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The Amaranth Project

Researchers Studying Potential Food Source

22 By Robert L. Shepard

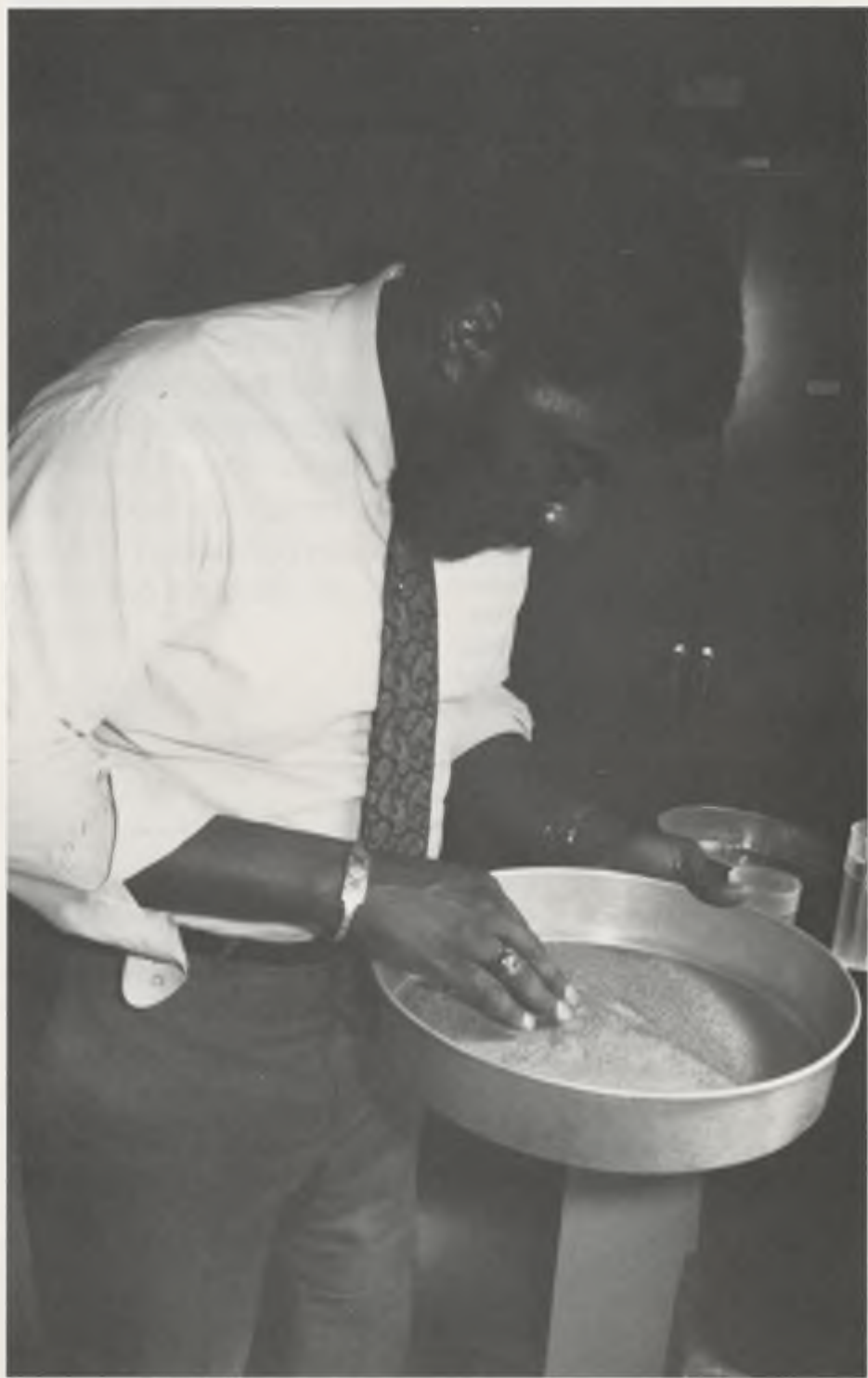
For the past two years, researchers at Howard University's Chemistry Department have been working with researchers at Obafemi Awolowo University (OAU), (formerly the University of Ife) Ile-Ife, Nigeria, on a plant which could become a major food source in West Africa.

