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PEANUT HARVEST LOSSES IN SUDAN

By

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ABSTRACT

PEANUT HARVEST LOSSES
AND THE LABOR SKILL IN SUDAN

By

Mohammed Khogali

Peanut harvest losses may in part be due to the physiological state of the plant at harvest time, but losses are also dependent upon the skill of handling the harvesting equipment. Peanut harvesting is a complex operation requiring timely and precise practices. As the harvest becomes more highly mechanized in Sudan, more sophisticated machinery is imported to the country, creating a need for skilled labor. Good peanut production practices can often be negated by improper harvesting practices. The harvesting operation has a direct impact on the final quality and quantity of the crop produced. A very high percentage of the crop is lost annually in kind and quality in Sudan, largely due to mishandling of harvesting equipment.

The present study deals with an investigation into the causes of high percentage (30-50) of peanut losses in the mechanized schemes in Sudan. The study was conducted by investigating the problem in the field and surveying a representative sample of the skilled labor. Two main procedures were followed to collect data:

1. Field experiments.
2. Questionnaires.

The two methods are described in the study and the data for both was statistically tested and conclusions were formulated. The study was designed to test the hypothesis that peanut harvest losses are mainly contributed to by two main factors:

1. The humans who are responsible for the management and handling of farm machinery.

2. The field conditions where the crop is grown.

The questionnaire survey and field data were conducted at the Rahad since it is one of the fully mechanized schemes in Sudan.

The justification of this project was based on the potential to improve the skills of those who handle peanut harvesting machinery. The intent was to focus on the specific competencies needed by persons in direct supervision of equipment in the field.

The results lead to the conclusion that a training program is needed to improve the laborers' understanding of certain subjects and procedures. A training program guide is presented with primary focus on agricultural mechanics, crop science and management subjects.

APPROVED:

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Major Professor

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Department Chairman

Dedication

This work is dedicated to my wife who gave me all the support and moral encouragement I needed through the years. Thanks, Nafisa.

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Finally I wish to express my thanks to my friends at the Rahad Corporation and researchers who gave me the back-up support for data collection. I hope that in some way this research serves to heighten consideration of their persons toward the prosperity of Sudan.

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CHAPTER I

INTRODUCTION

1.1 Agricultural Mechanization

Sudan is an Agricultural Country with wide areas of high potential for agricultural expansion and mass production of various crops. Land development for agriculture is the general policy guide for the Sudanese economy. This agricultural development leads to more specialization, and more specifically to the intensive use of farm machinery.

Intensification of agricultural practices generally requires either major concentrations of labor, or capital required for intensive machinery use, or both. Sudan lacks the sheer numbers necessary for a labor intensive strategy and thus must pursue a capital intensive mechanized approach to its agricultural projects.

Large numbers of tractors, with the necessary implements and other farm machinery, have been imported by the Sudan government, private enterprises, and various foreign technical assistance programs. These machines are mainly used in large government projects and schemes under government supervision. The private sector is actively involved in large mechanized farms.

Mechanized peanut production started late in the 70s in Sudan and surveys have reported that mechanization of agriculture needs special attention in order to become efficient. The life span of the imported farm machinery is very short and the cost of operation is high. Mishandling of peanut machinery is considered a major problem that results in heavy crop harvest losses.

In a report to the World Bank, Duke (1975) reported "...A training program is urgently needed to train an adequate number of technicians and tractor operators..." It was noted that the losses in peanut production often are significant and reduce the efficiencies of production. Some of the factors that affect this are machine design, soil types, variety of peanuts and environmental conditions. One of the main conditions contributing to the losses results from the lack of the necessary skills and knowledge on the part of labor, concerning the production machinery, and its proper use. The peanut harvesting machinery can easily be destroyed if not properly handled. Once a machine is disabled, it is a subject of cannibalism and adds to a pile of junk.

There is a constant flow of machinery imported to satisfy the need of the progressive land development. The machinery flow is far ahead of the available skills that are needed to operate and maintain these machines. Farm machinery manufacturers are not very aware of the need for these skills. However, in some instances, they sponsor a special training school or regional training facilities. Other manufacturers send a training team out occasionally to train their dealers, personnel, maintenance people and service people. Even so, little has been accomplished.

Although there are some training centers in Sudan for tractor drivers, they have limited purpose and meager facilities. The on-the-job service training is lacking and there is a big gap of know-how between the operators of the peanut machinery and their supervisors. The technical and scientific know-how is shallow, and there is a great need to fill this gap to accomplish the production goal.

The introduction and operation of foreign agricultural machinery into developing countries creates a specific need for trained skillful supervisors and farm machinery operators. Dealers are scarce, generally too far away, and often indifferent to the needs of the machinery owners and users. This is why the Sudan government has its own training schools, although in most cases for only a limited number of operators. This situation leads to an acute need to assess the skills necessary for machinery handling personnel.

