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Cynthia Louise Connolly

Iowa State University

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EFFECTIVENESS OF AN AGRICULTURAL INSTRUCTIONAL MODEL OF BASIC VEGETABLE PRODUCTION AT AHFAD UNIVERSITY COLLEGE FOR WOMEN IN OMDURMAN SUDAN

Iowa State University

Ph.D. 1980

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Effectiveness of an agricultural instructional model of basic vegetable production at Ahfad University College for Women in Omdurman Sudan

by

Cynthia Louise Connolly

A Dissertation Submitted to the Graduate Faculty in Partial Fulfillment of the Requirements for the Degree of DOCTOR OF PHILOSOPHY

Major: Agricultural Education

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In Charge of Major Work

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TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>INTRODUCTION</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Statement of the Problem</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Objectives of the Study</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Background and Setting</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Significance of the Problem</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Origin of the Project</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Variables</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Limitations</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>The Sudan</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Cultural and religious aspects</td>
<td>14</td>
</tr>
<tr>
<td>II</td>
<td>REVIEW OF LITERATURE</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Food Crisis Situation in Africa</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Role of Women in Developing Countries and the Integration of Women in</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Development</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Agricultural Education in Development</td>
<td>27</td>
</tr>
<tr>
<td>III</td>
<td>METHOD OF PROCEDURE</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Design</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Subjects</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Instrumentation</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Data Collection</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>Delimitations</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>Treatment Description</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>Analysis of Data</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>Data modification</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>Descriptive analyses</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>Analyses of data-gathering instruments</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Inferential analyses</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Summary of Research Procedure</td>
<td>40</td>
</tr>
</tbody>
</table>
### CHAPTER IV. FINDINGS AND DISCUSSION

- Student Characteristics 42
- Instrument Characteristics 50
- Inferential Analyses 51
- Summary of analyses 61

### CHAPTER V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS 62

- Summary 62
- Conclusions 64
- Recommendations 65

### REFERENCES 66

### ACKNOWLEDGMENTS 70

### DEDICATION 71

### APPENDIX A: PROJECT PROPOSALS 72

### APPENDIX B: SUMMARY OUTLINE OF TREATMENT 83

### APPENDIX C: INSTRUMENTS FOR DATA COLLECTION 91
**LIST OF TABLES**

<table>
<thead>
<tr>
<th>Table</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1.</td>
<td>Continuous descriptive variables of second and fourth year students</td>
<td>42</td>
</tr>
<tr>
<td>Table 2.</td>
<td>Number of students married, number employed outside the home, number with a sibling in agriculture, number of students whose families own their homes, and religious preference of students</td>
<td>43</td>
</tr>
<tr>
<td>Table 3.</td>
<td>Previous education/training in agriculture or science</td>
<td>44</td>
</tr>
<tr>
<td>Table 4.</td>
<td>Education of students' parents</td>
<td>45</td>
</tr>
<tr>
<td>Table 5.</td>
<td>Occupations of students' fathers</td>
<td>46</td>
</tr>
<tr>
<td>Table 6.</td>
<td>Student occupational choices at three different questionings</td>
<td>47</td>
</tr>
<tr>
<td>Table 7.</td>
<td>Families of students with poultry and vegetable gardens</td>
<td>48</td>
</tr>
<tr>
<td>Table 8.</td>
<td>Breakdown of students from urban and rural areas of Sudan</td>
<td>48</td>
</tr>
<tr>
<td>Table 9.</td>
<td>Descriptive summary of knowledge and attitude inventories</td>
<td>51</td>
</tr>
<tr>
<td>Table 10.</td>
<td>Mean scores, standard deviations, and t-values for knowledge pre- and posttest</td>
<td>53</td>
</tr>
<tr>
<td>Table 11.</td>
<td>Mean scores, standard deviations, and t-values for attitude pre- and posttest</td>
<td>55</td>
</tr>
<tr>
<td>Table 12.</td>
<td>Analysis of covariance for the knowledge posttest by class adjusted for the knowledge pretest</td>
<td>59</td>
</tr>
<tr>
<td>Table 13.</td>
<td>Analysis of covariance for the attitude posttest by class adjusted for the attitude pretest</td>
<td>59</td>
</tr>
<tr>
<td>Table 14.</td>
<td>Pearson correlation coefficients of pre- and posttests</td>
<td>61</td>
</tr>
<tr>
<td>Figure</td>
<td>Description</td>
<td>Page</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>1</td>
<td>Africa, 1979</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>The Sudan</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>Fourth year class</td>
<td>87</td>
</tr>
<tr>
<td>4</td>
<td>Fourth year class lab</td>
<td>87</td>
</tr>
<tr>
<td>5</td>
<td>Preparation of seedflats</td>
<td>87</td>
</tr>
<tr>
<td>6</td>
<td>The classroom</td>
<td>88</td>
</tr>
<tr>
<td>7</td>
<td>Second year student preparing her garden</td>
<td>89</td>
</tr>
<tr>
<td>8</td>
<td>Second year class lab</td>
<td>89</td>
</tr>
<tr>
<td>9</td>
<td>The harvest: eggplants</td>
<td>90</td>
</tr>
<tr>
<td>10</td>
<td>Second year class</td>
<td>90</td>
</tr>
</tbody>
</table>
Anthropologists have hypothesized that women were the first cultivators and as such were the inventors of agriculture. It is believed that human beings lived by hunting and gathering their food for about two million years. Men hunted the wild animals, and women gathered the wild plants, including fruits, nuts, and edible seeds. The observation was made at some point that seeds which were dropped on the earth would grow into new plants. And so, at the beginning of the Neolithic or New Stone Age, woman began to cultivate the plants she gathered, and man began to domesticate the animals he hunted (10). Thus, it is generally accepted that owing to her ancient role as the gatherer of foods, woman was responsible for the invention and development of agriculture (13).

In many of the developing countries of the world today, women carry out the work of production agriculture at the subsistence level as well as helping in the production of cash crops. Often, they have exclusive responsibility for food growing in addition to cooking, cleaning, care of the children, fetching the water, and gathering the fuel. In Africa, women do the weeding, manuring, harvesting, winnowing, shelling, and storing of crops besides tending domestic and farm animals. In addition, they usually take the produce to and from market even when it means walking fifteen to twenty miles with a baby on their back.

In general, agricultural education and training in the developing countries of the world has been limited. Unstable political systems and extreme poverty have been prohibitive of indigenous governments establishing a strong, stable system or structure for extension of information or for training and education in agriculture. Two additional obstacles to improving techniques and disseminating information have been the low status of agricultural work and the extremely high illiteracy rate especially in the rural sector and among women.

The world has continued to grow in population with the underdeveloped countries leading the way. These countries also suffer the high-
est rates of infant mortality, malnutrition and hunger, and death from curable and treatable diseases. The world is in the midst of a population-food-energy crisis with the developing nations suffering most severely and in greatest jeopardy.

Even more limited than agricultural education in general, almost to the point of being nonexistent, has been the education and training of women in this area. The illiteracy rate of women is higher than that of men in virtually every developing country; likewise, discrimination against women in high level positions in government, industry, and trade unions as well as agricultural co-operatives confirms women's restriction from decision-making in all countries of the world (21). Development agents have yet to deal with the problem directly. The interest and enthusiasm women have shown have too often been met with defeat as women have been cast in stereotyped roles transferred from the developed countries. The lack of educational training, vocational guidance and counselling, the traditional attitudes of both men and women, and the division of labor in the market place have been obstacles to women's participation in existing projects and often reinforce rather than do away with the inequality.

Agents of change influence and often determine not only what is introduced but also who will use it. Institutions that are the bases for cultivating change are usually exclusively male organization, i.e. the army, the priesthood or religious missionaries, trade unions, the boy scouts, and schools (21). As a result and all too frequently, feminine participation in development projects is excluded both at the point of contact as well as at the point of entry by the fact that the intermediary is a man. This is true especially, though not exclusively, in the Muslim culture. There are few female institutions, paralleling those of males', wherein women can acquire the leverage to learn the skills of the dominant culture and rise within their own communities.

Women suffer the unique status of being an oppressed majority throughout the world and throughout history. Their prime responsibility
from time immemorial has been the production and nurturance of our human resource—people. Integral to this responsibility has been the provision or procurement of food, its preparation, and its feeding to the helpless young of the species. A market value has never been set on women's work in the reproduction and maintenance of the labor force and, as a result, their contribution to production is consistently undervalued. This undervaluing has been an important factor in the omission of women from development projects, especially those projects initiated in the West. International projects based on the gross national product (GNP) of a developing country have not included women whose work and contributions have had no dollar value placed on them. As a result, the pattern of change emerging from international development projects—under the guise of modernization, Westernization, industrialization—has made things almost consistently worse, not better, for women (2).

Rural development theorists have not put forward many explicit ideas on the role of women in agriculture. Extension services have tended to exclude women or teach them things that do not enhance their skills in agriculture. However, the important point is the serious loss of potential brought about by neglecting the indigenous role of women in agriculture and food production. The lack of an integrated approach in project design involving and capitalizing on women helps explain the very limited impact of past development programs on the low-income rural populations in Africa.

This study and the work and efforts it reflects focuses on women in agriculture. It is an attempt to describe, analyze, and evaluate the effectiveness of an agricultural education project involving women, specifically Sudanese women who were students at Ahfad University College for Women (AUCW) in Omdurman, Sudan.
Statement of the Problem

The purpose of this study was to investigate the effectiveness of an agricultural instructional model of basic vegetable production presented to the second and fourth year classes at Ahfad University College for Women in Omdurman, Sudan.

Objectives of the Study

The primary objective of this study was to determine the effectiveness of instruction, measured by change in knowledge and attitude, with Sudanese students at AUCW in the study of general agriculture. To achieve this end a number of secondary objectives were established:

1. To evaluate, through the use of a pretest, the knowledge of nutrition and agriculture possessed by the test group before the treatment;
2. To evaluate, through the use of a posttest, the knowledge of nutrition and agriculture possessed by the test group after the treatment;
3. To evaluate, through the use of a pretest, student attitude toward agriculture before the treatment; and
4. To evaluate, through the use of a posttest, student attitude toward agriculture after the treatment.

Through implementation of the instructional model, the goal was to increase or reinforce the students' knowledge of general agriculture and skill in appropriate cultural practices in the garden. Likewise, a favorable attitude was to be fostered toward agriculture in general, including food production in gardens, and women's participation.

Over a longer period of time, it was hoped that the effects of the project would be extensive. Firstly, since the program was the first of its kind at AUCW, the precedent would be set for the continuation of teacher education in agriculture at the college. A byproduct of teacher
education in agriculture would be wider dissemination as the graduates went on to teach in the rural areas of the country; hence, the diffusion of information and practices in agriculture to the areas of greatest need. Secondly, it was hoped that the course in agriculture with the practical experience it included in the production of a "kitchen garden" would enhance the graduates professional qualifications in their pursuit of meaningful employment. If the students in the course could professionally integrate their training in agriculture in any capacity—work with a ministry of the government, in a health center, teaching, or extension work—a purpose of the project would be served.

Background and Setting

Due to the crucial role women play in the nutritional health of their families and their lack of education in general as well as in nutrition and agriculture specifically, this was believed a prime area for project development. The high illiteracy rate among rural women and the low status of farm work further indicate the need for agricultural education and training of women.

The best method of disseminating information is, perhaps, in teacher education. The majority of the African population able to attend school terminate their formal education at the primary level. In Sudan, only a select few (and an extremely small number of women) go on to secondary schools and the university. To reach the rural sector of a country like Sudan, utilizing the school system, the village or primary school provides the greatest access. Primary school teachers in Sudan, however, receive no special training beyond the secondary school which provides them only a general education. University schooled individuals go on to teach at the secondary level or higher, if they teach at all. The school system in Sudan resembles the British system of education due to the British colonialist interests and influences. General education takes place at the primary, intermediate, and secondary levels which are
sometimes grouped as just primary and secondary, the intermediate level being part of secondary education. Since 1970, the primary level of education has consisted of six years versus the four years of the old elementary school. The secondary level also consists of six years of schooling, divided into two stages of a general secondary school and a higher secondary school each of three years. The main purpose of this division of six and six is to ensure six years of schooling for all children enrolled in the primary schools. It was in 1979 that, for the first time in Sudanese history, the President of the Sudan said all girls, as well as boys, should attend primary school. Though a statement indicating progress, in actuality it is a fact not soon to be realized.

In 1907, Babikr Bedri opened a boys' school to which he also admitted girls from his own family. By 1910 it was officially recognized, after delays caused by the government's doubts about female education. Sheikh Babikr later served for many years in the Education Department of the government and he has an honored place as the first Sudanese to take a direct interest in the education of women (35).

Since its founding, the primary school of Sheikh Babikr has moved in the direction of higher education for women. The Ahfad University College for Women, as it exists now, is the only university of its kind in Africa. The focus of the curriculum is "family science," comparable to our College of Home Economics. It has diversified its curricula with the addition of programs in business management and psychology, neither being as strong or as popular as the Department of Family Science. The Arabic term "ahfad" means grandchildren as the school was established as a family institution with the next generations in mind. Today the University College is administered by the Bedri family with Babikr's son acting as the current principal. It is a diploma granting institution.

In conjunction with the Department of Family Science and as an improvement to the existing curriculum and goals of the department, a need was established for education in the area of nutrition and agriculture or
food production. The study of modern, economic, and efficient agricultural techniques, it was believed, could be used by the students of the university for the improvement of their own diets and that of their families. On a larger scale, with a number of the graduates of AUCW going on to teach at the secondary or higher level, the addition of agricultural education to the family science curriculum would be further disseminated to the rural areas where the greatest need for education in nutrition and agriculture currently exists.

Significance of the Problem

Women are integrally involved in the food production of the Sudan. In the western Sudan, women do the farming while men hunt, fish, and tend the larger livestock. In some instances women have been educated in food preparation, generally at home from their mothers, but they have culturally and traditionally been denied formal education particularly in the area of science and technology including agriculture. With agriculture being the most important sector of the economy in the Sudan and with women playing an important if unrecognized role in the production aspects, in addition to their role as provider for their children and families, it is essential that women be included in the development process through education in agriculture.

Origin of the Project

The joint project between the Department of Agricultural Education of Iowa State University and Ahfad University College for Women was born when interest met opportunity in the Fall of 1977. With the visit of Said Yousif Bedri, son of Babikr Bedri and current principal at AUCW, to the United States, his hopes and visions for curricula expansion at AUCW germinated with ideas from the Department of Agricultural Education at Iowa State University and began to take shape.
A proposal was formulated (Appendix A) and submitted to the World Food Institute at Iowa State University with a budget request. Curriculum planning and development began with the funds received from the World Food Institute upon acceptance of the proposal. A follow-up proposal was also funded to enable work in the United States to continue on the instructional materials and curriculum and to enable their shipment to Sudan for implementing the program in the Fall of 1978.

Variables

The independent variable of this study was the instructional model of basic vegetable production which served as the treatment. The dependent variables were attitude and knowledge.

Limitations

The sample of students involved in this study was neither random nor genuinely representative of a larger population, except perhaps the student population at Ahfad University College. The students were those already enrolled at AUCW and otherwise not specifically selected. The second and fourth year classes were designated by the administration of AUCW to receive the treatment. That is, they were to receive the instruction in agriculture since it best fit into the home science program at the second and fourth year levels.

The students at AUCW are not particularly profession or career oriented; women in the Sudan are very restricted and, therefore, are only beginning to see themselves in professional or semi-professional capacities. This limits the extent of diffusion and dissemination of the agricultural information and techniques initiated at AUCW intended as teacher education for diffusion to the rural areas. A follow-up study in a number of years could be valuable to measure the extent of dissemination more accurately. However, due to the nature of the students reflecting
the limited public and professional role of women in general in the Sudan, the expectation for dissemination is limited.