The plant is amaranth. It is not new to researchers and has been around for quite some time. Renewed interest in amaranth stems from a small program at the National Research Council, which for the past 15 years has been evaluating underutilized plants with promising economic value that could help developing countries.¹

Amaranth is indigenous to tropical regions and was widely consumed in Central and South America and parts of the southwestern United States before colonization. It was one of the basic foods of the "New World" and was viewed, then, more important than corn or beans.²

Now amaranth has the potential of gaining prominence in West Africa. Like soybean, sunflower and peanut, which were considered unworthy crops a century ago, amaranth could be the grain used to feed millions of people in Africa in the near future.

The plant is fast-growing, drought-resistant and produces sorghum-like seedheads which contain a significant quantity of edible seeds. Its adaptability to new environments is excellent. Agronomists at Rodale Research Center, in Kutztown, Pennsylvania, have studied the plant and produced strains of grain which routinely yield 1,800 kg of seed per hectare.³ The outcome of this research has resulted in amaranth now being marketed in health food stores throughout the United States in the form of cereals and baked goods.



Robert L. Shepard inspecting amaranth seeds



Howard researcher **Michael O. Olugunde** examining insect attack and root structure on an amaranth plant at the experimental farm in Ile-Ife, Nigeria.

(Amaranth seeds have unusually high levels of both total protein (16 percent) and the nutritionally essential amino acid, lysine (5.5 percent), making amaranth grains more nutritious than conventional crops like wheat (12-14 percent protein, 3 percent lysine), rice (7-10 percent protein, 4 percent lysine) and maize (9-10 percent protein, 3 percent lysine).⁴)

The importance of amaranth in West Africa is derived from the widespread use of the leaves and stems of the plant in vegetable soup. Other than what is retained for the next planting season, the high protein seeds are usually thrown away.

The West African species produces dark-colored grains, unlike species grown in Mexico, Peru and India which produce grains ranging in color from off-white to dark.

As a result of the paucity of agronomical information on the field performance of amaranth in West Africa, especially the lighter-colored variety, researchers at Howard and at OAU set out to address the issue. Hence the amaranth project.

Project Description

The collaborative project, "Agronomical and Chemical Studies of Grain Amaranth: A Potential Food Supplement for West Africa," consisted of agronomical trial plantings and chemical evaluation of grain amaranth cultivated under West Africa conditions.

The focus of the research was to examine and document (for the first time) the agronomical conditions favoring cultivation for optimum yield of light-seeded amaranth under West African farming conditions, and to perform chemical analyses on the African-cultivated grain to identify the

amaranth specie(s) showing greatest potential as a food supplement.

Chemical analyses were performed using the research facilities of Howard's Chemistry and Human Nutrition and Food Departments. The agronomical field tests were conducted at OAU's Teaching and Research Farm in Ile-Ife, Nigeria.

Project Significance

The significance of the Howard/Awolowo research project encompasses a number of crucial factors,⁵ all of which play key roles in the success of the cooperative effort.

There are no simple answers or quick solutions to Africa's food situation. Some of the pertinent factors associated with the Howard/Awolowo research activity include the following:

Existing Food Trends

Throughout history, mankind has used only about 3000 of the more than 750,000 known plant species for food.⁶ And over the centuries, the tendency has been to concentrate on fewer and fewer species. Today, most of the world's food comes from some 20 species.⁷ (See Figure 1). What this means is that the vast majority of the world's edible plants have yet to be developed to their potential.

Many of the plants with great food potential are located in the tropics, a region generally neglected because most of the research activities are concentrated in the temperate zones.⁸ In West Africa, for instance, there is the *Pentaclera marcophylla*, a plant whose fruit is a rich source of carbohydrates, proteins and minerals that could be used in the human diet. It is consumed sparingly, and remains relatively unknown in the parts of the tropical

region that are experiencing food shortage problems.⁹

Additionally, existing food trends show that the distribution of food is not uniform. Food deficits are more pronounced in regions of the world like Africa and Asia, as reflected in Figure 2. Therefore, the amaranth project, and many more similar efforts, can help expand the world's shrinking food base.

Population Trends

A graphic representation of population increase from year 1500 to the present, and projected to the year 2000, is given in Figure 3. If current population trends continue at the estimated global annual growth rate of 2 percent, world population will reach the 6.5 billion mark by the year 2000.

The 1988 combined population for 15 West African countries is estimated at 202 million (Figure 4). This number is expected to escalate to 300 million by the year 2000 should the average estimated annual growth rate of 3 percent remain unchanged (Figure 5). If this trend continues, the food base in West Africa and the world as a whole is likely to be under severe stress.