It was reported by Beasley (1963), that peanut harvesting losses in North Carolina average 3-5 percent of the total yield. By contrast, it was reported by Abdien (undated), of the agricultural engineering section of the ministry of agriculture, Sudan, that peanut harvesting losses in Sudan average 20-30 percent of the total yield. These serious yield losses could be reduced if the machinery was handled efficiently during the harvesting operation. This is one example of many malfunctioning production operations. There are no available statistics to verify the efficiencies of other major mechanized crops such as cotton, sorghum, and sesame.

1.2 Economic Importance of Peanuts

Mangelsdorf, (1961) reported that among crop plants in the world standing between mankind and starvation, peanuts rank thirteenth in importance. Peanut production now ranks in the top 10 crops of the United States, and rank second in Sudan.

McGill (1961) reported that world trade in peanuts was not very active until oil mills were developed. Peanuts are used locally for food in areas of production and are an important crop for local trade. Peanut importance in world trade has increased substantially due to its high content of digestible proteins. Peanut use as an edible food crop is expected to increase significantly because of an increased awareness of the protein shortage existing in the world. The United States is one of the few countries of the world where peanuts are grown and used extensively for domestic food use. The increase of peanut production was associated with the increase of population and the recent development of various industrial uses.

McGill (1972) reported that peanut farmers, manufacturers, and users were working diligently to stimulate interest in the worldwide utilization of peanuts. Scientists around the world are becoming increasingly aware that "peanuts," which in the past have been relished by many forms of animal life and used mainly by man for oil, are now destined to make a greater contribution toward solving the nutritional deficiencies of mankind.

Ishag (1982) reported that, in Sudan, peanuts are a major factor in the local trade. The peanut industry is expanding, and the increased production has gone into crushing for oil and the subsequent use of the vines and oil processing byproducts for animal feed. Recently, however, Sudan is moving toward more export as a cash crop.

1.3 Production for Export

To compete in the world trade a high quality product is required. Peanuts must be produced economically to achieve this goal. A developing nation that relies on revenues from agricultural products marketing must practice the basics of agricultural production. One of the objectives of this study is to define the common technical skills related to scientific crop production a technician in the field should be aware of to enable him to produce high quality.

Peanut production in Sudan has increased rapidly in the last decade. Substantial increases in horizontal and vertical production have been noted. The total area of peanut production is approximately 1.03 million hectares, Ishag (1982). Sudan has become a major peanut producer, now ranking fifth among the peanut-producing countries.

Sudan accounted for 25 percent of the world's crop export in 1974, World Bank (1975).

In terms of area planted, the three leading regions in Sudan are:

North Kordofan with 41 percent;

South Darfur with 16 percent;

Gezira and Managil with 13 percent.

With respect to production, the four leading regions are:

Gezira and Managil	40 percent
North Kordofan	15 percent
Rahad Project	12 percent
South Darfur	11 percent

The balance is widely distributed throughout the country. Peanuts have become increasingly important in the irrigated areas of Sudan. Ishag (1981) reported that the large areas of irrigated peanuts provide a stabilizing effect on peanut production which is not present in many other peanut producing areas of the world. This factor tends to make Sudan a more dependable supplier of peanuts for world trade. Sudan should capitalize on this. The quality of peanuts produced in irrigated areas should be more uniform than is the case for other areas, such as India where lack of dependable monsoon rainfall makes the size and quality of the peanut crop more variable.

1.4 Ecology

Ishag (1981) reported that peanuts are grown to 40^{o} North and South of the equator. They require abundant sunshine and warmth for normal development. For high yields and good quality, a growing period of four to five months is required. Dry weather should prevail during ripening and harvesting. When grown as a rainfed crop, peanuts need an evenly-distributed summer rainfall of at least 550 mm.

The most suitable soils are well-drained, loose, friable, sandy loams, well-supplied with calcium. Peanuts can be grown on heavier soils (like Gezira soils), but this makes the harvesting more difficult as the soil adheres to the nuts, and may stain them.

1.5 The Need for the Study

It was reported by FAO 1973, and Tyson 1982 that mechanized agriculture has a most important part to play in the economy and future development of Sudan.

The expansion of mechanized projects is the general trend in Sudan. The introduction of a variety of power machinery with the necessary equipment was noteworthy after 1970. For example, in 1975 the Agricultural Bank alone bought a consignment of 2,500 Massey-Ferguson tractors for mechanized production projects. Due to the heavy investment in farm machinery, which is all imported, there is a need for training programs to insure the effective use of these machines.