A third limitation of the study and its objectives is the continuation of the agricultural education program at AUCW. To make such a program self sustaining, more funds and time as well as trained leadership are required. At an institution like AUCW continuity of programs rests with the resources available, i.e. a teacher and funds to carry on. This has limited the scope of this project to essentially a one year period of time.

The Sudan

The Sudan is a difficult place to summarize describe for it is a land of many contrasts. It is home to both Arab and Black African. It is a land of desert and chronic drought as well as a land of torrential rains, floods, and swamps. It is the home of nomadic herders and subsistence farmers as well as highly mechanized irrigation agriculture. It is part of the Near East and part of Central Africa.

Sudan is the largest country in Africa with almost one million square miles, representing close to two percent of all the land on earth. For all its largeness, however, the Sudan is sparsely populated with only 17 million people, one of the smallest land/inhabitant ratios in the world. Many of its people are malnourished, underfed, and have little security against an ever present threat of famine. The Sudan is an impoverished nation, listed by the United Nations and World Bank as one of the 25 least developed countries of the world, unable to adequately feed its own population. And yet its Arab neighbors, the land-poor and oil-rich countries of the Middle East, view the quantity of arable land in Sudan as a potential "breadbasket" for that region of the world.

Geographically, Sudan is located in the Northeast portion of the African continent extending for 1200 miles from its northern boundary at latitude 22° North to its southern boundary at latitude 4° North of the
Figure 1. Africa, 1979 (17).
equator. From East to West the country extends 1000 miles. Its boundaries consist of eight different countries. To the North, Sudan is bordered by Egypt; the Red Sea and Ethiopia are to the East; Kenya, Uganda, and Zaire lie to the South; and, to the West, Sudan is bordered by the Central African Empire, Chad, and Libya. The country is perhaps most widely known for the river Nile and its junction in Khartoum where the sluggish White Nile flowing northward from Lake Victoria in Uganda and the swift flowing Blue Nile coming from Ethiopia come together.

The climate of the country is a major factor dictating the lifestyles and land use patterns of the people. Again, the Sudan is a country of extremes represented by arid desert in the North to tropical rainforest in the South. The amount of rainfall and humidity increases from North to South. Rainfall is the greatest limiting growth factor in agriculture. Less than one inch of rain falls annually in the North but it increases to about 55 inches per annum as one proceeds South. The rainfall distribution pattern makes for two distinct seasons, a rainy or wet season and a dry season. The lack of precipitation in the extensive dry season limits the effective growing season to about three or four months. Though the rainy season begins in June and continues until the end of October, 85 percent of the rain falls in July, August, and September. Together, the intensity and the uneven distribution of the rainfall can cause flooding which can greatly reduce or eliminate crop yields. The heat of the Sudan is extreme, over 100° F except in winter when it drops to the 70°s F. Between the extreme heat, extreme dryness or low humidity, and sparse and uneven rainfall, the climate of Sudan is a limiting aspect of life both for people and for plants and animals.

Administratively, Sudan is divided into nine provinces. These are: Bahr el Ghazal, Blue Nile, Darfur, Equatoria, Kassala, Khartoum, Kordofan, Northern, and Upper Nile. The provincial division of the country reflects neither demographic units nor natural geographic units, having been established more or less at random in the colonial past. The provinces vary in terms of population density, urbanization, communication,
Figure 2. The Sudan.
and transportation systems, and general types of agricultural production.

Northern Province is the least populated province of Sudan; the great majority of the land area of this province is uninhabited desert. There is no communication or transportation system west of the river. Camel and goat herds are kept by nomadic tribes in the areas away from the Nile River.

In sharp contrast, Khartoum Province has the greatest concentration of people in Sudan. It is the smallest province as well as the most urban with rail, air, and river transport and a few hard surfaced roads. The city of Khartoum, located in this province, is the capital of the country and is linked with Omdurman and Khartoum North by a series of bridges, and, as a whole, referred to as the three-town area. The other provinces vary between the extremes of population and development found in Northern and Khartoum Provinces.

Land is one resource the Sudan has in great abundance. Of its 650 million acres, it has been estimated that about 210 million acres are suitable for crops or grazing (35). At present, only about 17.5 million acres are cultivated. In contrast to other impoverished countries, overpopulation is not the prime cause of malnutrition and hunger in Sudan.

Most of the people in Sudan rely upon subsistence farming or herding for their food. There is little input of fertilizer, high-yielding varieties, modern pest management, or improved agricultural practices in this traditional agricultural sector.

Although Sudan as a whole can be considered sparsely populated, the population, as has been indicated earlier, is not evenly distributed throughout the country. The most "favorable" areas are already supporting considerable populations. The less populated areas—marginal lands—lack transportation and communication systems. Administrative and agricultural support systems are lacking or meagre and nomadic lifestyles which are prevalent in these areas are in direct contrast to settled farming.

Civil strife within the Sudan has been another constraint to the
country's development. The three southern provinces (Bahr el Ghazal, Upper Nile, and Equatoria) are inhabited by Black African tribes whereas the six northern provinces are comprised of tribes of Arab or mixed origin. There has been and continues to be considerable animosity among the ethnic groups of Sudan. This was one cause of the 16 year long civil war which broke out just after independence in 1956 and lasted until 1972. Since the administrative capitol of Sudan is in the North, the politicians and governing power has been also, much to the detriment of the South. One of the South's disadvantages is exemplified in the fact that most of the developmental programs have been in the North and the South has been systematically ignored. This disunity among the different ethnic groups of Sudanese is one of the greatest obstacles to the advancement of the country.

Cultural and religious aspects

Northern Sudan is predominantly Muslim. Islam was firmly established here during the fourteenth century. Much influence was in the hands of the holy men who were the teachers and sheiks. Their tombs are elaborate and are visited in much the same way as shrines of saints and martyrs are visited by Christians.

Islam has had tremendous influence on the life of many generations of Sudanese. Its effect on education and law cannot be overlooked in attempting to understand the culture of the country. Essentially, education in Sudan began with Islam. Whereas religious education is central to Islam and a Muslim society, the first schools in the country were Koranic schools called "khalwas." From the time of the Arab conquest of the Sudan in the fourteenth century, minor religious leaders called "fakis" entered the country and opened khalwas. However, the sole emphasis in these schools was on memorizing and reciting the Koran—to read and write was incidental. Only boys attended school; they began between four and seven years of age and finished at 15. The suc-
cessful student then was able to open his own school in his village where he enjoyed a reputation for knowledge. Girls were omitted from this limited education and thereby denied the opportunity to earn respect and assume leadership through education in Islam, and hence society in general. Today, khalwas have been replaced, for the most part, by elementary schools. More girls are attending the primary schools than ever before; but, the prevalent attitude remains that education is wasted on girls and that it is more valuable to educate boys. To change this attitude would mean a reinterpretation of the Koran and Islam's position on women in general.

Many of the traditions and social practices, which include popular attitudes as well as laws, on education, religion, and women stem back to Islam. Traditions are adhered to without question; they are the guiding force of the culture whether they are religious, colonial, or of unknown origins. The people are united in this and, at the same time, limited and inflexible. Tradition, cultural and religious, has been and remains a constraint on the advancement of the women and therefore the country.
CHAPTER II.
REVIEW OF LITERATURE

This chapter presents a review of literature relevant to this study. While a computer library search revealed no similar study involving the agricultural education of women in an institution of higher learning of a developing country, references to the need and food-crisis situation of Africa in general are believed relevant as a backdrop to this study. Integral in this review is the role of women in agriculture and in rural development. Sources are reviewed which present some of the dimensions and perspectives on the integration of women in development efforts. Finally, a review of the literature which deals specifically with agricultural education in development, its rise in the past decade, and conclusions and recommendations from studies done in this area, is presented.

Food Crisis Situation in Africa

Food production is Africa's most important activity. The vast majority of Africa's peoples, regardless of physical, social, or political environment, devote most of their effort to production of their basic food supply, though they may have other economic activities as well. They live in what are called subsistence societies (19, p. 3).

Food production, quite rightly, is increasingly receiving world attention. As McLoughlin states "the study of African food production systems and problems requires attention from all sciences. No one discipline has all the questions or all the answers" (19, p. vii).

Traditional African agriculture is becoming increasingly incapable of feeding the population. Modern agriculture is lagging behind population growth. The attraction of jobs in the towns along with the availability and greater access to goods remove incentives from the rural sector. Where agriculture is favored, as in Sudan, it is oriented
to export crops that earn hard currency for urban, commercial, administrative, and industrial growth. These factors, aggravated by climatic conditions, serve to undermine the defense of marginally arable land against the desert. Sub Saharan Africa is estimated to be cultivating only 27 percent of its 643 million hectares of land considered suitable for agriculture and producing less than one percent of its maximum agricultural potential of consumable protein (17).

These elements have immediate consequences. Governments must make a major effort to change agricultural policies or depend on increasingly large food imports (either as purchased goods or as public aid) or face the basic problems of food shortages and unrest. Food purchases deplete scarce currency reserves and provide only a temporary solution at best. Even if large aid programs were undertaken by the developed world, they would have other costs, including serious political problems of intervention and dependence.

Intensified agricultural production would seem a logical solution. Agricultural yields and acreage can surely be increased. Rapid agricultural growth, however, requires capacities for control, mobilization, knowledge, and implementation of resources; African states, with few exceptions, have not shown this to date. These trends indicate, as Legum (17) points out, that Africa as a whole will continue to undergo a crisis of food production compounded by a distributional crisis.

Between 85 and 95 percent of the nearly 310 million people living in Sub Saharan Africa live in rural areas. Most survive on a per capita income of less than $100 annually based on subsistence agriculture and livestock. Production is oriented mainly towards subsistence yet agriculture constitutes the largest sector in the gross nation product of most African countries according to Lele (18). Nomads constitute as much as 25 percent of the population of some Sahel countries. To support their livestock (cattle, sheep, goats, camels), they depend on vast areas of land with low production potential and unreliable annual rainfall. She (18) reports that statistics on the levels of living of this
traditional pastoral sector are even poorer than those on the subsis­tence agricultural sector. Nomadic living standards are comparable with, if not lower than, those in the subsistence agriculture sector.

A conventional assumption of development has been that growth would lead to greater participation, but increases in productivity in the al­ready commercialized rural subsector have had relatively little effect on the living standards of the subsistence population. There has been widespread interest in rural development programs being undertaken by the national governments and assisted by external donors. However, knowledge of how to bring about development of the subsistence rural sector remains very limited.

This continental picture sets the scenario for conditions in Sudan. Agriculture is the largest and most important sector of the economy as well as the traditional occupation of the village in Sudan (1). Of the 650 million acres of land in the Sudan, it is estimated that 120 million acres could be used for crop production (35). The lack of infrastructure in the form of roads, communication systems, agricultural support sys­tems, the remote location of untapped arable lands, and health hazards are only a few of the prohibitive factors to development.

The Sudanese government has chosen to attack the problem through large tract agricultural schemes which utilize imported seed, fertil­izers, and pesticides and require large powerful machinery and irrigation technology. The Gezira Scheme is perhaps the best known being "the largest farm in the world" (35, p. 148). It consists of a vast clay plain of five million acres which form an island between the Blue and White Niles. This area historically served as the granary of the Sudan dating back to the time of the Pharaohs where dura or sorghum, the main food crop of the country, was grown until the present century. The em­phasis today, however, is no longer on providing essential food crops to meet the needs of the country but on the production of cotton as an export crop.

While the problems with large scale government agricultural schemes
are not at issue here, they serve as an example of how development proj-

ects—even those indigenously originated—lack integration that would

enable benefits to be felt by the people, particularly the poor rural

sector at large. The foreign currency earnings of Sudan are important,

but they are not striking at the heart of the problem of hunger and wide-

spread malnutrition that affects the masses.

In coming to grips with the Sudan's food production problem, it is

important to recognize that the country has many different agricultural

systems under widely contrasting ecological, demographic, social, polit-

ical, and economic conditions. In view of the limited human and finan-

cial resources for assistance, how does one determine priorities? Does

one focus on large government schemes that generally provide crops for

export and food for urban areas, or on food economies in the villages

containing significant numbers of people, or those that are the poorest,

or those with the highest rates of population growth, or those with the

best agricultural conditions, or those with an infrastructure to accom-

modate assistance? Political considerations have an important role in

establishing such priorities. Sensible development programs work on a

variety of fronts simultaneously.

It is critically important for researchers and theorizers to see

food production systems through the eyes of the planners, policy makers,

extension personnel and others involved in the process of altering them.

Too often the "subsistence" sector has been overlooked or omitted en-

tirely from objectives in development plans which are of a grandiose

nature. Typical objectives for the agricultural sector include expansion

of agricultural exports, more volume of more crops, and diversification.
Role of Women in Developing Countries and the Integration of Women in Development

Anthropologists seem to generally accept that due to the ancient role of woman as the gatherer of vegetable foods, woman was responsible for the invention and development of agriculture. So long as the ground was prepared by hoeing and not by plowing, women remained the cultivators (13). Hawkes hypothesizes that with the invention of agriculture, women enjoyed greater esteem and "the earliest Neolithic societies throughout their range in time and space gave woman the highest status she has ever known" (13, p. 264).

With population pressures, more land must be used continuously and cultivated intensively. Agriculture with the hoe, allowing long periods of fallow, becomes inadequate and is replaced by plow farming. Since it is the man who is taught modern farming techniques, the men who remain in the villages use the plow and become the primary cultivators. This entails "a radical shift in sex roles in agriculture," which explains woman's deteriorated status after the plow was invented in the Middle East about 5,000 years ago (10, p. 288).

Tinker (36) tells us that the erosion of the role women played in subsistence economies began under colonial rule. Policies aimed at improving--through modernizing--the farming systems (particularly the introduction of the concept of private property and the encouragement of cash crops) favored men. When customary communal land tenure rights were changed to the private ownership of land through colonial influence, women were dispossessed and men were recognized as the new owners. Women still farmed the land but no longer owned it and therefore became dependent on their fathers and brothers.

Lancaster refers to the subsistence food production carried out by women in Sub Saharan Africa as "horticultural labor" (16). He states that in most cases "tribalists have not accorded simple horticultural labor a high prestige ranking in political terms, and this has generally
been true of most activities predominantly associated with women" (16, p. 540). Women have been in a marginal political position despite their contribution in family food production and distribution of food in the subsistence sector of the economy. Everyday work activities in the domestic sphere—including food production—have largely been linked to women and have been outside the "prestige sphere" which Lancaster calls a male dominated invention in most tribal societies. Sub Saharan Africa, he states, has been and is still the region of female horticulture par excellence.

...simple horticultural production in Africa... normally takes place within the private domestic realm of the nuclear or extended family household, together with a wife's other seasonal and daily chores. Primary day-to-day responsibility in weeding, cultivating, and protecting crops from animal marauders usually falls to her and the children....In this sense, simple horticulture is like kitchen gardening, even though a woman's field...may sometimes be some distance from her hut door...and rather larger than the conventional notion of a kitchen vegetable garden. A woman's gardening, like her various tasks in food preparation...is a private domestic concern...(16, p. 550).

Since subsistence activity is essentially a family affair rather than a public or political matter, and since it is carried out by women who hold a subordinate status in the family and society, and since it does not show an economic contribution to the gross national product, it is bypassed in national development schemes. With the introduction of simple technology into this sphere, the situation changes, as Boserup (4) notes, when women are displaced by the new tool, i. e. plow, and their domestic contributions thus lessen. The woman's role as a bread-winning mainstay is reduced to her role as a housekeeper and mother only, more dependent on the husband. The changing of subsistence agriculture at the hands of Western altruistic development agencies has had a drastic effect on tribal sociology particularly the status of women.
Control of the modes and means of subsistence production has affected family form and political attitudes.

In regard to the kitchen garden, Fagley (8) states that the woman normally has to choose and save the seeds or roots, work with primitive tools and follow primitive methods. Modernization has hardly begun to touch this key sector of agriculture. It is not studied by the experts; neither research nor agricultural extension is provided in significant amounts. The peasant woman farmer is still mostly on her own.

