le Développement en République du Zaïre and Comité Diocésain de Développement Intégral de Kananga, pp. 65–93.
- Jones, W. O. (1959). *Manioc in Africa*. Stanford University Press, Stanford. 315 pp.
- Kabadi, N. L. (1986). L'intégration du projet soya dans le programme agricole

- provincial. In *Séminaire National sur le Soja*. Proceedings of a conference held at Kananga, Zaire, 3–10 May 1972. Comité de Coordination pour le Développement en République du Zaïre and Comité Diocésain de Développement Intégral de Kananga, pp. 43–46.
- Keay, R. W. J. (1959). *An outline of Nigerian vegetation*. 2nd edn. Federal Government Printer, Lagos, Nigeria.
- Knipscheer, H. C., Menz, K. M. & Ay, P. (1985). The production and market potential of soybeans in Nigeria. *Quarterly J. International Agric.*, **24**, 171–84.
- Mellor, J. W., Delgado, C. L. & Blackie, M. J. (1987). Priorities for accelerating food production in Sub-Saharan Africa. In *Accelerating Food production in sub-Saharan Africa*, eds J. W. Mellor, C. L. Delgado & M. J. Blackie. John Hopkins University Press, Baltimore, pp. 353–75.
- Mestdagh (1915). Note sur la culture de *Soja hispida* à Lusambo, Sankuru. *Bulletin Agricole du Congo Belge*, **6**(3–4), 272–81.
- Miller, J. (1986). L'intégration de l'éducation sanitaire dans les activités des églises. In *Séminaire National sur le Soja*. Proceedings of a conference held at Kananga, Zaire, 3–10 May 1972. Comité de Coordination pour le Développement en République du Zaïre and Comité Diocésain de Développement Intégral de Kananga, pp. 124–9.
- Root, W. R., Oyekan, P. O. & Dashiell, K. E. (1987). West and Central Africa: Nigeria sets example for expansion of soybeans. In *Soybeans for the tropics: research, production and utilization*, eds S. R. Singh, K. O. Rachie & K. E. Dashiell. John Wiley & Sons, New York, pp. 81–85.
- Scohier, P. (1986). Le soya, buts poursuivis par les introducteurs et les résultats obtenus à la Station INERA de Gandajika. In *Séminaire National sur le Soja*. Proceedings of a conference held at Kananga, Zaire, 3–10 May 1972. Comité de Coordination pour le Développement en République du Zaïre and Comité Diocésain de Développement Intégral de Kananga, pp. 35–42.
- Shurtleff, W. & Aoyagi, A. (1990). *Bibliography of soybean varietal development, breeding and biotechnology*. Soyfoods Center, P.O. Box 234, Lafayette, California 94549–0234, USA, 267 pp.
- Smith, J., Woodworth, J.B., & Dashiell, K. E. (1993). Government policy and farm level technologies: the expansion of soybean production in Nigeria. *Agricultural Systems in Africa*, **3**(1), in press.
- Vanneste, G. (1986). De la campagne du soya à la campagne d'éducation sanitaire intégrale. In *Séminaire National sur le Soja*. Proceedings of a conference held at Kananga, Zaire, 3–10 May 1972. Comité de Coordination pour le Développement en République du Zaïre and Comité Diocésain de Développement Intégral de Kananga, pp. 47–58.
- Weingartner, K. E. (1987). Processing, nutrition and utilization of soybeans. In *Soybeans for the tropics: Research, Production and Utilization*, eds S. R. Singh, K. O. Rachie & K. E. Dashiell. Wiley & Sons, New York, pp. 149–78.
- Weingartner, K. E., Dashiell, K. E. & Nelson, A. I. (1987). Soybean utilization in Africa: making a place for a new food. *Food and Nutrition*, **13**(2), 21–28.
- Woodworth, J., Smith, J. & Dashiell, K. (1990). Survey and crop season study of soybean in Benue State Nigeria. *Tropical Oilseeds J.*, **1**, 75–76.