The World Bank (1978) reported regarding the "potential for yield improvement ... the main constraint in practice is the harvesting operation. By hand it is tedious work requiring much labor; while mechanical operations have shown great losses of pods left in the soil. Losses of 10 to 20 percent are not uncommon but much depends on the soil moisture at time of harvest. However for large scale production mechanical harvesting is essential. Based on the available information, a yield projection for all irrigated peanuts of 2,500 to 3,000 kg/ha appears to be feasible." The success of peanut mechanization in Sudan may depend on developing a set of recommended mechanized farming skills and on developing a training program to improve farm machinery handling in general. The World Bank (1978) concluded, "The mechanization of the harvest needs further research on types of machinery and efficency of operation."

As the institutions and agricultural projects stepped into the phase of heavy mechanization, they overlooked the proper training of technicians for agricultural modernization. The need for agricultural production technicians was not clear to the agricultural planners. Vocational agricultural research and teaching experienced some increase in general, but emphasis on farm supervision of agricultural machine operation is lacking.

In an age of food shortage, it is true that peanut production will continue to be very important to the Sudanese economy. To grow and to harvest quality peanuts, skillful operators are needed.

Training is probably the most important factor in developing a sound and efficient mechanization program.

Traditionally, on-the-job training may be adequate but most of the time it is costly and slow. Technology is changing. The difference between success and failure of mechanized farming will depend on the ability to handle and manage machines in such a way that will allow the Sudanese to compete in the world production. Large-scale farming projects will be the general way of agricultural development in Sudan for some time. The Rahad project, involving 1,200,000 ha in phase one, is one example of these projects, World Bank (1978). Even the older traditional schemes designed for family labor are now totally dependent on tractor power for most of the agricultural operations. When management provides agricultural machinery services to the farmer in large development projects, skilled and knowledgeable operators and technicians must be available. This is especially true when the farmers themselves have very little training and experience and are often being resettled.

The employment potential in these projects is high. The increased opportunities for technicians, middle managers and professionals on certain types of large and commercial farming enterprises is the basis for the present concern about the level, content and type of education that will be needed in the years ahead.

The immigration of large numbers of skilled labor and trained personnel to the neighboring rich oil countries is another serious concern.

1.5.1 The Purpose

The purpose of this study was to determine the extent of peanut losses in the Rhad irrigated fields and to project ways to reduce these losses.

1.5.2 Justification

The justification of this project was based on the need to improve and upgrade the skills of technicians and operators who handle peanut harvesting machinery. The intent was to focus on the specific competences needed by persons in direct supervision of peanut harvesting equipment operations in the field. It was hypothesized that through proper management of the peanut harvesting operation, a high percentage of peanut losses could be avoided. This loss might either reduce total yield or quality of nuts. Proper handling of machinery will save time and money. Many technicians and operators in agricultural projects in Sudan do not possess basic knowledge of peanut harvesting machinery. Therefore, they end up with high losses at harvest and machinery misuse.

1.5.3 Objectives

The main objective of this study is to identify and determine the occupational competencies and machine operation characteristics which will be necessary for use as a guide to train peanut production machinery supervisors and operators.

The specific objectives:

1. To determine skills needed by supervisors of peanut machinery and machinery operators with special attention to:

   a) Technical knowledge of machines.

   b) Scientific knowledge of plant and soil.

2. to determine the present needs of training on the basis of peanut farming for quality production with emphasis on improving the harvesting techniques.

3. to determine the effect of digging shaking speeds on peanut losses.

4. to determine the effect of soil moisture content at harvest time on peanut losses.

5. to determine the effect of different levels of plant curing and different combine cylinder speeds on peanut losses.

6. to determine the competence areas needed by technicians in peanut production; in addition to mechanical knowledge.

CHAPTER II

LITERATURE REVIEW - PART ONE

2.1 Factors Affecting Peanut Harvesting

Influence of row spacing and seed rates:

Hull and Carver (1936) stated that one of the difficulties in testing yields of experimental peanut lines with the commercial types is to obtain optimum spacing for each kind. Optimum yields were obtained for three varieties. The upright Spanish type produced optimum yields when spaced 10 to 20 cm apart, the runner growth habit produced higher yields from spacing of 15 to 25 cm, and a hybrid variety with intermediate growth habit produced the highest yields at 10 to 25 cm within row spacing.

Shear and Miller (1960) studied the influence of plant spacing of Jumbo Runner peanuts on fruit development, yield and border effect at the Tidewater Research Station in Virginia. They found that spacing as close as 15 cm between plants resulted in highest yields but retarded the rate of fruit development.

Ishag (1970) studied the optimum yield of two varieties at the Gezira Research Station (Sudan). He concluded in his studies that the largest pod yield of Ashford (Runner) was obtained at 60 cm between rows and 15 cm spacing between plants (220,000 plants/ha). While in Barberton (upright) the optimum yield was found at 40 cm between rows and 15 cm between plants (332,000 plants/ha).