O'Kelly (23) reiterates the premise that the growing of the food which feeds the family is women's work almost everywhere, and usually only when farming is on a commercial scale does the man take part.

Development has not yet reached most people in rural Africa; however, in the areas where it has had an impact, men have received more benefits than women. Where women have been reached by extension and other programs, these have largely dealt with the improvement of home and family tasks and rarely with improved crop production or other economic functions (29). In citing blocks to national development, Richie (29) states that the concentration of extension services on men and cash crops with the consequent neglect of the needs of women in the subsistence agricultural sector has been an inhibitor of progress. To strengthen the role of women in development, education and/or training is mandatory. It is important, however, to have specific aims for adult education:

\[\text{Education for women is advocated but for what? Is it, for example, so that they will fetch a higher bride price or to enable them to play a greater role in the development of their country? To be effective, learning must be linked to the needs and problems of the learner, which in Africa are likely to be related to agriculture (29, p. 140).}\]

A consistent problem with past development efforts has been their failure to consult the local people, who are to be the beneficiaries of the aid, for their views on needs and solutions. Perdita Huston (15)
sought to do this in conducting interviews with the people of Sudan and five other countries. The women she spoke with proved to be very articulate both on identifying their needs and on suggesting solutions.

When talking with a rural Sudanese woman, Huston queried the woman on what she thought the women of her tribe needed most to learn. The response was "women want to learn the new things in health, how best to dig and do the work in the field or vegetable garden and in the house... they want to learn about foods and cooking" (15, p. 88). When the women spoke about training or education, they saw the need for it as a primary means of improving their existence in the immediate future. Huston elaborates:

Speaking of their own educational needs, some rural women told me they would rather learn how to improve their crops than learn how to read. Successful crops were necessary for survival, they said; reading was not... these women know that they need first to meet their families' most critical, immediate needs, and their responses pointed to one of the problem areas of educational "relevance:" the usefulness of existing literacy training programs to meeting everyday needs (15, p. 89).

The women in Sudan, based on Huston's interviews, were interested in training or education for two basic reasons. First, they wanted to improve the health of their families. For this they seek knowledge and skills pertinent to cultivation, nutrition, hygiene, and health care. Secondly, they seek training in remunerable skills in order to earn the income necessary to improve the health and economic situation of their families and to send their children to school. Huston reiterates that "whenever I asked rural women what they would most like to learn if they had the opportunity, they invariably named several health-related skills: improved ways of growing food for family subsistence, nutrition, cooking, hygiene, health care, budgeting, and family planning" (15, p. 89).

There are problems with integrating women into the mainstream of development. Even educated women are bound by mores, religion, and tradition. Muslim women particularly have historically been kept in the
house, out of the public eye and work sector. Middle Eastern nations, including Sudan, are allowing more women to receive education but they are not providing the new opportunities and avenues for these women to contribute to national development.

...the governments in most Middle Eastern nations have contented themselves with establishing numerous intermediate-level schools without attempting to change the overall structure and occupational opportunity within the exchange sector... no genuine steps have been taken at any social level toward redefining what types of jobs other than teaching are appropriate or socially acceptable for an educated and respectable Muslim girl to pursue (40, p. 53).

Muslim women have, by tradition, been kept in a secluded atmosphere. Where outsiders can observe the Muslim woman in public, especially where there is contact with the opposite sex, morality taboos assume a great importance. As a result, there is general prejudice against women in employment because it fails to guarantee a secluded atmosphere (40).

The use of the veil as part of the traditional dress of women illustrates her seclusion from the public eye.

In ancient Arab society, the use of the veil and the retirement into seclusion were means of distinguishing the honoured wife from the slave girl who was exposed to the public gaze... In Sudan even today it appears to be a mark of distinction and sophistication for an educated girl to retire into seclusion when she has finished her education (4, p. 48).

The restrictive role of women in society, particularly Muslim society bars her from participation in the development of her country even if she is able to procure education or training. The potential contribution of women in development efforts is virtually incalculable. It is impossible to accurately estimate the social and economic costs of underutilizing fully 50 percent of a country's human resources.

Whether a society has the enlightenment to allow women's economic and social contributions should not be the determinant factor in educa-
ting women and girls. To be integrated into the development effort means to have the legal right, as well as access, to the available means for self-improvement and societal improvement. The failure of girls and women to be educated and trained equally with men leads to the marginal participation of women in development efforts (28).

Not only have women been overlooked in past development efforts, they have been hurt by international developers' and policy planners' disregard and ignorance of them. In questioning why development programs have failed to reach women and have ignored the contribution of women to economic and social growth, Tinker states:

The unquestioned transfer of erroneous beliefs about women from developed Western to developing societies seems to be at the root of many of the negative effects development has had on women's lives (37, p. 2).

According to Tinker, development has had a negative effect on women because planning has erred in one or more of the following ways:

a) By omission—that is, by failing to notice and utilize the traditional productive roles which women are playing;

b) By reinforcement of values already in existence in the society which restrict women's activities to household, child-bearing, and child-rearing tasks; and

c) By addition—that is, by superimposing Western values of what is appropriate work for women in modern society on developing societies (37, p. 5).

The World Conference of the International Women's Year in outlining specific areas for national action spoke to the issue of education and training.

Access to education and training is not only a basic human right recognized in many international instruments, it is also a key factor for social progress and in reducing the gaps between socio-economic groups and between the sexes. In many countries girls and women are at a marked disadvantage. This not only constitutes a serious initial handicap for them as individuals and for their future position in society; it also seriously impedes the effectiveness of their contribution to development programmes and the development process itself....As long as women remain illiter-
ate and are subject to discrimination in education and training, the motivation for change so badly needed to improve the quality of life for all will fail, for in most societies it is the mother who is responsible for the training of her children during the formative years of their lives....Opportunities should be created for women to contribute more efficiently to the production of proper types of food through vegetable gardens in rural and urban areas....Girls and boys should also be encouraged to grow food in school gardens...(37, p. 196 and 203).

The education of girls and women is a new concept in some countries and, therefore, not widely practiced. The conference of the International Women's Year points out how vital education is to national and personal growth. Once again, though, education should have specific aims and be relevant to meeting the crucial needs of the people and country. Hahn and Presvelou state:

...if one could single out the main factor that has precipitated interest in the education and training of women, it is probably the critical shortage of food supplies. Labour-force statistics are beginning to show the significant extent to which women are actively responsible for food production in different parts of the world. This applies particularly to countries where subsistence agriculture is the main source of livelihood (11, p. 50).

Institutions, including educational institutions, are often the bases for cultivating change. Unfortunately, these are usually exclusively male organizations (21, p. 176). A nation as a whole incurs certain losses when women are poorly educated, in bad health, or barred from many activities. Development must mean more than greater productivity or more industrialization. Some critics of past failures of development efforts have urged "more investment in education, provision of health and social services, and the development of 'human resources,' of which women are a particularly important aspect" (26, p. 19).

So, while women have been recognized as important, even essential, to family food production and sustenance in developing countries, they have not been rewarded or remunerated for their role either monetarily
or with prestige. Their role has been altered with the introduction of technology beginning with the plow—a plow that was, perhaps, designed for male use and was therefore too large, heavy, and cumbersome for women's use—and colonization and the imposition of western ideas in general. Nevertheless, women continue to work the kitchen garden and provide much of the manual labor of subsistence agriculture. As development continues, the contributions of women both in subsistence agriculture and the mainstream of the economy via agriculture and agriculture-related professions will, hopefully, continue to grow and be appreciated.

Agricultural Education in Development

Agricultural education can address itself to the educational needs of women, as directed by the United Nations during international women's year 1975. It can serve both the subsistence sector where women are often restricted to household activities including food production, as well as the public or service sector enabling women to teach, to work in health or nutrition, to work in a government position, or to work in extension. Considerable efforts have been made in developing countries to increase the effectiveness of agricultural education systems. A world conference in agricultural education and training, sponsored by the Food and Agricultural Organization of the United Nations (FAO), the United Nations Educational, Scientific, and Cultural Organization (UNESCO), and the International Labor Organization (ILO), was held in Copenhagen in 1970. In devising agricultural education and training systems, needs in the following fields were concerned:

a) higher agricultural education (specialists, research workers, teachers)
b) intermediate agricultural education
c) vocational training
d) farmer training (38, p. 73).

Trouillot states "agricultural education should be viewed as con-
continuous education...without distinction as to sex" (38, p. 77). Agricultural education can only make real progress in coordination with research and extension and it is essential to have a coordinating body at the highest level. This is lacking in most developing countries.

At present, most of the personnel trained in agriculture are likely to be required for occupations in extension, education, and administration (14). A broad-based teaching program in general agriculture is needed. The attitude of students toward farming and rural life and toward a professional career involving agriculture is more important than previous practical experience. A teaching program must be relevant and applicable and must fit into the over-all education system. Relevant experience for the students in crop production should be an essential part of the program. In making suggestions for the modification of curricula in agriculture, Hoffman emphasizes that utmost attention should be paid to "practicals in the field and in the laboratory...keeping in mind that 'theory' and 'practice' must go hand in hand" (14, p. 52).

Coombs tells us that "enormous strides have been made in just a few years in many nations--many of the poorest ones--toward creating an infrastructure for agricultural education and research" (5, p. 1). But there have been heavy handicaps under which these new agricultural education programs have been obliged to operate. He cites inadequate budgets, shortages of talent, and low prestige among other hinderances. Further, he credits inadequate integration with the larger strategies, plans, and needs of agricultural development to be a major cause of poor performance by agricultural education systems.

As long as conditions of fragmentation within agricultural education systems exist, and as long as this lack of complementarity between educational inputs and other essential factors and preconditions for development continues, it must be expected that investments in agricultural education and research will produce much lower returns than would be possible under better planning and management (5, p. 3).
Quite a number of developing countries have introduced the subject of agriculture into their curricula in order to relate them more closely to pupils' subsequent occupation. According to Gooday (9) an agricultural curriculum was developed in Swaziland incorporating the following important principles:

a) local relevance—materials were applicable to locale of program.

b) unit approach—a series of teaching units were used, each complete in itself but closely related to other units intended to precede, parallel, or follow the unit concerned.

c) teaching method—sufficient time was allocated to enable practical work as well as classroom instruction.

d) supply of materials—those materials required in addition to books, i.e. tools, fences, irrigation, seeds, fertilizers, and pesticides, were procured.

e) flexibility—factors such as weather, the speed at which students' learn and the teacher determined the rate at which units were taught and their order of sequence.

f) integration—efforts were made to ensure that there was integration between the agricultural content of curricula and that of other subjects taught in the school.

g) participation—local technical experts were consulted for input into preparation and evaluation.

h) relationship to rural development—realizing that the teaching of agriculture in isolation can achieve little, it was associated with a study of the comprehensive rural development programs in the country (9).

The objectives of this same project fell within three areas: attitude formation and change, knowledge to be acquired, and skills to be learned. The students were encouraged to regard agricultural work and farming as a way of life as good and profitable personally and nationally. Likewise, positive attitudes to development and conserva-
tion were fostered.

The syllabus content reflected three main aspects to the study of agriculture. These were:

a) scientific—the theoretical background to modern agriculture practice.

b) practical—the inclusion of practical activities in every part of the program.

c) business—emphasis on the economic aspects of farming, whether it be subsistence or market-oriented.

Gooday (9) goes on to state that school agriculture programs can only be carried out properly with adequate equipment. This requires funds, which are lacking in most schools in developing countries. Among the facilities found necessary in the Swaziland study were:

1. An agricultural center—a multi-purpose place for a) storing equipment b) for students to carry out simple experiments, and c) use as a classroom.

2. Garden tools—quantities should be related to class size and expected utilization. A full range of tools is essential if pupils are to carry out all the normal practices.

3. Irrigation equipment—provision should be made for items appropriate to indigenous agriculture. This could be engines, pumps, pipes, hoses, taps, and watering cans.

4. Livestock and housing—this depends on the local situation.

5. Recurrent materials—provisions of items such as fertilizers, seeds, and spray chemicals. These should be supplied in the first year unless schools are able to finance these inputs themselves.

This study revealed some important points, all in all, for consideration in the planning of an agricultural curriculum in a developing country.

The review presented herein represents works, studies, and views which provide a framework for the study at hand. As international development planners begin to look at sociological and cultural patterns and come to more of an integrated approach, agriculture and agricultural
education means more than simply increased crop production. There is much more historical and philosophical literature that could be included here. However, it is hoped this review with its emphasis and diversity serves as a backdrop for the study at hand.
CHAPTER III.
METHOD OF PROCEDURE

The primary purpose of this study was to evaluate the effectiveness of an agricultural instructional model of basic vegetable production at Ahfad University College for Women. To accomplish this objective, the following methods and procedures were used.

Design

The nature of this study did not lend itself to a true experimental design. To a large extent it was impossible to control the conditions under which the study was conducted, i.e. it was a foreign situation and many of the conditions were not known until the researcher began implementation. Therefore, this investigation could be classified as a preexperimental design or, more specifically, a one-group pretest-posttest design.

The one-group pretest-posttest design involved three steps:

1. A pretest measuring the dependent variables was administered.
2. The experimental treatment was applied to the subjects.
3. A posttest again measuring the dependent variables was administered to the subjects.

The design may be represented graphically as

\[
\begin{array}{c|c|c}
\text{Pretest} & \text{Independent Variable} & \text{Posttest} \\
Y_1 & X & Y_2 \\
\end{array}
\]

The symbols are explained as follows:

- \(X\) represents the independent variable, or treatment, which is the model of agricultural instruction in basic vegetable production.
- \(Y_1\) and \(Y_2\) represent the dependent variables administered to the subjects before and after they received the instruction in basic vegetable production.
Subjects

The situation at Ahfad University College for Women in Omdurman Sudan was such that neither full control over the scheduling of experimental conditions nor the ability to randomize could be realized. As is often the case in the real educational world, there were real limitations upon the researcher's ability to select or assign subjects and manipulate conditions.

The subjects in this study were all the students enrolled in the Department of Home Science in their second or fourth year at Ahfad University College. There were 19 students in the second year class and thirteen in the fourth year class for a total of 32 subjects. These two classes were selected by the administration of AUCW to receive the instruction.

Since the internal validity of a preexperimental design can be called into question and is an inherent weakness of the pretest-posttest design, external validity is of little value. Therefore, an attempt is not made to generalize the results of this study onto a larger population than the student population at AUCW.

Instrumentation

Three instruments were developed to measure the dependent variables and to record personal and situational information from the students who were the subjects of this study. Two of the instruments were pretests which were administered before instruction began. These same two instruments also served as posttests following the completion of instruction. The third instrument was to record personal and situational information on the subjects and was completed by the students during the course of the year. A copy of each instrument is included in Appendix C. A description of the instruments is provided in the following paragraphs. Other procedures including data analysis,
scoring, and data modification are presented in the analysis section.

The first instrument was developed to measure knowledge as a dependent variable. It consisted of a subject matter questionnaire of 100 multiple choice questions. The students were to select the correct answer from four choices—\text{a, b, c, or d}. The questions reflected the content of the agricultural instructional model of basic vegetable production. This included agriculture in the Sudan, production of food, and nutrition.

The second instrument was developed to measure attitude and intended behavior of students. It consisted of a total of 42 statements; 41 of these were designed to elicit a response of agreement or disagreement from the students and one was to ascertain the students' professional goals. The student indicated her agreement or disagreement of each statement by circling a number from one to five representing:

1. strongly disagree
2. disagree
3. undecided
4. agree
5. strongly agree.

Some of the statements in the attitude survey were written in a positive (pro) direction and some in a negative (con) direction. The statements in this survey pertained to instruction in agriculture, women in agriculture, gardening and food production, deterrents to gardening and food production, and, finally, the students' professional goals.