Availability of Suitable Land

Although West Africa's population is rapidly increasing, the amount of cultivable land remains constant for the most part. In some cases, though, it is decreasing due to soil erosion, water pollution and other environmental conditions.

An interesting comparison between population and arable land results when one divides a country's present population into its arable land.¹⁰ This ratio is a measure of the availability of food producing land on a per person basis. I refer to this ratio as the

Figure 1. Some Major World Food Source

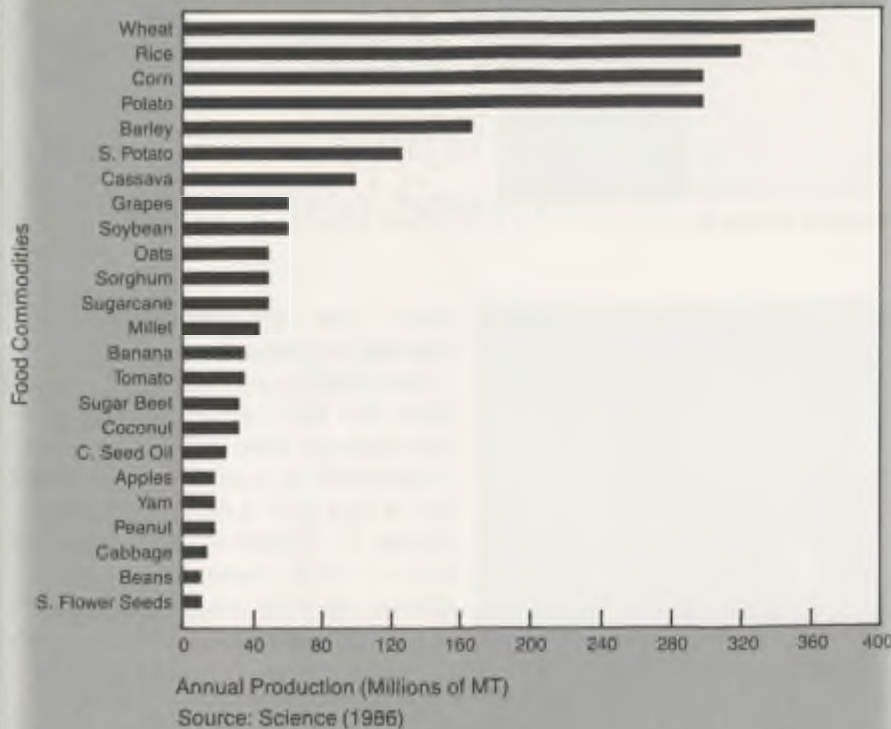
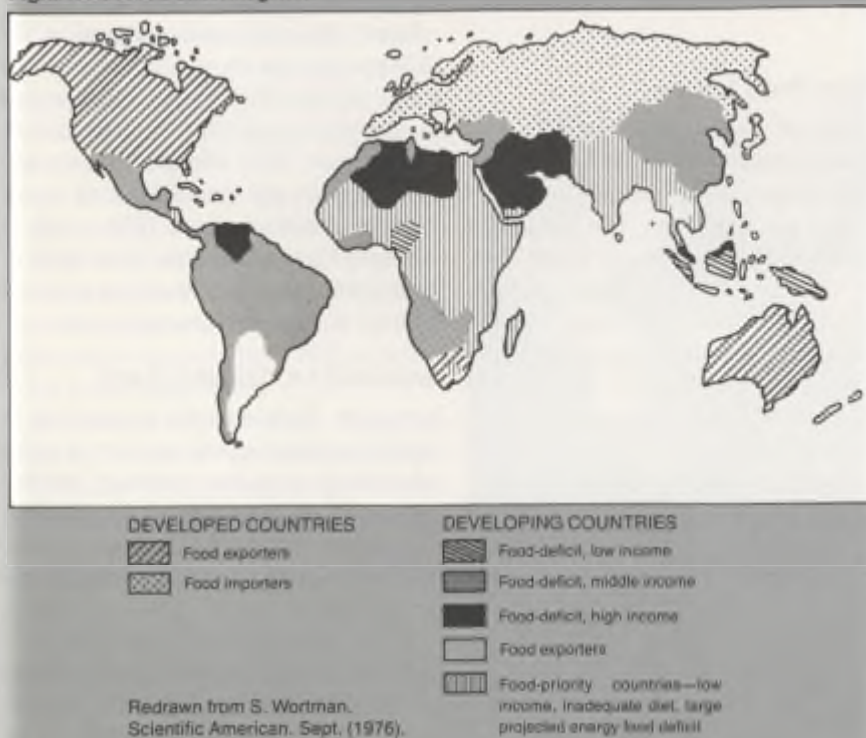


Figure 2. Food Deficit Regions



"Population-Land Index" (PLI), which ranges from a low 0.04 hectare (0.1 acre) per person for Liberia to as high as 0.70 hectare (1.7 acres) per person for Senegal (Figure 6).