Duke and Alexander (1964) found that yield of large seeded Virginia bunch-type were often higher in close rows than in standard width rows. Norden and Lipscomb (1969) reported 16 percent higher yields with bunch type peanuts planted in 46 cm rows rather than 91 cm rows.

From North Carolina, Cox and Reid (1962) reported that increasing populations of peanut plants, either by increasing the seeding rate in the rows or by decreasing the row width, led to higher yields of peanuts. They further reported that the responses to the use of close rows were often negligible at high yield levels (4,300 kg/ha or higher).

2.2 Peanut Harvest Methods

Peanuts are harvested by several methods as the situation and the crop dictates. In Sudan most of the mechanized peanut areas are harvested by the windrow method. The windrow method is best described by Duke (1960) and Ogburn, et al. (undated). In this harvesting method peanuts are dug with a digger-shaker-windrower when pods are ripe and at approximately 50 percent (wet basis) moisture content. The harvested peanuts are left in the windrow to cure for a few days depending on the weather. After partial field curing from 50 to 25 percent moisture they are combined and artificially dried in wagons to an optimum storage moisture content. In Sudan the peanuts are left in the field to dry since there is no risk of rainy weather at harvest time and the temperature is advantageously high for field curing. In peanut producing areas similar to the United States the crop is subjected to damages and losses due to inclement weather factors, birds, and rodents during the curing period. If it rains heavily, a total loss of the crop is possible. On the other hand, if it is too dry, the crop will be very brittle at harvest and high combine losses will occur. Duke (1975) reported that "... in the United States, combine harvested peanuts that are overdried (below 8 percent moisture) are generally of poor quality with reduced flavor and increased skin slippage. If overdrying becomes a quality factor in Sudan, it may be advisable to provide a type of storage that prevents overdrying ..."

2.2.1 Conventional Harvesting System

In the conventional harvesting system described by Duke (1960) and Ogburn, et al. (undated), the plant and peanuts are first dug or separated from the soil and two rows of plants are placed in an inverted windrow to expose the peanuts to the sun. The peanuts are left in the windrow until they have partially dried to a moisture content in the range of 10-25 percent. This usually takes 4-7 days. After this interval of time, risk of loss from adverse weather greatly increases, and the rate of drying in the windrow decreases.

In the digging operation, Duke (1972) found peanut losses are affected by the timing of the operation, physical conditions of the vines, soil moisture, peanut cultivar, and equipment condition and operation. Peanut losses on normal digging dates may range from 6-20 percent.

Conventional combines all employ the cylinder picking principle. Even though the pick-up mechanisms and cylinder diameters vary among models, the threshing action of shredding the vines for peanut plant separation is similar.

Depending on capacity and vine conditions, the combines are pulled through the field at 2.4 to 6.4 km/h. One windrow is picked up, and the peanuts are separated from the plant material and placed in a bulk container. The plant material is returned to the soil surface in a shredded condition. From the bulk containers the peanuts are dumped into drying trailers or trucks and are moved to the drying facilities. (On Sudan farms, the peanuts are dumped at a chosen site in the field where they are sacked and then transported to storage facilities, usually in the open.)

2.2.2 Direct Harvesting

Mills (1961) initiated research on the concept of green harvesting Virginia bunch peanuts, i.e., digging and picking in one pass through the field.

Coffelt, et al. (1973) experimented on a new method of harvesting and curing breeding seed peanuts. The objectives of research on direct harvesting have been to:

1. reduce the labor requirement;
2. maintain a high level of germination;
3. maintain varietal purity at 100 percent;

4. minimize peanut exposure to adverse weather conditions after digging;
5. eliminate the risk of pod losses or degradation as the result of adverse (too slow, rapid, etc.) windrow drying conditions;
6. reduce the potential for contamination by fungi and insects during artificial drying and storage by reducing mechanical damage during harvest; and
7. harvest under wetter field conditions than is possible using a conventional combine.

2.2.3 Limitations to Conventional Harvest

The present conventional peanut harvesting method is subject to many variables that determine its degree of successful use.

Duke (1951) summarized the factors that contribute to combine efficiency as related to losses, capacity, loose shelled kernels, and foreign material as follows:

1. General condition of peanuts and vines at harvest time depending upon:
   a) Moisture of the vines and nuts.
   b) Type of windrow, whether tight or loose.
   c) Amount of foreign material; particularly dirt, weeds and grass.
   d) Degree of brittleness of the vines.
   e) Quality of the peanuts.
2. Speed or rate of combining the windrow.
3. Method of feeding, whether uniform or intermittent.