The third instrument was designed for the collection of personal data on the students. It consisted of 13 questions pertaining to the students' professional goals, educational background, family background, and general information. Other relevant information was added during the course of the year to complement the responses of the students to the original 13 questions.
Data Collection

The academic year for 1978-1979 at Ahfad University College began officially August 2, 1978. Time schedules are flexible in the Sudan as few events are able to be controlled to a precise time. This was true with the opening of the school year. A severe gas shortage followed the Organization of African Unity Conference held in Khartoum in July. As a result, the country was literally immobilized from the airlines to the motor scooters. Students who lived in the vicinity of the College were able to walk to class but these were very few in number. Meaningful instruction was therefore delayed until the beginning of September. The pretest was administered at the end of the month of August except to the few students who did not arrive at AUCW until later.

The agricultural instructional model of basic vegetable production was administered in the form of a course titled "Food Production in the Kitchen Garden." It was a required course for the second and fourth year students in the home science program at AUCW. As an academic requirement in the formal educational setting of Ahfad University College, the schedule of classes followed that of the other courses with a required number of class meetings. Classes met, except for holidays and semester break, until April 10 which marked the beginning of final examinations. The posttest was administered as a final examination for the course "Food Production in the Kitchen Garden."

Following the final examination, an interview was conducted with each student to gather final information, to note progress, and to round out the experience of the course.
Delimitations

The subjects of this study were not a random sample representing a delineated population. They were all women, mostly upper class in Sudanese society. While being typical of students at Ahfad University College, they did not represent an even cross section of Sudanese women. By their presence at AUCW they were an elite group as the illiteracy rate for women in Sudan is over 90 percent.

As the course in food production was taught in English, this affected the study. The English language skills of the students of this study varied considerably which presents an obvious weakness in the instrument which was in English. Some of the students had great difficulty with comprehension, vocabulary, and writing in general due to their limited skills in English as a second language. For the most part, these students worked hard to compensate for this deficiency by studying in groups with other students who were more fluent in English. Nevertheless, it would be impossible to accurately distinguish a random guess versus a reasoned response to the questions and statements of the instrument.

Treatment Description

The treatment in this study was instruction in general agriculture in the form of a course entitled "Food Production in the Kitchen Garden." It is sometimes referred to herein as a model of instruction, as it was intended to be broad-based and general; and, it was the first course of this nature at Ahfad University College for Women. The model of instruction was based upon theory and its application. Students were given instruction that coincided with the planting/harvesting season of northern Sudan. A garden plot of approximately 100 square feet was given to each pair of students for which they maintained primary responsibility. These gardens were located on the AUCW campus
and were easily accessible. Laboratories met four hours per week; lectures met for two hours weekly. During the off-season, laboratory lessons were conducted in the classroom where such activities as the planting, thinning, and transplanting of seed flats; soil testing; and, seed germination tests took place. For the most part, laboratory lessons consisted of the application of theory and practices discussed in lecture. Field trips were undertaken in lieu of laboratories at different times.

Instructional materials consisted of illustrated posters of various vegetables grown in the gardens, subject matter handouts that coincided with each unit taught, extension publication from the United States, and a small library of books and journals on vegetable gardening. A small chalkboard was the only teaching aid available. A summary outline of the instruction can be found in Appendix B.

Analysis of Data

The data gathered from the students' pretests and posttests were coded and recorded on IBM cards, and analyses were done using computer facilities at Iowa State University. An overview of the statistical treatment of the data follows. The Statistical Package for the Social Sciences (SPSS) was the computer program system used in this analysis.

Data modification

The only modification of data that took place was on the attitude instrument observations. There were 14 negative items (# 7, 11, 12, 16, 18, 20, 23, 24, 27, 28, 30, 34, 38, and 41) for which the scoring was reversed so that a positive direction was consistent throughout the instrument.
Descriptive analyses

The instrument used to collect personal information on the subjects of this study called for simple responses either by check mark, when choices were provided, or number, when a quantity was requested, or by short answer of one of several words. For the short answer questions a coding system was devised to fit the data. A description of the coding categories follows:

1. What occupation do you plan to enter upon completion of your formal education?
   Teacher = 1
   Work in a Ministry = 2
   Work in a Hospital or Health Center = 3
   Housewife = 4
   Other = 5

2. Have you ever studied agriculture before?
   Yes = 1
   No = 2
   No, but Botany or other biological science = 3

3. Describe your educational background before coming to AUCW.
   Primary and secondary school = 1
   Other = 2

4. What is your father's occupation?
   Businessman/Merchant = 1
   Farmer = 2
   Teacher = 3
   Politician = 4
   Government worker = 5

5. What is your mother's occupation?
   Housewife = 1
   Employed = 2
   Professional = 3
6. Did your father go to school?
   Yes, primary school only = 1
   Yes, primary and secondary school = 2
   Yes, college = 3
   Yes, graduate school at a university = 4
   No = 5

7. Did your mother go to school?
   Yes, primary school only = 1
   Yes, primary and secondary school = 2
   Yes, college = 3
   No = 4

**Analyses of data-gathering instruments**

The instruments for attitude and knowledge were analyzed for consistency using SPSS subprogram RELIABILITY. A measure called reliability alpha was computed for both pretest and posttest responses for attitude and knowledge. The results are reported in Chapter IV: Findings and Discussion.

**Inferential analyses**

A paired samples t test was used to analyze the observations made before and after the treatment. This was done using SPSS subprogram T-TEST.

SPSS subprogram PEARSON CORR was used to calculate Pearson product-moment coefficients of correlation for inferring correlations between attitude and knowledge and the pretests and posttests measures. Significant correlations were inferred from the procedure.

Subprogram ANOVA was used to perform analysis of variance and covariance. The F statistics produced assume a fixed-effect model.
Summary of Research Procedure

This study was conducted in the Fall of 1978 when the pretest was administered at Ahfad University College for Women in Omdurman, Sudan. The treatment took place over the course of the academic year followed by a posttest. From the analyses of the data collected, the effectiveness of the instructional model was evaluated. Effectiveness was assessed in terms of the objectives pertaining to student attitude and knowledge of agriculture.

The pretest-posttest one group design was used in the study. Since the treatment was administered to two groups (second year and fourth year students) a replication existed which further substantiated the results of the treatment. The second and fourth year classes were selected by the administration of AUCW to receive the treatment and, therefore, do not represent a random sample.

Administration of data collecting instruments was done by the author as the instructor of the course which served as the treatment. The data were statistically analyzed upon the author's return to the United States using the computer facilities at Iowa State University.
CHAPTER IV.
FINDINGS AND DISCUSSION

The purpose of this study was to evaluate the effectiveness of an agricultural instructional model of basic vegetable production at Ahfad University College for Women in Omdurman, Sudan. To accomplish this purpose, the second and fourth year students of the Home Science Department were selected by the AUCW administration to receive instruction. The treatment was administered to both classes; hence, a replication of treatment took place. Data were collected from the subjects as follows: (1) personal and situational information from the students, (2) student knowledge of agriculture prior to treatment, (3) student attitude toward agriculture prior to treatment, (4) student knowledge of agriculture after treatment, and (5) student attitude toward agriculture after treatment. Results of the analyses of the data generated by this investigation are presented in this chapter.

Results of data analyses are presented in three sections: (1) descriptions and analyses of personal and situational characteristics of the AUCW students participating in this study; (2) descriptive analyses of dependent variable data-collection instruments; and, (3) inferential analyses including correlational analyses and t-test results.

Since complete randomization of sample was not possible, generalizations of results should be made with caution beyond this sample group. However, an assumption resulting from this study is that the results of this treatment, the agricultural instructional model, could be duplicated in a similar formal and, perhaps, non-formal education situation.
Student Characteristics

The students of this study were, more or less, typical of the students enrolled at Ahfad University College for Women as a whole. They were all women and all Sudanese. The women in this study ranged in age from 18 to 32 years, with 22.4 years being the mean age. In analyzing the family backgrounds of the students it was found that they were from households that had a range of two to 17 people, the mean being 8.3 people per household. The students, on the average, each had four brothers and three sisters.

Table 1. Continuous descriptive variables of second and fourth year students

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Overall Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brothers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4th year class</td>
<td>13</td>
<td>3.85</td>
<td>1.77</td>
<td>3.56</td>
</tr>
<tr>
<td>2nd year class</td>
<td>19</td>
<td>3.42</td>
<td>2.54</td>
<td></td>
</tr>
<tr>
<td>Sisters</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4th year class</td>
<td>13</td>
<td>3.38</td>
<td>1.76</td>
<td>3.16</td>
</tr>
<tr>
<td>2nd year class</td>
<td>19</td>
<td>3.00</td>
<td>1.89</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4th year class</td>
<td>13</td>
<td>23.08</td>
<td>2.33</td>
<td>22.44</td>
</tr>
<tr>
<td>2nd year class</td>
<td>19</td>
<td>22.00</td>
<td>3.46</td>
<td></td>
</tr>
<tr>
<td>Number in Household</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4th year class</td>
<td>13</td>
<td>7.69</td>
<td>3.01</td>
<td>8.34</td>
</tr>
<tr>
<td>2nd year class</td>
<td>19</td>
<td>8.79</td>
<td>3.41</td>
<td></td>
</tr>
</tbody>
</table>
Table 2. Number of students married, number employed outside the home, number with a sibling in agriculture, number of students whose families own their homes, and religious preference of students

<table>
<thead>
<tr>
<th>Class</th>
<th>Married</th>
<th>Parent's House</th>
<th>Employed Previously</th>
<th>Sibling(s) in Agriculture</th>
<th>Religion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
<td>Own</td>
<td>Rent</td>
<td>Yes</td>
</tr>
<tr>
<td>4th year</td>
<td>3</td>
<td>10</td>
<td>12</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>2nd year</td>
<td>4</td>
<td>15</td>
<td>12</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>7</td>
<td>25</td>
<td>24</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>%</td>
<td>21.9</td>
<td>78.1</td>
<td>75</td>
<td>25</td>
<td>25</td>
</tr>
</tbody>
</table>
Seven out of the 32 students of this study were married, representing 21.9 percent of the sample. All of the students in the fourth year class, except one, had pending engagements and/or marriages. The majority of students, 87.5 percent, were Muslim with the others professing Christianity. Few students, 15.6 percent, had a sibling or siblings in agriculture, either employed or in school. Twenty-five percent, or eight out of the group of 32, had worked outside the home either for remuneration or as a volunteer. Indicative of their upper socio-economic backgrounds, the majority of the sample, 75 percent, had parents who owned their own houses. These data are more specifically broken down by class in Table 2.

All of the students came from similar educational backgrounds before entering college, having attended primary and secondary school in Sudan. Only two of the students had ever received any previous education or training in agriculture before receiving the treatment of this study. However, the fourth year class had studied Botany or another biological science in a previous year at AUCW whereas the second year class had not yet received that instruction. The previous education in science was not significant as far as influencing or improving results of the treatment.

Table 3. Previous education/training in agriculture or science

<table>
<thead>
<tr>
<th>Class</th>
<th>Agriculture</th>
<th>None</th>
<th>Botany or Bio. Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>4th year</td>
<td>2</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>2nd year</td>
<td>0</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>2</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>%</td>
<td>6.2</td>
<td>31.3</td>
<td>62.5</td>
</tr>
</tbody>
</table>
There was considerable variation in the educational background of the students' parents. Most of the mothers of the students had no education whereas the majority of the students' fathers had received primary and secondary education. A further breakdown of the parents' education can be found in the following table.

Table 4. Education of students' parents

<table>
<thead>
<tr>
<th>Level of Education</th>
<th>Primary</th>
<th>Primary &amp; Secondary</th>
<th>College</th>
<th>Graduate School</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fathers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4th year</td>
<td>1</td>
<td></td>
<td>7</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>2nd year</td>
<td>6</td>
<td>7</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>7</td>
<td>14</td>
<td>6</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>%</td>
<td>21.9</td>
<td>43.7</td>
<td>18.8</td>
<td>9.4</td>
<td>6.3</td>
</tr>
<tr>
<td>Mothers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4th year</td>
<td>6</td>
<td></td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2nd year</td>
<td>6</td>
<td></td>
<td>2</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>%</td>
<td>37.5</td>
<td>15.6</td>
<td>3.1</td>
<td>0</td>
<td>43.8</td>
</tr>
</tbody>
</table>

Reflecting a society basically closed to women, all of the students' mothers were housewives and had little education. The students' fathers' occupations fell into the categories of: (1) businessman/merchant, (2) farmer, (3) teacher, (4) politician, and (5) government worker. The breakdown of this information can be found in Table 5.
Table 5. Occupations of students' fathers

<table>
<thead>
<tr>
<th>Occupation</th>
<th>4th year</th>
<th>2nd year</th>
<th>Total</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Businessman/Merchant</td>
<td>7</td>
<td>10</td>
<td>17</td>
<td>53.1</td>
</tr>
<tr>
<td>Farmer</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>12.5</td>
</tr>
<tr>
<td>Teacher</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>9.4</td>
</tr>
<tr>
<td>Politician</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>3.1</td>
</tr>
<tr>
<td>Government worker</td>
<td>3</td>
<td>4</td>
<td>7</td>
<td>21.9</td>
</tr>
</tbody>
</table>

The question of occupation or job preference upon completion of their formal education was asked of the students at three different times. Their responses were not consistent at the different times. In Table 6 the sequence of the question of occupation is presented with the various responses. The variability and uncertainty of direction that it reflects is believed to be an indicator of the lack of profession and career-orientation exhibited by the women of the restrictive Sudanese society.

One student response to the first occupation questioning was missing. From this information we can see how the students fluctuated in their responses as to what they planned to do upon completion of their formal education. The category of teacher illustrates this fluctuation as we can see that five students indicated this as a career choice the first questioning, six students at the second questioning, and nine students at the third questioning. The point illustrated by this category as by the others is that the students were confused as to what their professional and occupational choices and opportunities were.
Table 6. Student occupational choices at three different questionings

<table>
<thead>
<tr>
<th>Category</th>
<th>First questioning</th>
<th>Second questioning</th>
<th>Third questioning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher</td>
<td>5</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Work in a Government Ministry</td>
<td>2</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Work in a Hospital or Health Center</td>
<td>1</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Housewife</td>
<td>6</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Other</td>
<td>17</td>
<td>7</td>
<td>11</td>
</tr>
</tbody>
</table>

Students were questioned as to whether their families had ever raised chickens or had a vegetable garden. The majority of students in this study, 84.4 percent, were from urban areas (Table 8) of Sudan by their own definition. This may have had some bearing on their families' decision to undertake a vegetable garden or poultry operation at their homes. With eggs and poultry being difficult food items to procure at the market, where the supply was irregular and of questionable quality, it was not surprising that 46.8 percent of the students' families had raised poultry at some time with varying degrees of success (Table 7). The extreme heat and disease were responsible for the greatest loss of poultry. On the other hand, very few of the students' families, 12.5 percent, had cultivated vegetable gardens at their homes. This lack of vegetable gardening could be attributed to two causes: (1) vegetables were not a mainstay of the diet as was meat in the northern part of Sudan, and (2) most of the students, having lived in urban areas, primarily Khartoum Province, had access to the market or souk which made it easy for them to purchase desired, available vegetables.
Table 7. Families of students with poultry and vegetable gardens

<table>
<thead>
<tr>
<th>Class</th>
<th>Poultry</th>
<th>Vegetable Garden</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>4th year</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>2nd year</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>17</td>
</tr>
<tr>
<td>Percent</td>
<td>46.8</td>
<td>53.2</td>
</tr>
</tbody>
</table>

Table 8. Breakdown of students from urban and rural areas of Sudan

<table>
<thead>
<tr>
<th>Class</th>
<th>Rural</th>
<th>Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td>4th year</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>2nd year</td>
<td>3</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>5</td>
<td>27</td>
</tr>
<tr>
<td>Percent</td>
<td>15.6</td>
<td>84.4</td>
</tr>
</tbody>
</table>
To complete the description and analyses of student characteristics in this study, a summary of some of the findings follows. Though the sample could be divided by class into two groups the data collected on student characteristics indicated that there was more variation within groups than between groups. For the most part, the classification of the sample into second and fourth year students made little difference; there was no predominant difference in characteristics by group. While the fourth year students had studied Botany at AUCW and were, perhaps, a little more proficient in the use of English as a second language, these distinctions had little impact on the study. From the data presented in this section a profile of a typical student of the sample follows.