The combined average PLI value for West Africa is 0.30 hectare (0.7 acre) per person as compared to 0.09 hectare (0.2 acre) per person for both China and Haiti; 0.03 hectare (0.07 acre) for Japan; 0.39 hectare (0.96 acre) for Brazil; 0.32 hectare (0.79 acre) for Mexico. The PLI value for the United States is 0.72 hectare (1.8 acres) per person.

Assuming today's arable land remains constant and the world population continues to increase at the current annual growth rate of 2 percent per year, less than 0.01 hectare (0.02 acre) per person of arable land will be available on a world-wide basis by the year 2000.

In many parts of the world, as in West Africa, the population continues to crowd into urban centers where arable land is less available—away from rural areas where arable land is more abundant. This pattern has compounded the problem of increasing food production.

In view of the higher PLI values for West Africa and the need to increase the food base in the region, emphasis needs to be placed on farming and on relocating some of the population to rural areas.

Human and Institutional Factors

Cultural likes and dislikes have played a role in keeping some edible foods from reaching their full potential. Collaborative interactions, like the amaranth project, must incorporate strategies for handling the synergistic relationships associated with various cultural influences.

In addition, other human and institutional factors, like infrastructure, science and technology—what's appropriate versus what's available—maintenance, natural resources, transportation systems and storage, must also be considered.

Summary of Results

Days for flowering for light-seeded amaranth in the project's trial plant-

ings ranged from about 37 days (early) to about 60 days (late). Days to maturity did not follow directly from days to flowering.

These plantings showed that light-seeded amaranth is, indeed, adaptable to the prevailing agronomic conditions. The plants demonstrated luxuriant growth.

The insect pest attack was minimal and comparable to what has been reported in the literature for plantings of amaranth seed elsewhere. Further, seed color was still maintained as in each parent stock. And in spite of the unusual weather pattern, seed yields were encouraging, ranging from 585 kg/acre to 1750 kg/acre.

In addition, the amino acid profile of the planted amaranth seeds showed them to be high in the essential amino acid lysine. The data compares favorably with the Food and Agriculture Organization (FAO) Provisional Amino Acid Scoring Pattern, suggesting that the essential amino acids are present in the seeds at a level indicative of protein of good nutritional quality.

Conclusions

- Light-colored amaranth seeds can be grown successfully in West Africa.
- Without the use of fertilizers, amaranth seed yield compares with conventional cereals.
- In spite of adverse weather, the yield was substantial even without irrigation.
- Weed management was not a problem. Spraying herbicide immediately after planting will help to bring weeds under control.
- The mode of drying the seed used in the project is within the reach of low-income farmers, as is the mode developed for cleaning the seeds.
- Seed yields can be improved further with use of fertilizers.
- There was positive correlation between the growth of amaranth and conventional food crops.

What Next?

As stated, the agronomical conditions have been established for cultivating light-seeded amaranth in West Africa. Up to this point, raw chemical analysis



Howard researchers (left to right) **Folahan O. Ayorinde** and **Michael O. Olugunde** standing amongst amaranth plants growing on an experimental plot at research and teaching farm affiliated with Obafemi Awolowo University in Ile-Ife, Nigeria.



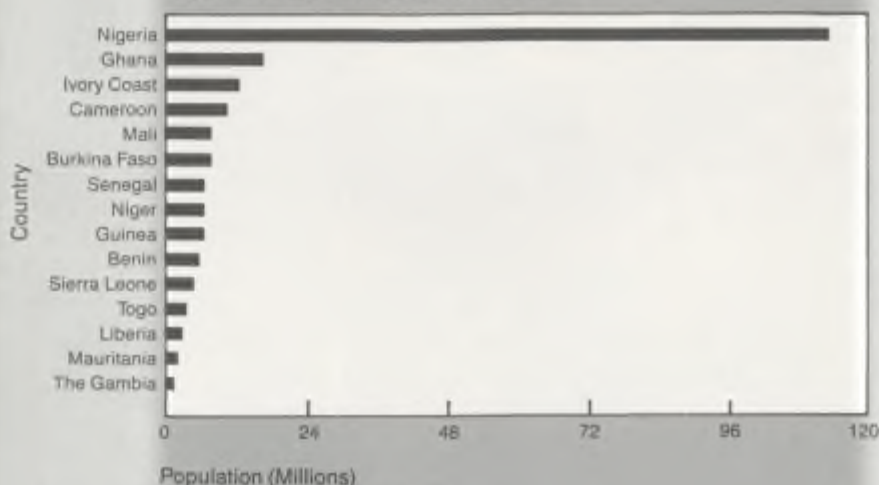
Experimental farm in Ile-Ife, Nigeria.