4. Speed of the picker mechanisms.
5. Adjustments of the picking, separation, and cleaning units.
6. Type of picking principles employed.
7. Type of machine as related to make and model.

2.3 Factors Affecting Losses

2.3.1 Sowing Date

Fadda (1962) found that losses in peanut yield due to delaying sowing from June to July were high. A delay of one month in sowing resulted in a loss of more than 40 percent in pod yield, and about 50 percent loss in straw yield.

Ishag (1962) studied the effect of sowing date in two varieties of peanuts, Barberton and Ashford. The results obtained showed that the earliest sowing dates in June gave the highest yield of pods and hay. July sowing reduced the pod yield of Ashford by 42 percent and that of Barberton by 27 percent. He added further that pod yield was reduced by 70.2 percent when sowing was delayed till September.

Nur (1966) found that sowing in June produced 53.6 percent more flowers than late sowing in August. Late sowing also reduced the number of mature pods per plant by 38.2 percent.

El Ahmadi (1966-69) found that yield decreased linearly with delayed planting, and differences due to sowing dates were highly significant. El Amin (1975) reported that sowing peanuts later than the end of June prolongs the growing season and subjects the plants to heavy attack of aphids (Aphis craccivora).

A major requirement for obtaining a high peanut yield is the attainment of good field stands. This has been a major problem for growers in Sudan over the years and becomes even more critical as the control of other production factors is improved.

2.3.2 Digging Date

Young, et al. (1979) stated that field emergence is affected by quality, physical environment, and biological environment of the seed. They evaluated the maturity indices and determined the correlation between germination results and maturity index-values. They found:

1. Seed quality as evaluated by all testing methods decreased with delay in digging.
2. A high correlation between field emergence percentages and the lowest temperature to which the peanuts were subjected during the period covering three days prior to digging and the day of combining.
3. Significant interactions of digging dates with harvest methods, storage conditions, storage forms, and planting dates were found for field emergence percentages. Seed from later digging dates were more adversely affected by unfavorable treatments during other production processes.

Moore (1969) stated that: 1) the seed itself may be changed chemically or physically in such a manner that germination is either inhibited or prohibited entirely; and

2) a second possible manner in which seed quality might be adversely affected by latter digging dates is by a physical deterioration of the hull resulting in more mechanical damage to kernels during combining and subsequent processing. The studies of Wright and Mozingo (1971) indicated that the hull damage did indeed increase at the later digging dates. This might indicate more adverse reaction of seeds to mechanical injuries at later diggings.

The preceding discussions reflect the indeterminate fruiting pattern of peanuts, which produces its fruits below the ground where pod formulation and development cannot be easily observed. Consequently, to determine the exact time for digging is rather difficult. Butler et al. (1972) recommended that for maximum recovery yield, harvest should not be delayed. Also, peanuts left in the soil after maturity are more susceptible to invasion of fungi, including A. Flavus, which may produce toxins. Digging too early reduces yields, and the nuts are generally lower in quality. Duke (1970) stated that peanuts combined the same day as they are dug contain more immatures than those combined after 6-8 days in the windrow. He added that immature peanuts have no economic value, increase the cost of drying, lower the quality and grade, and are first to mold under unfavorable drying conditions. If green harvesting of peanuts becomes an alternative harvesting method, it will be desirable to remove the immatures before drying. Duke (1970) further stated that in the lots of peanuts combined the same day as they were dug: 54 percent, graded No. 1; 6.1 percent, No. 2; 17.1 percent, No. 3; and 22.8 percent were immature. This further indicates the indeterminate fruiting pattern of peanuts.

Butler et al. (1972) reported that perhaps the primary method of determining when to dig is based on observation of the color of the interior of the hull and the skin of the kernel. The Spanish-type peanut shows a pronounced darkening and veining of the interior of the pod as the fruit matures. It is generally accepted that the peanuts should be dug when 80 percent of the hulls become dark. The runner-type peanut has a less pronounced darkening of the interior of the hull and the Virginia-type even less. As a result, these are judged more on the basis of the color of the skin. For these, it is recommended that they be dug when about 67 percent of the kernels have a red skin. One of the obvious problems with this method lies in determining how dark is dark enough, and how pink is pink enough. Consequently, in practice, many producers dig when they observe their neighbors digging.

The development of a simple, objective measure of determining the optimum time to dig would allow the producer to harvest the maximum yield of top quality peanuts. The AERD and MQRD of the ARS-USDA, undertook cooperative studies with the Georgia Coastal Plain Experimental Station in 1970 to address this issue. This study put some light on the effect of peanut maturity on light transmittance through a blended extract of the examined peanut sample and methanol. This showed that as peanuts become more mature, the transmittance decreased.