She was a Sudanese woman, single, and of the Muslim religion. She was in her early 20s, a person from an upper socio-economic family background relative to the poverty level of the majority of Sudanese, someone whose father was literate, probably educated through secondary school, and a businessman. She had about four brothers and three sisters at home and was from a more urban than rural area of the country, probably Khartoum Province. Being a college student she was more educated and had more freedom than the vast majority of her countrywomen. The changing times, influence of the West, and new emerging roles for women in her country made for conflict with her religion, strong traditions, and cultural mores and taboos. Her mother was illiterate and traditional, a housewife. Her family, particularly her father, encouraged and facilitated her education. Prior to Ahfad University College, her education consisted of primary and secondary school. At AUCW the home science curriculum she was enrolled in consisted of home economics, textiles, mathematics, English, diet and nutrition, Arabic, and other related subjects. A course in food production and gardening was a new experience for her.

Though this picture is a hypothetical composite, as a generalization it is based on the data and the author's knowledge of the student sample as a whole.
Instrument Characteristics

Reliability coefficients were computed for the four instruments used to collect information on the dependent variables. Both the pretest and posttest knowledge inventory responses were analyzed as were the pretest and posttest attitude inventory responses.

Reliability can be called the accuracy of a measuring instrument. A test must be reliable to be interpretable; there can be no good scientific results without reliability but high reliability is no guarantee of good scientific results. Hence, reliability is a necessary but not sufficient condition of the value of research results and their interpretation. A large error variance of items on a measuring instrument indicates low reliability of the measuring instrument. More items increase the probability of accurate measurement. Reliability tests, in this case, were performed to check the internal consistency of the instruments. The reliability coefficient, or reliability alpha, is reported as a decimal less than one; the whole number symbolizes the hypothetical situation of complete reliability.

All of the instruments had a reliability coefficient alpha higher than .5 which indicates good internal consistency. The knowledge inventory had the highest reliability of the four instruments with a reliability coefficient alpha of .834. The magnitude of the coefficients of reliability is evidence that the dependent variable data-collection instruments had consistency, dependability, and predictability.
Table 9. Descriptive summary of knowledge and attitude inventories

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Knowledge</th>
<th></th>
<th>Attitude</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>pretest</td>
<td>posttest</td>
<td>pretest</td>
<td>posttest</td>
</tr>
<tr>
<td>Mean Score</td>
<td>45.8</td>
<td>78.7</td>
<td>72.6</td>
<td>75.9</td>
</tr>
<tr>
<td>Reliability</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coefficient Alpha</td>
<td>0.647</td>
<td>0.834</td>
<td>0.596</td>
<td>0.603</td>
</tr>
</tbody>
</table>

Inferential Analyses

The second part of the analyses of data collected in the study was the computation of inferential statistics. T values have been calculated on the mean scores of the pretest and posttest for knowledge and for attitude with a breakdown by class. Analyses of covariance follow in further analyzing the data. Finally, the computation of Pearson product-moment coefficients of correlation was used to show the relationship of the dependent variables.

The analyses of the pretest and posttest measures were utilized along with the descriptive analyses to meet the objectives of this study. That is:

1. To evaluate, through the use of a pretest, the knowledge of nutrition and agriculture possessed by the test group before the treatment;
2. To evaluate, through the use of a posttest, the knowledge of nutrition and agriculture possessed by the test group after the treatment;
3. To evaluate, through the use of a pretest, student attitude toward agriculture before the treatment; and
4. To evaluate, through the use of a posttest, student attitude toward agriculture after the treatment.
The analysis of the data was based on the testing of several null hypotheses. The first hypothesis stated was:

\[ H_{01} : \text{There is no difference in the mean scores of the knowledge pretest and the knowledge post-test.} \]

The alternative or research hypothesis stated that the mean score of the knowledge posttest would be higher than that of the pretest. Mean scores, standard deviations, and t-values for knowledge are presented in Table 10 with a breakdown for class. The mean score of the knowledge pretest was 45.77. The posttest compared favorably after treatment indicating a substantial increase in the mean score of 78.61. The posttest score represented general improvement without specific pattern. At the .05 level of significance the null hypothesis was rejected and it was concluded that the model of instruction did increase the knowledge of the students as indicated by a higher score on the posttest.

The substantial increase on knowledge posttest scores could be attributed to a number of relevant causes. First and foremost, it is assumed that the treatment, instruction in agriculture, was responsible for increasing the students' knowledge of agriculture. In looking at some of the specific circumstances of the treatment, other factors also seem relevant either as part of the treatment or because of the nature of the situation involved.

An integral part of the instruction in agriculture was experiential learning. The students were expected to perform in the garden or in related activities conducted in the classroom laboratories for approximately 50 percent of the course. This was a new experience in itself for the AUCW students who were accustomed to only lecture. The results produced by this emphasis on application of theory were relevance and increased student interest. These factors, perhaps generated by the treatment, in addition to the treatment itself, were
Table 10. Mean scores, standard deviations, and t-values for knowledge pre- and posttest

<table>
<thead>
<tr>
<th>Class</th>
<th>Variable</th>
<th>Mean Score</th>
<th>Standard Deviation</th>
<th>T Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4th year</td>
<td>Knowledge pretest</td>
<td>47.08</td>
<td>8.93</td>
<td>-19.43***</td>
</tr>
<tr>
<td></td>
<td>Knowledge posttest</td>
<td>78.69</td>
<td>8.49</td>
<td></td>
</tr>
<tr>
<td>2nd year</td>
<td>Knowledge pretest</td>
<td>44.83</td>
<td>6.23</td>
<td>-20.60*</td>
</tr>
<tr>
<td></td>
<td>Knowledge posttest</td>
<td>78.72</td>
<td>7.99</td>
<td></td>
</tr>
<tr>
<td>4th &amp; 2nd year</td>
<td>Knowledge pretest</td>
<td>45.77</td>
<td>7.43</td>
<td>-28.08***</td>
</tr>
<tr>
<td></td>
<td>Knowledge posttest</td>
<td>78.61</td>
<td>8.22</td>
<td></td>
</tr>
</tbody>
</table>

* Significant at .05 level.
*** Significant at .001 level.
contributory to posttest results.

Students received additional reinforcement and encouragement from other teachers at the college. Two teachers started their own gardens and compost piles after the lead of the students. Some of the students were approached to sell their produce and were asked advice by others not in the course on gardening practices. Students who lived in the dormitory were involved in a communal cooking arrangement and were able to share their produce direct from the garden for the pleasure and gratification of their peers.

Another factor which may have had considerable influence on the knowledge posttest results and the general success and favorable reception of the course in general was the woman instructor. Being actively involved in demonstrations and field work, a woman instructor set the example of physical activities expected of the students. Thus, the students saw that the labor was physically possible for them as women and that an educated and respected person, i.e. a teacher, could be involved in manual labor in the field. The Sudanese show a kind respect for foreigners from the West in general and being a Western visitor as well as an instructor the author was afforded many courtesies. The students were willing and trusting from the beginning of instruction. These are all factors believed to have influenced the positive change in test results after the treatment.

The second hypothesis dealt with the attitude pre- and posttests.

\[ H_0^2: \text{There is no difference in the mean scores of the attitude pretest and the attitude posttest.} \]

The mean scores, standard deviations and t-values for the attitude pre- and posttests can be found in Table 11. Again, from the results of the t tests, the null hypothesis was rejected and it was concluded that the treatment did increase the scores of the students significantly at the .05 level.

Questions on the attitude survey fell into five categories which were: (a) instruction, (b) women in agriculture, (c) gardening and food production, (d) deterrents, and (e) professional goal.
Table 11. Mean scores, standard deviations, and t-values for attitude pre- and posttest

<table>
<thead>
<tr>
<th>Class</th>
<th>Variable</th>
<th>Mean Percentage Score</th>
<th>Standard Deviation</th>
<th>T Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4th year</td>
<td>Attitude pretest</td>
<td>71.97</td>
<td>5.48</td>
<td>-2.92*</td>
</tr>
<tr>
<td></td>
<td>Attitude posttest</td>
<td>75.38</td>
<td>4.39</td>
<td></td>
</tr>
<tr>
<td>2nd year</td>
<td>Attitude pretest</td>
<td>72.98</td>
<td>5.06</td>
<td>-3.39**</td>
</tr>
<tr>
<td></td>
<td>Attitude posttest</td>
<td>76.21</td>
<td>4.68</td>
<td></td>
</tr>
<tr>
<td>4th &amp; 2nd year</td>
<td>Attitude pretest</td>
<td>72.56</td>
<td>5.18</td>
<td>-4.55***</td>
</tr>
<tr>
<td></td>
<td>Attitude posttest</td>
<td>75.86</td>
<td>4.51</td>
<td></td>
</tr>
</tbody>
</table>

* Significant at the .05 level.
** Significant at the .01 level.
*** Significant at the .001 level.
In general, the responses of the students on both the pretest and posttest indicated a favorable attitude toward instruction in agriculture. The posttest responses were slightly more positive where there was a change. The students were almost evenly divided on both the pretest and posttest on statement #7. It stated:

7. Field activities are generally too strenuous for women.

On the posttest 37.5 percent of the sample disagreed and 37.5 percent agreed with this statement; 15.6 percent strongly agreed whereas 6.3 percent strongly disagreed. Similarly, responses to statement #20 were split with roughly half the students agreeing and half disagreeing with

20. There is just too much hard work in farming for women.

On the pretest, 43.8 percent of the students agreed with or were undecided on the statement:

12. If a girl's father has a limited income which does not enable him to educate both his boys and girls, he should choose to educate the boys.

This changed to 34.4 percent in agreement or undecided on the posttest. Some students who originally disagreed indicated stronger disagreement on the posttest.

In the beginning of the school year 22 of the students believed

13. Women in rural areas of Sudan make a substantial contribution to agriculture.

as indicated by their agreement on the pretest. This increased to 28 students at the time of the posttest.

The students indicated a split response in feeling to the statement

16. Women should be more concerned about preparing food than producing food.

The posttest results yielded 15 students in agreement and 16 in disagreement with one student undecided. The preparation of food for the family consumes the greater part of each day for Sudanese women who do not have modern appliances, time saving devices, or means of
storing and saving food.

All of the students agreed, or strongly agreed, on the posttest that

17. Educational programs for women should not concentrate on home economics only but should include training in agriculture, animal husbandry, and other employment-oriented subjects.

This represented a slight change from the pretest where five students were in disagreement. However, in the final assessment 11 students agreed that

23. There are no professional opportunities in Agriculture for women in the Sudan.

Seventeen disagreed with this statement while four were undecided. This bears out the conclusion in the descriptive analysis that students were unclear as to the professional opportunities that existed and the choices available to them. The majority, 84.4 percent, of the students on the posttest felt strongly that

26. Growing one's own food is a good idea.

Similarly, on both the pre- and posttest most students felt food produced in the kitchen garden was more nutritious than food bought at the store.

At the end of instruction there was a change in students' feelings about the statement

30. Working with crops and soil is basically for people without education.

Originally, only 17 students were in disagreement; however, this changed to 24 students, mostly in strong disagreement, after the treatment.

The students had a strong positive attitude toward gardening. There was general agreement on both pre- and post-treatment measures on the statements

32. It is better to be independent by growing your own food than dependent upon someone else to provide it.
33. If more people know how to produce food there will be less hunger in the world.

35. Gardening and farming can provide much happiness and satisfaction as well as food.

By the end of the course the feeling was just about unanimous to the statement

36. I would like to grow enough food for myself and my family even though it means hard physical work.

Likewise, practically all were in agreement, after the treatment, with statement #37 which stated

37. Government should provide educational programs for women in agriculture.

So, while the students were split between agreement and disagreement on certain statements both before and after treatment, the mean score of 75.86 on the posttest showed a positive change over the pretest mean of 72.56. Students seemed to have basically positive attitudes about gardening and food production; they were divided in their feelings on the physical capabilities of women and the physical requirements in farming and gardening; and, they all felt education for women should include training in agriculture and employment-oriented subjects and the government should specifically make this available to women.

In order to identify differences between the mean knowledge posttest scores based on class, a third null hypothesis was tested. This hypothesis stated:

\[ H_0^3: \text{There is no difference in the mean knowledge posttest scores of the second and fourth year classes controlling for knowledge pretest.} \]

The research or alternative hypothesis stated that there was a difference in scores between the second and fourth year classes. An analysis of covariance of the difference between the knowledge posttest mean scores by class, adjusted for knowledge pretest, revealed an F-value of .50 which was not significant. These data, presented in Table 12, failed to reject the third null hypothesis. Our con-
Table 12. ANOCOVA for the knowledge posttest by class adjusted for the knowledge pretest

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge pretest</td>
<td>1</td>
<td>818.41</td>
<td>818.41</td>
<td>20.57</td>
</tr>
<tr>
<td>Class</td>
<td>1</td>
<td>19.96</td>
<td>19.96</td>
<td>0.50</td>
</tr>
<tr>
<td>Residual</td>
<td>28</td>
<td>1114.01</td>
<td>39.79</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>1952.39</td>
<td>65.08</td>
<td></td>
</tr>
</tbody>
</table>

Table 13. ANOCOVA for the attitude posttest by class adjusted for the attitude pretest

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitude pretest</td>
<td>1</td>
<td>265.27</td>
<td>265.27</td>
<td>21.60</td>
</tr>
<tr>
<td>Class</td>
<td>1</td>
<td>0.44</td>
<td>0.44</td>
<td>0.04</td>
</tr>
<tr>
<td>Residual</td>
<td>28</td>
<td>343.86</td>
<td>12.28</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>609.57</td>
<td>20.32</td>
<td></td>
</tr>
</tbody>
</table>
clusion was that the mean scores of both classes on the knowledge posttest were essentially the same.

A fourth null hypothesis was postulated concerning attitude posttest scores between classes.

\[ H_{04} : \text{There is no difference in the mean attitude posttest scores of the second and fourth year classes controlling for attitude pretest.} \]

Again, analysis of covariance was used to determine the difference of posttest mean scores adjusted for the pretest. An F value of .04, as presented in Table 13, was not significant. Therefore, there was insufficient evidence to reject the null hypothesis and, indeed, there was no difference in mean attitude posttest scores between classes.

From these analyses, it may be concluded that the two classes which comprised the sample, while being distinct and different, were statistically equivalent in their knowledge and attitude of agriculture following the treatment.

The Pearson product-moment coefficients of correlation were computed to measure the relationship between scores of the attitude pretest, attitude posttest, knowledge pretest, and knowledge posttest. Table 14 presents this information.

The highest correlation existed between the knowledge pretest and posttest followed by the attitude pretest and posttest. These correlations indicate a good test-retest reliability of the knowledge and attitude inventories.

All of the six coefficients of correlation shown in Table 14 were found to be statistically significant. The positive intercorrelations suggest that students tended to score similarly on all of the four criterion tests. Coefficients were relatively large; they ranged in value from .3067 for the correlation between the knowledge pretest score and the attitude posttest score to a highly significant
Table 14. Pearson Correlation Coefficients of Pre- and Posttests

<table>
<thead>
<tr>
<th>Variable</th>
<th>Knowledge Pretest</th>
<th>Attitude Pretest</th>
<th>Knowledge Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude pretest</td>
<td>.5767***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge posttest</td>
<td>.6474***</td>
<td>.6149***</td>
<td></td>
</tr>
<tr>
<td>Attitude posttest</td>
<td>.3067*</td>
<td>.6597***</td>
<td>.5385***</td>
</tr>
</tbody>
</table>

*Significant at .05 level.
**Significant at .01 level.
***Significant at .001 level.