Figure 3. World Population Trends



Redrawn from Food Science
R.L. Shepard (1988)

Figure 4. Population of West Africa



Population (Millions)
Source: World Factbook (1986)

has been used to determine its nutritional possibilities. This is reflected in the positive correlation between the essential amino acid profile of amaranth grain compared to the level of these components in conventional foods like rice, wheat, soybean and millet. In addition, amaranth fat contains high levels of nutritionally valuable unsaturated fatty acids. These correlations, although scientifically based, are not conclusive when describing the nutritional value of the seed.

Further quantitative analysis and animal feeding studies are required before a definitive conclusion can be reached as to the nutritional value of the seeds as a food supplement. For example, additional laboratory studies are needed to determine the *bioavailability* in the seeds of important minerals like calcium and essential amino acids like lysine. The presence of these nutritional substances in great abundance in the seed is not a direct indication of their availability for dietary use.

Thus, controlled animal feeding studies will be able to assess the quality of the protein by providing insight into the following questions:

- Are toxicants present in all varieties of amaranth?
- Assuming they are present, are their levels beyond safe limits?
- Is the protein of the required quality to meet man's dietary needs?
- Are essential minerals, amino acids and other micronutrients present in amaranth in a form readily available for dietary use?

Definitive and conclusive statements can be made regarding the potential of amaranth seed as a food resource for West Africa once these studies are completed. An important start has been made.

The Amaranth Team

As noted earlier, two teams of investigators, one at Howard and the other at Abafemi Awolowo University, made up the initial amaranth project team.

Folahan O. Ayorinde, an assistant professor of chemistry at Howard, is

my co-principal investigator, while Joseph B. Morris, a graduate professor of chemistry at Howard, directed the Howard component.

Michael O. Olugunde, currently working on a Ph.D. in chemistry at Howard, served on both the field work in Nigeria and the laboratory analyses at Howard.

Other investigators who participated in the Howard segment include Benjamin Taylor of the Department of Comprehensive Science and Barbara Harland of the Department of Human Nutrition and Food.

In Nigeria, the amaranth team consisted of OAU faculty members O.L. Oke (team leader), O.A. Afolabi, G. Adeqoroye and A. Akinyemiju.

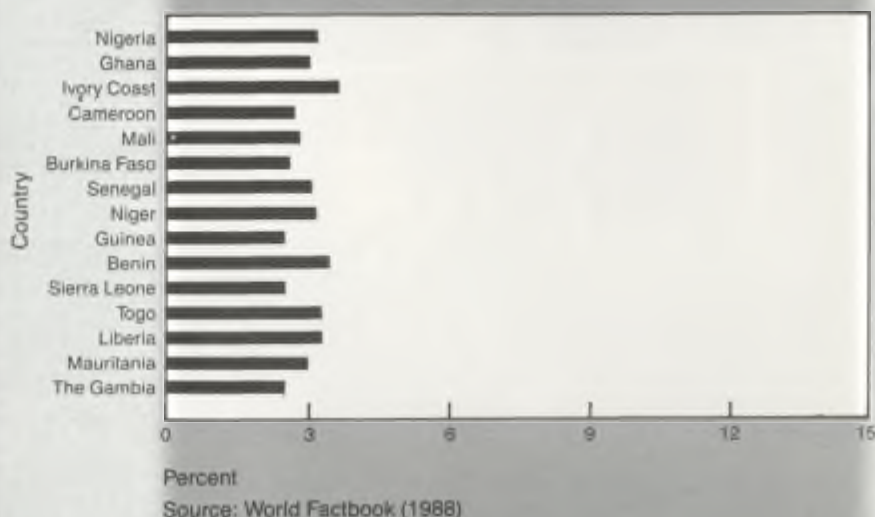
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Figure 5. Estimated Annual Growth Rate



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Figure 6. Availability of Food Producing Land