From the producer point of view, in order for a method to be useful, it should:

1. be relatively inexpensive.
2. be simple to use.
3. give results in a short time.
4. be reliable.

For the farmer in the field, the color of the darkening of the hull and kernel skin color is an accepted judgment, which could be refined through experience and practice.

Sanders (1978) stated that for many years the shell-out method (SO) has been the standard for determining harvest time. By this method, all the pods, excluding those that are obviously immature, are cracked open; then, their maturities, subjectively evaluated on the basis of seed coat and internal pericarp color, are used to determine overall crop maturity.

He added that some producers still erroneously use age of the peanut plant as the sole basis for determining harvest date. A method such as the shell-out method, that indicates whether or not the crop is ready to be harvested immediately is of immense value. However, a method enabling the producer to predict the date of optimum yield would be even more useful. The producer could then manage labor and equipment with maximum efficiency at harvest. There are, of course, conditions of weather and disease that might override any prediction.

2.4 Peanut Maturity

Peanut maturity is closely related to grade, yield and money return per hectare. Woodrof (1973) reported that maturity is important to the producer because peanuts continue to grow and gain weight until fully mature. Optimum maturity is an important factor to the shellers and processor because quality grades are dependent upon maturity factors; and it is important to the consumer because kernel size, texture and color are affected by kernel maturity. Miller and Burns (1971) have developed a maturity index based on the color of the internal shell which was found to be feasible as a good index of quality and maturity. Kernel density and light transmittance of the oil at 480 nm were confirmed as good indices of quality. However, the internal hull color, kernel density and light transmittance of peanut oil were found to be significantly related.

Sanders et al., (1978) reported that the optimum time to harvest peanuts is complicated by the presence of seed at various stages of maturity on the plant at any given time, and the subteranean fruiting habit. Because of the increasing close profit margins, peanut producers must harvest the crop when the greatest proportion of high quality, sound, mature fruit are on the plant.

2.4.1 The Seed Hull Maturity Index (SHMI)

Mozingo and Ashburn (1977) have shown that the seed hull maturity index is a low cost maturity estimation method that is correlated to yield and value per hectare for selected cultivars.

Barr, et al. (1976) published a similar method which uses average kernel mass as an indicator of time to harvest peanuts.

Pattee, et al. (1967) tested and equated the correlation coefficient of the seed hull maturity index as an indicator of yield and value for Virginia-type peanuts. They found a correlation of 93 percent existed. They also concluded that a significant correlation of 98 percent between the seed hull maturity index and price per kg indicates that the peanut grower can use SHMI to estimate the price per kg he will receive at the buying station.

Mason et al. (1969) found that the changes in free ariginine were very dramatic and that its concentration was inversely correlated with maturity of peanut seed. From measurements of free ariginine content, Young (1972) developed the ariginine maturity index (AMI) to estimate the maturity level of peanut fruit and to predict the optimal digging date. Young and Hammons (1974) came to the conclusion that cultivar and harvesting time affect AMI. Hammons, et al. (1978) found that the ariginine maturity index is a better method for determining the quality of peanuts. They concluded that AMI gives a better estimation of the level of percent total sound and mature kernels (TSMK) than of pod yield. Because market value is predicted on percent TSMK, this attribute has considerable economic implications.

2.4.2 Pre- and Post-Harvest Effects

Holley and Young (1963), who used a methanol extraction procedure to remove peanut oil and read the color of centrifugal extracts at 435 nm, showed color loss to be highly correlated with peanut maturity. They also found that slowly cured peanuts produced lighter colored oil than rapidly cured peanuts.

Woodruf (1973) reported that the problem of "off-flavors" in raw and processed peanuts and peanut products has been of increasing concern to various segments of the industry. Extraneous and objectionable flavors can arise from many sources. There is a type of off-flavor which has been shown to occur whenever uncured peanuts are subjected to high temperatures. Pattee et al. (1965) found that the level of off-flavor is a function of curing temperatures, time of exposure to the temperature, moisture content, and maturity stage of the kernels.

2.4.3 The Effect of the Digging Loss

The initial peanut harvesting operation consists of digging the roots and peanuts, dislodging the soil, and depositing the inverted plants in a windrow to partially field-cure and dry before combining. Duke (1971) studied

the peanut losses that consist of pods which have separated in the uprooting, lifting and windrowing operation. Further losses may occur during the combining and curing operation. Dukes findings, after three years of experimentation, were that 80 percent of the pods lost were below the soil surface. Peanuts are indeterminate plants, and mature seed may have a long period until the crop is killed or dug out. As each peanut matures the gynophore (peg) connecting it to the plant deteriorates due to age, disease, insect damage or other causes. The quantity of peanuts lost is influenced greatly by time of digging and physical conditions of the peg and plant. Duke (1971) describes the optimum digging date as that date when the crop should be dug to give the maximum recovery yield and highest quality. Digging too early is one way to avoid high field losses but may end up with low yield and quality. Digging later than the optimum date results in higher field losses and lower recovery yield due to additional shedding of the mature peanuts.