...coefficient of .6597 for the correlation between the attitude pretest and the attitude posttest measures.

Summary of analyses

The knowledge scores and attitude scores were significantly higher for the posttest than the pretest. This indicated that knowledge of agriculture and attitude toward agriculture increased and became more positive, respectively, during the treatment phase for the combined group of students. From the analyses of covariance, looking at posttest scores by class adjusted for pretest scores, the difference was not statistically significant. The two classes comprising the sample had statistically equivalent scores.
Summary

This study reflects an encompassing international project originated in the Fall of 1977 as the first international agricultural education venture of the Department of Agricultural Education at Iowa State University. In coordination with Ahfad University College for Women, an institution of higher education in Omdurman Sudan, the project revolved around the introduction and teaching of basic applied agriculture as a part of the home science curriculum at AUCW. This study and the work and effort it reflects focuses on women in agriculture. It is an attempt to describe, analyze, and evaluate the effectiveness of an agricultural education project involving women, specifically Sudanese women who were students at AUCW in Omdurman.

While the project as a whole aimed to improve the diets of the students and their families, to educate the students to economical means of food production and self-sufficiency, and to be diffused at the village level, the objectives of the study focused more specifically on the attitude and knowledge of the student sample toward agriculture and the changes that resulted as a result of the treatment.

The purpose of this study was to investigate the effectiveness of an agricultural instructional model of basic vegetable production presented to the second and fourth year classes at AUCW. The primary objective was to determine the effectiveness of this instruction. The secondary objectives which served as a means to to this end were:

1. To evaluate, through the use of a pretest, the knowledge of nutrition and agriculture possessed by the test group before the treatment;
2. To evaluate, through the use of a posttest, the knowledge of nutrition and agriculture possessed by the test group after
the treatment;
3. To evaluate, through the use of a pretest, student attitude toward agriculture before the treatment; and
4. To evaluate, through the use of a posttest, student attitude toward agriculture after the treatment.

Through implementation of the instructional model, the goal was to increase or reinforce the students' knowledge of general agriculture and skill in appropriate cultural practices in the garden. Likewise, a favorable attitude was fostered toward agriculture in general, food production in gardens, and women's participation in agriculture.

The classes for the study were selected by the administration of the college for this instruction. They were the second and fourth year students enrolled in the home science curriculum. The second year class was comprised of 19 students and the fourth year students numbered 13 making a total of 32 students in the sample.

The research procedure in this study involved a one group pretest-posttest research design. The method of procedure entailed three steps:
1. Administration of a pretest measuring dependent variables,
2. Application of treatment which was instruction in agriculture, and
3. Administration of a posttest again measuring the dependent variables.

The independent, experimental variable was the instructional model, including curriculum and instructional materials, developed as part of the project. It was administered in the form of a college course entitled "Food Production in the Kitchen Garden." The dependent variables were attitude and knowledge.

The course on food production consisted of nine units covering a broad spectrum of general agriculture topics. Half of the course involved scientific theory and basis for agricultural practices and was presented in lecture and classroom discussion; and, half involved the application of theory and practices during laboratory periods. An occasional field trip supplemented instruction and local specialists were
consulted as needed.

Three instruments were developed to collect the research data; (1) a questionnaire to elicit personal information on students' educational and family backgrounds and students' occupational plans; (2) an inventory to measure student knowledge of agriculture; and (3) a scale to quantify students' attitudes toward agriculture.

Data collection took place during the academic year 1978-1979 at Ahfad University College for Women in Omdurman. The pretest was administered at the end of the month of August. Treatment was administered over a two semester period followed by the posttest in mid April.

The data were analyzed to: (1) determine if significant differences existed between pretest and posttest scores on the agriculture knowledge inventory and the agriculture attitude scale; (2) determine if a significant difference existed between pretest and posttest scores by class; and, (3) determine the correlation of the variables and the reliability of the instruments.

Conclusions

Based on findings from the sample, the following conclusions were drawn:

1. The students at AUCW were interested in learning agriculture because they saw its benefits and relevance.
2. The treatment was effective as measured by the posttests.
3. Classes scored significantly higher on the agriculture knowledge and attitude posttests than on the pretests.
4. Class had little or no effect on achievement in an agricultural course of the type in this study; the second year students achieved similarly to the fourth year students.
5. Through a course of instruction in agriculture, women's knowledge and skills increase and a more favorable and positive attitude is formed toward agriculture.
Recommendations

The findings of this research identified characteristics of Sudanese students at Ahdaf University College for Women, determined positive change in attitude and knowledge of agriculture after the treatment, and revealed relationships among the variables. The following recommendations, based on these findings and personal observations, are made for further related research:

1. Similar studies should be conducted involving the agricultural education and training of women in developing countries.

2. A follow up study should be conducted in a number of years to determine the involvement of the same student sample in agriculture both professionally and domestically in the form of kitchen gardening.

3. While an institution of higher learning provides a suitable structure for introduction and teaching of agriculture, a women's college is uncommon and women represent a small minority of enrollment at universities in developing countries. Efforts should be made to reach women in other informal education situations. Some alternatives to a formal institution of higher education for women would be projects involving inservice workshops for village school teachers, extension agriculture programs geared toward women and/or entire families, and courses or units on gardening incorporated at the secondary school level.

4. Guidance services should be provided for women at the college level to help them determine professional opportunities and potential career choices.

5. Agricultural instruction must be flexible, relevant, and individualized to accommodate a wide range of educational aspirations.
REFERENCES


ACKNOWLEDGEMENTS

I would like to express gratitude to certain people for their support, guidance, and cooperation during my graduate program.

To Dr. Harold Crawford, my department head, my major professor, my mentor, my deepest gratitude is extended.

To Dr. Gary Briers, I give special thanks for his time and assistance in data analyses.

To Dr. David Williams, Dr. Thomas Hoerner, Dr. Roger Lawrence, and Dr. Irene Beavers, my appreciation is given for serving as members of my committee.

To Dr. Charlotte Roderuck and the World Food Institute, I give thanks for making this project possible by providing necessary funds.

To the women students and administration of Ahfad University College for Women, I owe many rich memories.

These individuals all contributed in their own way to my accomplishments.
DEDICATION

This dissertation is dedicated to my mother. It has been with her implicit encouragement and psychological support that I have achieved and found a way to fulfillment through my work. She has not understood my pursuits—working in Africa, working for a Ph.D., working with agriculture and agricultural mechanics, or working with women in development—but she has given me strength in everything. I owe to her more than to any other individual.
APPENDIX A: PROJECT PROPOSALS

<table>
<thead>
<tr>
<th>Proposal</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project proposal submitted to World Food Institute</td>
<td>73</td>
</tr>
<tr>
<td>Letter from World Food Institute</td>
<td>79</td>
</tr>
<tr>
<td>Proposal for project renewal</td>
<td>80</td>
</tr>
<tr>
<td>Letter from World Food Institute</td>
<td>82</td>
</tr>
</tbody>
</table>
1. TITLE: Joint project of Iowa State University, Ames, Iowa and Ahfad University College for Women, Omdurman, Sudan for the introduction of an Agricultural Education Program at the Ahfad University

2. PERSONNEL:

Cynthia L. Connolly
Typed Name

Cynthia L. Connolly
Signature
3/15/78
Date

H. R. Crawford(Major Professor)

H. R. Crawford
3/14/77

3. SUBMITTED BY:

Harold R. Crawford
Faculty Member/Signature*

Cynthia L. Connolly
Student(s) Signature(s)*

4. DATES INCLUSIVE: Present until July 1 (Phase I of project - Curriculum Development and Preparation of Materials)

5. OBJECTIVES:

1) To develop a program of study on basic agricultural techniques of home gardening for use in teaching the students of Ahfad U.C.W.
2) To procure reference materials and teaching resource materials for use in the program and/or as a supplement to it.
3) To prepare teaching and student instructional materials.

6. BUDGET: $5,500 (See addendum)

7. SOURCES OF OTHER FUNDS: Ahfad University College for Women has committed funds for living expenses, salary, and travel of the ISU staff person while in the Sudan, beginning August 1, 1978.

8. ADMINISTRATIVE APPROVAL:

Harold R. Crawford D.E.O. of Agricultural Education 3/14/78
Date

Dean/Director of

Director WFI

*Where proposal is made jointly by faculty member and students, the students advisor must sign and share responsibility for the program.

(page one must include this information only)
9. REASONS FOR UNDERTAKING THE PROJECT:
   1) Opportunity to contribute to the solution of world food problem
   2) Opportunity for research in this area
   3) An objective of Ag Ed Dept to venture into international ag education
   4) Timely opportunity to work with women in development in agriculture

10. PREVIOUS WORK AND PRESENT OUTLOOK:
    This project represents a new venture in the formal education of women in agriculture. Women play a vital role in the food production of the Sudan but have not been able to benefit from education and training, formal or otherwise, in agriculture due to limited opportunity, their demanding work-load, and tradition. This is a unique opportunity to educate women in agriculture in hopes of the future educating and training by AUCW graduates of both girls and boys at primary schools in agriculture. This project also

11. PROCEDURE: represents a commitment on the part of the Department of Agricultural Education to develop and promote international agricultural education with a perspective on the role and importance of women in development.

Phase I Preliminary Preparation (present until July 1)
   A. Curriculum development
   B. Preparation of materials

Phase II Actualization (academic year Sept. 78-Aug. 79)
   A. Implementation of curriculum materials in lectures and laboratories over 2 semesters
   B. Field work trip Dec. 15-Jan. 7
   C. In-service training at the school feeding center over the long vacation, April 15-June 30
   D. Research to be conducted - acceptance and adoption of agricultural techniques as a result of the Agricultural Education Program

Phase III Evaluation

Phase IV Revision & New Strategies

12. ADDENDUM: (Personnel vitae)
PROGRAM NARRATIVE

This proposal is a request for funds from the World Food Institute for the efforts of the Agricultural Education Department in world-food related research.

I. Objectives and Need for this Assistance

The major purpose of the project will be:

1. to help establish the tradition of kitchen gardening in villages as well as urban homes in the Sudan; and thereby
2. to stimulate the production of more foods by the people for their own domestic consumption.

The Ahfad University College for Women in Omdurman, the Sudan, has agreed to a joint project with Iowa State University for the introduction of Agricultural Education in the School of Family Sciences at the Ahfad University College for Women. They have agreed to provide financial support in the following amounts to this end:

1. Annual Accommodation Subsidy $1,500
2. Trainer's Emolument - Annual 2,400
3. Air Fare for Trainer - Biannual 600

Total A.U.C.W. Component $4,500

The plan for research and dissemination of agricultural information and methodology for the improvement of kitchen gardening will be effectuated through formal education channels at Ahfad University. The students will be instructed in agriculture in lectures and laboratories and they in turn will teach at the primary level in the surrounding villages. Of particular significance to this
project and research is the introduction of formal agricultural education to women—a phenomenon which is perhaps not very popular in our own culture but is of vital importance to potential development in the Sudan where women are integrally involved in subsistence farming and food production for the family.

II. Results or Benefits Expected

The benefits to be gained from the proposal may be classified as both general and specific. In the first category, it is with the realization of the world food shortage and the rate of population growth that the project is conceived. The eventual result will be as a stimulant and realistic influence in the following areas:

1. Consumer patterns of food supplies in the Sudan.
2. Socio-economic attitudes toward feeding, e.g. balanced diet, production of the kitchen garden, education and training of women in production.

The specific benefits to be realized will emerge in the following ways:

1. A liaison built on cooperative effort will have been established between ISU and AUCW in the Sudan.
2. Through this project and its duration the relationship between universities will enhance the education at both and assist in the development and improvement of programs in international agricultural education and research.
3. A model of curricula pertinent to basic agricultural education in an underdeveloped country will be prepared.
4. Research related to the world food situation will be conducted.
5. (continued from page 1) - Budget

**Additional Funding Requested 1978-1979**

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
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<tbody>
<tr>
<td>Supplies &amp; Equipment for first year of program</td>
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<td>Postage &amp; Air Freight</td>
<td>350.00</td>
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<td>Supplemental living expenses for instructor ($100/mo.)</td>
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<td>Travel (Ames - London $325.50</td>
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<td>Khartoum - Ames $835.00</td>
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<td>Clerical &amp; Artistic Assistance (July 1 - July 15)</td>
<td>300.00</td>
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<td><strong>TOTAL</strong></td>
<td><strong>$3,700.00</strong></td>
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</table>

6. SOURCES OF OTHER FUNDS:

Ahfad University College for Women has committed partial funds for living expenses, salary, and travel of the ISU staff person while in the Sudan, beginning August 5, 1978.

**A.U.C.W. Component:**

1. Annual accommodation subsidy $1,500
2. Trainer's emolument - annual 2,400
3. Air fare for trainer - biannual 600

**TOTAL** $4,500

In addition, the Department of Agricultural Education will provide a 1/4 Agricultural Experiment Station Assistantship to the ISU staff person ($230 per month).
BUDGET

I. Curriculum Development

Consultants:

1. Sudanese expert
   Abdel R. Bedri (tentative) 500

2. Vegetable production specialist
   To be named 500

II. Materials Preparation

Supplies and equipment 1,000

For the preparation of:

1. Teaching instructional materials:
   flip charts, pictures

2. Reference:
   library of resource and reference materials

3. Student instructional materials:
   8½" x 11" subject matter handouts, student
   handbooks, lab manuals

Clerical and Artistic Assistance 2,200

To prepare teaching and student instructional materials

Duplication and Printing 700

   Student instructional materials

Postage 100

Reference Materials and Resources 500

Total $5,500
April 17, 1978

Dr. Harold Crawford  
223 Curtiss Hall  
Iowa State University  
Ames, Iowa 50011  

Dear Dr. Crawford:

The Project Review Committee of the World Food Institute has recommended that the joint project between Iowa State University and the Ahfad University College for Women in the Sudan be funded. However, the reviewers excluded the consulting fees to be paid to Sudanese students from your proposed budget. If translation of educational materials is necessary, that service could be charged to the project. Therefore, the World Food Institute will support the development of a program of study and instructional materials for the "Introduction of an Agricultural Education Program at the Ahfad University".

It is my understanding that Cynthia Connolly will not only develop the program on basic agricultural techniques of home gardening and the materials for it, but will also implement the program at Ahfad University College for Women. Because expenditures at Iowa State University will end by 30 June 1978, we will not establish a separate account for you. Instead, please use the World Food Institute account 701-28-10-28-0000 plus Crawford in parenthesis after the account number so that we can identify items ordered for your project. The amount granted for your use is $4,500.00 (plus translation costs if appropriate).

I am pleased that you are initiating a study that addresses agriculture and women in development. The USAID currently is emphasizing the need to consider the role of women in development, so funding for continuation of the project in the Sudan should be given favorable action by USAID.

If you have any questions, please contact me or my secretary at 4-7699.

Sincerely,

Charlotte E. Roderuck  
Director

cc: Lee Kolmer  
    Richard Willham  
    Cynthia Connolly
1. TITLE: Joint Project of Iowa State University, Ames, Iowa and Ahfad University College for Women, Omdurman, Sudan for the introduction of an Agricultural Education Program at the Ahfad University.

2. PERSONNEL:

   Cynthia L. Connolly
   Typewritten Name

   Cynthia L. Connolly
   Signature

   216 Curtiss Hall
   Campus Address

   6/30/78
   Date

   Harold R. Crawford
   Signature

   223 Curtiss Hall
   Campus Address

   6/30/78
   Date

3. DATES INCLUSIVE: July 1, 1978 - July 1, 1979

4. OBJECTIVES:

   1) To continue development of the program of study on basic agricultural techniques of kitchen gardening for use in teaching the students of Ahfad U.C.W.
   2) To procure reference and teaching materials for use in the program as the need arises during the course of the year.
   3) To enable communication and transference of necessary information between Iowa State University and Ahfad University College for Women.
   4) To provide for supplemental support of an Iowa State University staff person to act as instructor & liaison to Ahfad Univ. for academic year 78-79.

5. BUDGET: (divide into current expenses, salary, equipment, travel, and expenses in foreign countries, if applicable)

<table>
<thead>
<tr>
<th>1978 WFI Allocation</th>
<th>WFI Funds Expended</th>
<th>Additional Funding Requested 78-79</th>
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<tr>
<td>$4,500</td>
<td>Curriculum materials &amp; development $1,148.20</td>
<td>$3,700.00</td>
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<td>Clerical Assistance 533.75</td>
<td>(see page 3)</td>
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<tr>
<td></td>
<td>Honoraria &amp; Misc. 31.00</td>
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<tr>
<td></td>
<td>$1,712.95</td>
<td></td>
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</tbody>
</table>

6. SOURCES OF OTHER FUNDS:

   (see page 3)

7. ADMINISTRATIVE APPROVAL:

   Harold R. Crawford
   D.E.O. of Agricultural Education

   John Olm
   Dean/Director of Agriculture

   Director, WFI

   7/3/78
   Date

   7/3/78
   Date

   (page 1 must include this information only)
8. EXPLANATION OF LINKAGE DEVELOPMENT if project is involved with a foreign country:

With the support of the Department of Agricultural Education, this project and related research will be linked to an Agricultural Experiment Station project -- a study of women in agriculture in the United States. Cultural and attitudinal similarities and contrasts as well as knowledge of agriculture are variables being scrutinized in relation to women.

9. SUMMARY OF WORK TO DATE (relate to objectives):

1) An outline of the course of study for introduction at A.U.C.W. has been established for the first year of the program, 1978-79.
2) Reference and resource materials for use in the Sudan have been collected and compiled in a file system.
3) Essential hand tools have been procured in conjunction with the planned instruction.
4) Teaching and student instructional materials are still being developed.
5) Preparation of the ISU staff person for travel to the Sudan (passport, immunizations, visa) is underway.
Dr. Harold Crawford  
223 Curtiss Hall  
Iowa State University  
Ames, Iowa 50011

Dear Dr. Crawford:

The Project Review Committee of the World Food Institute recommended approval of your request for renewal of the joint project between Iowa State University and Ahfad University College for Women in the amount of $3,191.00 to be allocated as follows:

- Travel (Ames to London to Ames) $ 651.00
- Salary Supplement ($100/month) $1,000.00
- Current Expenses $1,540.00
- $3,191.00

This letter confirms our telephone conversation today on adjustment in the budgetary items you had requested. The travel must be paid from the World Food Institute account 400-28-10, while the other items will be paid from state funds. When you process Cynthia's appointment, use the account 704-23-10. (We will transfer monies to that account for her.) In addition, we will allocate $1,540.00 to the following separate current expense account for your project:

701-28-10-28-0019

As I indicated to you, I have just received five bachelor's theses from Professor Badri plus the course outlines for the degrees granted by Ahfad University College for Women. If Cynthia has time to glance through them before she leaves for Sudan, she is welcome to do so. I will have them in the World Food Institute office after 6 July.

If you have any questions, please contact me or my secretary at 294-7699.

Sincerely,

Charlotte E. Roderuck  
Director

CER:jo  
cc: Lee Kolmer  
Richard Willham  
/Cynthia Connolly
APPENDIX B: SUMMARY OUTLINE OF TREATMENT
The following is a summary outline of the course "Food Production in the Kitchen Garden." It consisted of nine units covering a broad spectrum of general agriculture topics from soils to nutrition. The units varied in length and depth depending on students' progress, local relevance, and instructor's ability. Each class met for one hour of lecture twice a week and one two hour lab period weekly. Scientific theory and the basis of cultural practices were presented and discussed during lecture periods. Subject matter handouts, prepared in the United States as part of the agricultural instructional model, coincided with each unit. Laboratories involved (1) the practical application of scientific or theoretical information; (2) students' performing different activities for skill development, i.e. transplanting, composting, soil testing, et cetera; and, (3) an occasional field trip.

Summary Outline

I. Soils

The subject matter covered in this unit included: definition, types of soil, origins, components, characteristics, soil management, soil testing, soil amendments and how to apply them, and acidity. At this time, garden plots were assigned to the students and preliminary work was begun with the soil. Students performed the following activities during the unit on soils: determined the texture of different types of soil to be sandy, clay, loam, or silt; prepared soil for seed flats; took soil samples from their gardens; performed litmus paper pH tests; performed simple chemical soil tests for Nitrogen, Potassium, and Phosphorous.

II. Fertilizer

The subject matter in this unit included compost, organic matter, mulch, methods of application, macronutrients, micronutrients, essential elements, and chemical fertilizers. Students participated in making compost and mulching their gardens. They applied fertilizer and compost
using different methods.

III. Climatic Factors

This unit included the study of the climatic factors that affect plant growth, i.e., rainfall, humidity, temperature, atmosphere, and light. Different aspects of these factors were discussed particularly in relation to their significance and relevance to plant growth in northern Sudan. Students observed and made decisions for their gardens based on the climatic factors.

IV. Plant Parts

Identification and vocabulary of plant parts and their respective functions were the focus of this unit. The parts of main concern were: roots, leaves, stems, flowering parts, and seeds. Photosynthesis, transpiration, and pollination were included. Finally, the system of binomial nomenclature was covered as the universal classification system of plants. Students collected samples of different types of vegetation and identified their parts. Seeds were collected and germination tests were performed in lab.

V. Plant Disease

Physiological diseases from bacteria, fungus, and virus were discussed. Colored photographs on subject matter handouts helped students to identify disease and disease symptoms and to distinguish differences between the signs of bacteria, fungus, and viral disorders. Specimens were collected and analyzed from the gardens. Local specialists were consulted for diagnosis. Common practices of prevention were stressed and practiced.

VI. Entomology

The subject matter of this unit included the major orders of insects of economic importance in vegetable production. Particularly, the major pests in Khartoum Province were considered. Types of insect damage and methods of control were discussed and related activities were performed.
during laboratories. Classification of insects based on type of mouth parts, metamorphosis, and development according to the system of binomial nomenclature was included in this unit. Colored photographs on subject matter handouts helped students to identify various pests. Students collected insects found in the gardens and analyzed them in lab.

VII. Poultry

A brief unit on poultry was included in the curriculum because of its relevance and interest to the students. Origin, external characteristics, digestive tract, and nutritional requirements of chickens were discussed in lecture. Students went to see different types of local housing and equipment and discussed the benefits and disadvantages of them. They were able to handle and work with poultry in the laboratory. Different local breeds and adaptive qualities were discussed. Common diseases were discussed; prevention and control of disease through sanitation was stressed.

VIII. Agriculture in Sudan

This unit dealt with highly mechanized irrigated agricultural schemes underway in Sudan. Topics included cash crops, regional food supplies, and potential for agricultural production. Cultural practices on a small scale were discussed and related to work in the kitchen garden. Farmers were observed throughout the year working small plots of land along the Nile.

IX. Nutrition

The nutritional value of different vegetables was discussed. Their importance in a healthy diet was stressed. The safe processing, storing, and preparation of garden foods was discussed; students brought different samples to class.
Figure 3. Fourth year class.

Figure 4. Fourth year class lab.
Figure 5. Preparation of seedflats.

Figure 6. The classroom.
Figure 7. Second year student preparing her garden.

Figure 8. Second year class lab.
Figure 9. The harvest: eggplants.

Figure 10. Second year class.
APPENDIX C: INSTRUMENTS FOR DATA COLLECTION

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Page</th>
</tr>
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<tbody>
<tr>
<td>Personal data questionnaire</td>
<td>92</td>
</tr>
<tr>
<td>Attitude questionnaire (pretest-posttest)</td>
<td>95</td>
</tr>
<tr>
<td>Knowledge questionnaire (pretest-posttest)</td>
<td>99</td>
</tr>
</tbody>
</table>
Personal Data Questionnaire

I. Professional Goals

II. Educational Background

III. General Information
1. What occupation (job) do you plan to enter upon completion of your formal education?

____________________________________________________________________________________
____________________________________________________________________________________

2. Have you ever studied Agriculture before? Please explain the circumstances.

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

3. Describe your educational background before coming to Ahfad University College.

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

4. What is your father's occupation?

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

5. What is your mother's occupation?

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

6. Did your father go to school?

   ____ yes
   ____ no

   If "yes", what is the highest level of education he completed?
7. Did your mother go to school?
   ____ yes
   ____ no
   If "yes", what is the highest level of education she completed?

8. How many brothers do you have?____________________________

9. How many sisters do you have?____________________________

10. Do you have any brothers or sisters who work in agriculture?
    ____ yes
    ____ no

11. I live in __________________________(name of town or village)

12. My age is ______.

13. I was born in __________________________(name of town or village).
Attitude Questionnaire (pretest-posttest)

I. Instruction
   Questions #1 - #10

II. Women in Agriculture
    Questions #11 - #25

III. Gardening and Food Production
     Questions #26 - #36

IV. Deterrents
    Questions #37 - #41

V. Professional Goal
   Question #42
Following is a list of statements about the Agricultural program and Agriculture in general. There are no right or wrong answers to these statements. In each case circle the number that best represents your own ideas about each statement. Be sure to answer each question.

1 - strongly disagree
2 - disagree
3 - undecided
4 - agree
5 - strongly agree

1 2 3 4 5 1. Lectures in agricultural subjects are effective means of instruction.

1 2 3 4 5 2. Demonstrations of agricultural techniques are effective means of instruction.

1 2 3 4 5 3. An instructional program in agriculture is worthwhile.

1 2 3 4 5 4. Pictures and flip charts are effective means of teaching agriculture.

1 2 3 4 5 5. An agricultural program will improve the diet of people.

1 2 3 4 5 6. There is not enough information available on modern farming and gardening for the home.

1 2 3 4 5 7. Field activities are generally too strenuous for women.

1 2 3 4 5 8. Agriculture should be taught to children in the village schools.

1 2 3 4 5 9. Studying agriculture is a good idea.

1 2 3 4 5 10. Much improvement can be made in people's health if they are taught to produce their own nutritious food.

1 2 3 4 5 11. The woman in Sudan depends on her family for everything.

1 2 3 4 5 12. If a girl's father has a limited income which does not enable him to educate both his boys and girls, he should choose to educate the boys.

1 2 3 4 5 13. Women in rural areas of Sudan make a substantial contribution to agriculture.

1 2 3 4 5 14. Boys should be taught to grow food and keep a garden in elementary school.
12345 15. Girls should be taught to grow food and keep a garden in elementary school.

12345 16. Women should be more concerned about preparing food than producing food.

12345 17. Educational programs for women should not concentrate on home economics only but should include training in agriculture, animal husbandry, and other employment-oriented subjects.

12345 18. Women should farm or grow a garden since men have more important things to do.

12345 19. It is more difficult for women to get information or training in agriculture than men.

12345 20. There is just too much hard work in farming for women.

12345 21. Sudanese women enjoy working with crops and soil.

12345 22. Sudanese women enjoy working with livestock.

12345 23. There are no professional opportunities in Agriculture for women in the Sudan.

12345 24. In Sudan, the role of women in agriculture is to provide hand labor.

12345 25. In Sudan, the role of women in agriculture is to provide management and labor.

12345 26. Growing one's own food is a good idea.

12345 27. It is easier to get good food by buying it than growing it.

12345 28. There is no prestige in farming or gardening.

12345 29. Food produced in a kitchen garden is more nutritious than food bought at the store.

12345 30. Working with crops and soil is basically for people without education.

12345 31. Everyone should know where their food comes from and how it is produced.

12345 32. It is better to be independent by growing your own food than dependent upon someone else to provide it.
33. If more people know how to produce food there will be less hunger in the world.

34. For the most part, people are not interested in farming or gardening.

35. Gardening and farming can provide much happiness and satisfaction as well as food.

36. I would like to grow enough food for myself and my family even though it means hard physical work.

37. Government should provide educational programs for women in agriculture.

38. Seedstock to plant in a kitchen garden is not available.

39. Getting fertilizer to use for food production at home is very difficult.

40. Chemical pesticides for use in a kitchen garden are difficult to obtain in the Sudan.

41. One of the greatest obstacles to kitchen gardening is not having enough money to buy necessary items to start a garden.

42. When I complete my formal education I plan to
Knowledge Questionnaire (pretest-posttest)

I. Agriculture in the Sudan
Questions #1 - #9

II. Production of Food
Questions #10 - #89

III. Diet and Nutrition
Questions #90 - #100
1. The main agricultural crop of the Sudan:
   ___ a. Sugar
   ___ b. Sesame
   ___ c. Cotton
   ___ d. Peanuts

2. The most serious growth limiting factor of plants in Sudan is:
   ___ a. Temperature
   ___ b. Sunlight
   ___ c. Humidity
   ___ d. Rainfall

3. A crop that has been grown in Sudan from antiquity is:
   ___ a. Rice
   ___ b. Date palm
   ___ c. Citrus fruit
   ___ d. Wheat

4. In the national economy of Sudan, agriculture is:
   ___ a. an important factor
   ___ b. the largest and most vital sector
   ___ c. a very small part
   ___ d. on the decline

5. The staple food crop of the country is:
   ___ a. wheat
   ___ b. citrus fruit
   ___ c. cassava
   ___ d. durra

6. The main forest product exported by Sudan is:
   ___ a. beeswax
   ___ b. gum arabic
   ___ c. lumber
   ___ d. medicinal herbs
7. The Sudan is a vast country of nearly:
   _____a. one million hectares
   _____b. one million square miles
   _____c. one million acres
   _____d. one million kilometers

8. The principal stock-raising part of the Sudan is:
   _____a. in the semi arid south
   _____b. in the bare desert extreme north
   _____c. in the tropical forests in the south
   _____d. throughout the country

9. The soil type in this area has been formed from:
   _____a. glacial till
   _____b. alluvial deposits
   _____c. ocean deposits
   _____d. loess

10. Three climatic factors which affect plant growth are:
    _____a. Nitrogen, sunlight, and rainfall
    _____b. Rainfall, soil, and temperature
    _____c. Light, temperature, and rainfall
    _____d. Soil, humidity, and fertilizer

11. The two basic types of soil are:
    _____a. Mineral and organic
    _____b. Sand and loam
    _____c. Clay and volcanic
    _____d. Coarse and fine

12. Essential nutrients for plant growth are:
    _____a. Nitrogen, hydrogen, and fluoride
    _____b. Water, light, and fertilizer
    _____c. Iron, soil, and water
    _____d. Nitrogen, phosphorous, and potassium

13. Water and air provide a plant with:
    _____a. Nitrogen, phosphorous, and potassium
    _____b. Calcium, sulfur, and magnesium
    _____c. Carbon, hydrogen, and oxygen
    _____d. Iron, manganese, and zinc
14. The pH of the soil:

   a. is needed in large amounts by the plant
   b. is not related to plant growth
   c. indicates acidity and alkalinity
   d. indicates deficiencies in nitrogen

15. The use of fertilizer:

   a. helps to chemically control insects
   b. is a means of mulching the garden
   c. adjusts the pH of the soil
   d. provides nutrients

16. Organic matter is valuable because it:

   a. is a source of nutrients
   b. destroys insects and fungi
   c. prevents erosion
   d. assists in photosynthesis

17. All of the following are sources of organic matter except:

   a. manure
   b. decomposed leaves and grass
   c. peat
   d. sand

18. Decomposition in a compost pile is most rapid if:

   a. the pile is kept dry
   b. there is little exposure to the air
   c. the pile is covered
   d. chemical fertilizer is added

19. A seed should be planted at a depth of about:

   a. twice its smallest diameter
   b. 3"
   c. 1"-2" depending on the soil
   d. ½"