Troeger et al. (1974) identified the factors affecting peanut peg attachment force (PAF) as:

1. variety.
2. moisture content.
3. peg dimensions.
4. maturity.

They concluded that PAF is an extremely variable characteristic. Their results indicated that variety has a significant effect on PAF. The PAF along with the size of the pod can provide a guide as to losses to be expected at harvesting. He found that peanut moisture content and maturity have an effect on PAF. The results of his tests suggest that losses will be least for less mature, high moisture peanuts. Conversely, however, these peanuts would be difficult to separate from the vines and thus may be subject to more damage because of the higher energy requirements during combining.

2.4.4 Lateral Fruit Distribution

Quantitative information about the fruiting distribution of peanuts is important. This information is very important in the degree of harvesting machinery and placement of chemical fertilizers. Wright and Steel (1971) examined the distribution histogram of a Virginia runner-type peanut versus lateral distance from the plant's tap root. They found that 36.6 percent of the fruits were produced in the center section, 20.1 and 22.1 percent were produced in the two adjacent sections, and 8.4 and 9.7 percent were produced in the next two sections from the row center. Thus 96.6 percent of the peanuts were produced within a lateral distance of 33 cm, or a bandwidth of 66 cm.

In contrast to the fruit distribution, they found that the moisture content of the fruit varied across each section with lateral distance from the plant's tap root.

The peanut fruit moisture content during the first week of curing averaged about 8 percentage points higher than the peanut fruit moisture content during the fifth week. They found that average peanut moisture content increased from about 49 percent in the center to about 67 percent in the outer sections.

The meat relationship was inverse to that of moisture content. These results illustrate quantitatively the maturity pattern of peanuts. That is, on a group basis parallel to the row the peanuts have a higher moisture content and less meat content with increase in distance perpendicular to the row center. Less than 4 percent of the total peanuts were produced outside a 66 cm bandwidth centered over the plant's tap root. Fruiting pattern information of selected varieties would be very valuable to the producer. Agricultural chemicals and granular insecticides can then be applied to a bandwidth to cover an area in which a specified percentage of peanuts is produced.

They observed that the long vine growth of runner-type peanuts tends to wrap around the plow shank of most diggers during the digging operation. This wrap retards the flow of plants through the digger and increases the possibility of peanuts being stripped off the plants. Decreasing the bandwidth from 91.4 cm (row width) to 66 cm may decrease the overall losses (stripping losses) by more than the amount being lost outside the 66 cm bandwidth.

2.5 Harvesting, Curing and the Mold Damage

Mill and Dickens (1958) reported peanuts left in the windrow to dry may be exposed to prolonged periods of adverse weather conditions that can cause heavy mold damage and high field losses.

Allcroft and Carnaghan (1963) added that mold damage has become a major concern to the peanut industry since the discovery of aflatoxin, a metabolite of Aspergillus Flavus and some other mold, which has been shown to be highly toxic to many animals.

Dickens (1966) and McDonald and Harkness (1964) generally agree that invasion of peanut pods and kernels by A. Flavus and other fungi usually occurs during curing when the variety has been dug near maturity. After lifting, peanuts are most rapidly invaded by A. Flavus during drying in windrows or stacks at 14-30 percent kernel moisture content. Austwick and Ayerst (1963) also reported that when peanuts being cured are in the general range of 15-30 percent kernel moisture content, an interruption or retardation of the field drying cycle by showers or overcast humid weather, or even prolonged contact with moisture after picking and storage, will usually result in the development of A. Flavus with subsequent toxin formation. The surge of present-day interest in mycotoxins resulted from the death of 100,000 turkey pullets on 500 farms in England in 1960. Investigation revealed the presence of a toxic fungal metabolite (aflatoxin) of A. Flavus in the Brazilian peanut meal fraction of the feed, Lancaster, et al. (1961).

Mechanical damage to peanuts that are picked by cylinder-type combines is a considerable economic importance to the peanut industry. The hull brusing and breakage exposes the kernels to mold damage and insect attack during curing and storage, McDonald and Harkness (1963).

Turner, et al. (1965) concluded that impact on peanuts reduces milling quality, by increasing broken and skinned kernels during subsequent shelling, and reduces the germination of the seed.