20. Each week during the growing season the garden requires the equivalent of about _________ by rainfall or irrigation.

   a. one liter of water
   b. one inch of water
   c. as much water as possible
   d. enough water to wet the soil surface and plant leaves
21. The purpose of fertilizing the soil is:
   ____ a. to improve the soil texture
   ____ b. to enrich it and make it more productive
   ____ c. to add nitrogen, phosphorous, and potassium
   ____ d. to supply nitrogen

22. Probably the most physical part of vegetable gardening is:
   ____ a. planting
   ____ b. preparing the soil for planting
   ____ c. weeding
   ____ d. harvesting

23. Most vegetables grow best on a soil that has a pH:
   ____ a. between 5.5 and 6.5
   ____ b. 7.0
   ____ c. 7.1 or above
   ____ d. 6.9 or below

24. Most plant diseases are caused by:
   ____ a. mineral deficiencies
   ____ b. bacteria, fungi, and viruses
   ____ c. too much water
   ____ d. temperature extremes

25. A 12-8-4 fertilizer has:
   ____ a. 12 pounds of plant food and is to be applied at 8:00 a.m. and 4:00 p.m.
   ____ b. nitrogen, calcium, phosphorous and other essential elements for plant growth
   ____ c. 12% N
       8% P₂O₅
       4% K₂O
   ____ d. enough plant food for a garden that is 12' x 8' for the top 4" of soil

26. Clay soil is:
   ____ a. fine particled, heavy, and tightly-packed
   ____ b. large particled, gritty, and loose flowing
   ____ c. medium particled and textured
   ____ d. muck or peat
27. To correct the pH in a soil that is too acid, _______ can be added in recommended amounts.
   ___ a. sulfur
   ___ b. fertilizer
   ___ c. lime
   ___ d. manure

28. Which of the following will have the largest water holding capacity?
   ___ a. sand
   ___ b. organic matter
   ___ c. silt
   ___ d. clay

29. Soils washed to their present location by rivers are called ______ soils.
   ___ a. clay
   ___ b. alluvial
   ___ c. loess
   ___ d. sandy

30. Soil of silt sized particles moved to their present location by wind are called:
    ___ a. clay
    ___ b. alluvial
    ___ c. loess
    ___ d. sand

31. The three major elements in a fertilizer are:
    ___ a. Nitrogen, oxygen, and potassium
    ___ b. Phosphorous, nitrogen, and potassium
    ___ c. Carbon, oxygen, and nitrogen
    ___ d. Calcium, nitrogen, and potassium

32. Soil samples should be taken:
    ___ a. from the edge of the garden
    ___ b. from each corner of the garden
    ___ c. from the best part of the garden
    ___ d. from five areas representing the corner areas and the center
33. The largest part of photosynthesis occurs in the ________ of a plant.
   ___ a. roots
   ___ b. stalk
   ___ c. leaves
   ___ d. seed

34. Banding is a method of fertilizer application whereby the fertilizer is:
   ___ a. spread over the soil and mixed with the top few inches before planting
   ___ b. sprinkled on the plant as it grows
   ___ c. placed in a furrow alongside the seed or plant
   ___ d. mixed with water and watered into the soil

35. The following are from a leguminous plant:
   ___ a. cucumbers
   ___ b. tomatoes
   ___ c. beans
   ___ d. radishes

36. The element which produces a luxurious dark-green color in a plant and functions to increase growth is:
   ___ a. phosphorous
   ___ b. nitrogen
   ___ c. oxygen
   ___ d. potassium

37. The element which aids in transferring substances from the stalk, leaves, and other growing parts to the seed, and is usually necessary for normal flowering and fruit formation is:
   ___ a. phosphorous
   ___ b. nitrogen
   ___ c. oxygen
   ___ d. potassium

38. The element that is essential to proper development of roots and other underground tissue is:
   ___ a. phosphorous
   ___ b. nitrogen
   ___ c. oxygen
   ___ d. potassium
39. Organic matter:
   ___ a. is necessary for plant growth
   ___ b. is produced from the breakdown of soil
   ___ c. is any kind of partly or wholly decomposed vegetable or animal matter
   ___ d. appears to aid plants in resisting certain diseases

40. The ideal soil mixture for gardening, with a consistency that is somewhere between clay and sand is called:
   ___ a. loam
   ___ b. organic matter
   ___ c. silt
   ___ d. humus

41. Compost can effectively be used in all the following ways except:
   ___ a. as a fertilizer worked into the soil
   ___ b. as a mulch to keep down weeds
   ___ c. as seed-starting soil
   ___ d. as an insecticide to keep insects from destroying the plants

42. The principle function of roots is to:
   ___ a. stabilize the plant
   ___ b. gather the water soluble minerals and nutrients in the surrounding soil
   ___ c. store food for the plant
   ___ d. to assist in photosynthesis

43. Each leaf (or green surface area) contains millions of tiny deposits of a green substance called:
   ___ a. chlorophyll
   ___ b. stomata
   ___ c. shoots
   ___ d. pollen

44. Vegetables which flower and produce seed the year they are planted are called ____________. After producing their seed, this type of plant dies.
   ___ a. perennials
   ___ b. biennials
   ___ c. annuals
   ___ d. semiannuals
45. Vegetables which flower and produce seed in their second year and then die are called:
   ___a. perennials
   ___b. biennials
   ___c. annuals
   ___d. semiannuals

46. Plants which flower and produce seed year after year are called:
   ___a. perennials
   ___b. biennials
   ___c. annuals
   ___d. semiannuals

47. Plants are less likely to develop insect and disease problems if you do all of the following except:
   ___a. choose disease resistant varieties
   ___b. thin the plants so they are not crowded allowing air to circulate around them
   ___c. use good sanitation practices and get rid of debris that might have disease organisms and attract insects
   ___d. burn your garden residue annually

48. A 50 pound bag of 5-10-5 fertilizer would contain:
   ___a. 5 pounds of nitrogen, 10 pounds of phosphorous, and 5 pounds of potassium
   ___b. 2¥2 pounds of nitrogen, 5 pounds of phosphorous, and 2¥2 pounds of potassium
   ___c. 10 pounds of nitrogen, 20 pounds of phosphorous, and 5 pounds of potassium
   ___d. 5 pounds of phosphorous, 5 pounds of potassium and 10 pounds of nitrogen

49. Mulch could be defined as:
   ___a. the botanical name for the muskmelon
   ___b. a condition characterized by an over abundance of nitrogen in the soil
   ___c. a three-inch layer of organic material spread between the rows of vegetables
   ___d. an organism that lives on and derives its sustenance from another organism
50. A mulch will not:
   ___ a. kill most weeds
   ___ b. hold down evaporation
   ___ c. stabilize soil temperatures
   ___ d. cause the soil to dry out

51. Cultivation of the soil:
   ___ a. destroys weeds and aerates the soil
   ___ b. increases water evaporation from the soil
   ___ c. causes the soil to become compacted
   ___ d. adds nutrients

52. ________________ is the process by which green plants combine carbon dioxide and water in the presence of sunlight, to form carbohydrates.
   ___ a. chlorosis
   ___ b. photosynthesis
   ___ c. respiration
   ___ d. aeration

53. Hybridization:
   ___ a. destroys weeds and aerates the soil
   ___ b. is the way nature provides for the continuation of the species
   ___ c. is the result of scientific breeding techniques that search out specific qualities
   ___ d. is a process of enriching the soil

54. A cultivar is:
   ___ a. any member of the gourd family (pumpkin, squash, cucumber, melon, etc.)
   ___ b. the developed ovary of higher plants in which ripened ovules or seeds occur
   ___ c. a cultivated variety, developed by plant breeding or selection, which differs from its original botanical species
   ___ d. the growing point above the root where tops originate

55. Crop rotation is:
   ___ a. turning the seedlings at the time of transplanting so they face east and west and receive full sunlight
   ___ b. a plan that is followed whereby one crop follows another from one growing season to the next
   ___ c. placing the plants so that the tallest, such as corn, does not block the sunlight from the others
   ___ d. a method of drainage control in areas where erosion is a problem
56. All of the following are characteristics of a light soil except:

   ☐ a. does not compact easily
   ☐ b. is high in fertility
   ☐ c. has good drainage
   ☐ d. has low water holding capacity

57. Light is an environmental factor which affects plants in all of the following ways except:

   ☐ a. its intensity
   ☐ b. its length of exposure
   ☐ c. its wave length
   ☐ d. none of the above

58. Mixing organic matter with soil does all of the following except:

   ☐ a. makes looser soil
   ☐ b. makes better drainage
   ☐ c. improves aeration
   ☐ d. thwarts disease and insect attacks

59. Pumpkin, squash, watermelon, cucumber, and cantaloupe are all members of the family:

   ☐ a. Cruciferae
   ☐ b. Leguminosae
   ☐ c. Cucurbitaceae
   ☐ d. Compositae

60. Which of the following is not a means of general disease control in the garden:

   ☐ a. rotation
   ☐ b. sanitation
   ☐ c. protective sprays
   ☐ d. leaving crop residue in the field rather than composting or burning it

61. The green pea, kidney bean, snap bean, lima bean, and cowpea are members of the family:

   ☐ a. Cruciferae
   ☐ b. Leguminosae
   ☐ c. Cucurbitaceae
   ☐ d. Compositae
62. The principle disadvantage of midday watering is:
   ___ a. scorching the plants
   ___ b. shocking the plants
   ___ c. increased water loss by evaporation
   ___ d. burning the plant

63. The transfer of the male sex cells (pollen) of flowering plants to the female part (pistil) of the plant is:
   ___ a. transpiration
   ___ b. respiration
   ___ c. photosynthesis
   ___ d. pollination

64. Stomata are:
   ___ a. secondary shoots
   ___ b. pore-like openings in the leaf and stem of plants
   ___ c. the slender, coiled, fingerlike organs developed by certain climbing plants to grasp vertical structures
   ___ d. the stalk or stem of a leaf

65. The damage caused by applying commercial fertilizer directly to foliage or roots:
   ___ a. is death of the plants
   ___ b. is known as fertilizer burn
   ___ c. is loss of leaves
   ___ d. prevents growth

66. The yellowing of foliage caused by a lack of chlorophyll is a condition referred to as:
   ___ a. etiolation
   ___ b. chlorosis
   ___ c. dormancy
   ___ d. blight

67. Diseases that cause sudden spotting, wilting, or death of plants are known as:
   ___ a. blight
   ___ b. blasting
   ___ c. bolting
   ___ d. bulbil
68. All of the following may induce chlorosis except:

   ____ a. a mineral deficiency
   ____ b. excessive soil alkalinity
   ____ c. lack of moisture
   ____ d. premature harvesting

69. Biological control is a means by which:

   ____ a. plants are allowed to grow at their own rate in natural surroundings
   ____ b. harmful insects and other insects are controlled without the use of chemicals
   ____ c. the leaves or stems of certain plants are whitened by excluding light while they are growing
   ____ d. plants are propagated

70. Seeds are distributed by all of the following except:

   ____ a. air
   ____ b. animals
   ____ c. birds
   ____ d. plants

71. All of the following factors control success or failure in a vegetable garden except:

   ____ a. soil
   ____ b. water
   ____ c. temperature
   ____ d. commercial fertilizers

72. For continuous row crops, a soil sample and test should be made:

   ____ a. every three years
   ____ b. every two years
   ____ c. once a year
   ____ d. whenever a different crop is planted

73. Adding plant nutrients to the soil to increase plant growth:

   ____ a. is a recent discovery
   ____ b. was practiced by the ancient Greeks, Romans, and Chinese
   ____ c. is not widely practiced today
   ____ d. none of the above
There are _____ macronutrients (nutrients required by plants in large amounts).

a. 6
b. 5
c. 4
d. 3

The method of applying fertilizer uniformly over the soil surface is known as:

a. banding
b. broadcasting
c. integrating
d. side dressing

Growing crops and plants:

a. add nutrients to the soil
b. remove nutrients from the soil
c. replace the nutrients they use
d. do not require nutrients for normal growth

Plants require _______ elements for proper growth and development.

a. 16
b. 12
c. 10
d. 6

Many of the elements required by plants are:

a. unique to plants
b. the same as those required by animals and people
c. extremely rare
d. replaced by the plant

Whenever one or more of the essential elements for plant growth is not present in sufficient amount, plants:

a. grow the same but don't bear fruit
b. compensate by taking in more of the other elements
c. do not make satisfactory growth, or die
d. mature more quickly and die sooner

Plants take in the essential nutrients:

a. through the petioles on the leaves
b. primarily through their roots
c. through their flowering parts
d. through the stem
81. The three sources from which plants get their nutrients are:

   ___ a. birds, animals, people
   ___ b. plants, animals, people
   ___ c. soil, air, water
   ___ d. all of the above

82. The basic requirements for plant germination do not include:

   ___ a. fertilizer
   ___ b. available water
   ___ c. favorable temperature
   ___ d. oxygen

83. Nitrogen is supplied by all of the following except:

   ___ a. manure
   ___ b. legumes
   ___ c. commercial fertilizer
   ___ d. crop rotation

84. The following are reasons for failures in germination of seeds except:

   ___ a. damaged seeds
   ___ b. lack of fertilizer
   ___ c. soil or media is too wet
   ___ d. temperature is too cold

85. The removal of mineral elements from the soil by the percolating action of rainwater is known as:

   ___ a. drainage
   ___ b. leaching
   ___ c. nitrogen fixation
   ___ d. escape

86. Most of our food supply comes from:

   ___ a. water
   ___ b. soil
   ___ c. air
   ___ d. man

87. The permanent wilting point:

   ___ a. is when the plant dies
   ___ b. can be caused by overwatering
   ___ c. the point at which plants can't get enough water to recover
   ___ d. the level below which the soil is saturated with water
88. Soils with a pH of 4.6 to 5 are considered:
   ___ a. very acidic
   ___ b. a little acidic
   ___ c. alkaline
   ___ d. very alkaline

89. A pH of 8.0 to 10.0 is considered:
   ___ a. acidic
   ___ b. strongly acidic
   ___ c. alkaline
   ___ d. strongly alkaline

90. A good diet consists of:
   ___ a. plenty of food
   ___ b. meat, milk, cereal, vegetables
   ___ c. cassava or rice
   ___ d. durra

91. A good source of protein is:
   ___ a. cassava
   ___ b. durra
   ___ c. peanuts
   ___ d. fruit

92. Vitamins C and A are provided by:
   ___ a. deep green and deep yellow vegetables
   ___ b. root crops such as cassava and potatoes
   ___ c. plantains
   ___ d. meat

93. Vitamin A deficiency can cause:
   ___ a. poor vision particularly at night
   ___ b. rickets
   ___ c. coughing and body aches
   ___ d. poor digestion

94. Fruits and vegetables are more nutritionally useful to people than are:
   ___ a. fish
   ___ b. meat
   ___ c. bread
   ___ d. all of the above
95. Vegetables are:
   ___a. very high in calories
   ___b. can cause an overweight condition if eaten regularly
   ___c. are low in calories but tasty and nutritious
   ___d. often difficult to digest

96. For good digestion and healthy muscle tone in the large intestine, many vegetables provide necessary:
   ___a. fats
   ___b. carbohydrates
   ___c. roughage
   ___d. water

97. Nutritionists advise __________ serving(s) a day of vegetables and fruits, with particular emphasis on those rich in vitamins A & C.
   ___a. one
   ___b. two
   ___c. three
   ___d. four

98. Most germs that cause food poisoning are killed when:
   ___a. you eat food
   ___b. you boil, broil, or roast foods
   ___c. foods are left at room temperature for a long period of time
   ___d. you expose the food to the air after it has been in storage

99. It is a good idea to store food in the refrigerator because:
   ___a. germs in the air can't get to it
   ___b. germs can't multiply very fast if the storage temperature is 40° F. or below.
   ___c. it tastes better cold
   ___d. it stays fresh longer

100. Vitamin C deficiency can cause:
     ___a. poor vision particularly at night
     ___b. rickets
     ___c. scurvy
     ___d. headaches