2.5.1 The Effect of Cylinder Impact and Cylinder Speeds

A laboratory study conducted by Turner (1963) indicated that the percentage of hull damage and loose shelled kernels (LSK) was directly proportional to the impact velocity and inversely proportional to the moisture content of the peanuts when subjected to the impact forces. Khalsa (1965) showed that peanut moisture content at harvest affected the percent of loose shelled kernels, hull damage, subsequent shelling damage, and seed germination. This indicates that as far as the hull condition is concerned, it is desirable to subject peanuts to mechanical processes involving impact forces only when they have moisture content in the vicinity of 20 percent, and to avoid such processes when moisture contents are in the vicinity of 10 or 40 percent.

Khalsa (1965) found that damage to kernels, as indicated by the tetrazolium staining technique, increased with an increase in moisture content at impact. The kernel in the end of the hull opposite the peg attachment (root kernel) was considerably more susceptible to impact injury than was the kernel at the peg attachment end (peg kernel). If considering the embryo damage only, then for all orientations and all moisture levels the damage was greater in the root kernel. It might be concluded that to avoid kernel injury, peanuts should be at low moisture levels when subjected to mechanical processes involving impact forces. This would be true if it were not for the fact that the kernels tend to split at lower velocities when the moisture level of peanuts is low. The magnitude of the velocities involved would be a factor in deciding the ideal moisture level.

Wright (1968) tested the effect of combine cylinder speeds and feed rate on peanut damage and combining efficiency. He concluded that:

1. The total losses for the slow cylinder speed were lower than the losses for medium and fast cylinder speed. Losses for the one-half normal feed rate were less than the losses for the normal feed rate. The peanut losses decreased with an increase in exposure time in the windrow.
2. Damage increased with an increase in the cylinder speed and remained fairly uniform with a change in the moisture content. Therefore, a reduction in the visible hull damage can be made by reducing the cylinder speed of the combine.
3. In general, the percentage of loose shelled kernels (LSK) increased with a decrease in the moisture content. Likewise, the percentage of LSK increased with an increase in the cylinder speed.

2.5.2 Effect of Mechanical Injury to Seeds

Mechanical injury to the seeds causes an increase in the percentage of plants with an abnormally-developed root system. Turner et al. (1963) demonstrated similar effects when the hull of a peanut was subjected to various impact velocities. Damage in terms of percent germination and abnormal root development was most prevalent with the opical kernel when the hull was stuck on the opical end.

Sullivan and Parry (1976) examined the performance of normal and abnormal seedlings in the field. They classified abnormal seedlings as those that emerged 7-10 days later than the field average, and stated that 95 percent of the abnormal seedlings had abnormal root development. Further, they reported the reduction in field yield of plants with abnormal root systems was mainly due to decreased pod set and that a high percentage of those plants in the field population could considerably reduce final yield, even though some compensation from adjacent normal plants was likely. They finally hypothesized that the amount of yield reduction associated with plants with abnormal root systems would be inversely related to plant population.

2.6 Windrow Orientation and Harvesting Damage to Peanuts

Dickens and Khalsa (1967) examined the effects of plant orientation on the drying of peanuts in windrows and the effects of windrow orientation and moisture content at time of combining on the following factors:

1. Loose shelled kernels (LSK) and pod damage caused by combining.
2. Milling quality.
3. Germination of seed.
4. Aflatoxin contamination of peanuts.

They found that the amount of LSK caused by combining decreased with an increase in moisture content at time of combining. Moisture content at time of combining or hand-picking had a significant effect on the amount of kernel damage caused by subsequent mechanical shelling. However, early work by Bailey et al. (1952) found that curing treatments had no effect either on the percentage of oil in peanuts or fatty acids and peroxide values for the oil.

For milling and processing quality, windrow orientation is a very important step to enhance the peanut quality, both for processing and for seed. Peanuts have 30-60 percent moisture when they are dug which must be reduced to 10 percent for safe storage. Windrow orientation is the first step in the process of proper curing. The methods used to dry the seed to the safe storage level have a significant effect on flavor and quality.

2.7 Aflatoxin Contamination

Kulik and Holaday (1967) defined aflatoxin as a metabolic product of several fungi. Certain isolates of *Aspergilliss flavus*, *A. niger*, *A. parasiticus*, *A. ruber*, *A. Wenkii*, *Penicillium citrinum*, and *P. variabile* produced aflatoxin. Jackson and Bell (1969) proposed the common name

"yellow mold." It is pathogenic to emerging peanut seedlings. Aflatoxin is also noticed as a dry rot and sometimes yellow-green spores are produced on infected cotyledons. Decay is most rapid when infested seed are planted where the fungus becomes active as the seed hydrate. Cotyledons of germinating seed are usually invaded first and, under favorable conditions, the emerging radicle and hypocotyle are decayed rapidly. During harvest, when the mature plants are brought above ground, the fruit becomes highly susceptible to infection by the fungi. Harvesting procedures which damage the pod or seeds, or both, greatly increase the chances of seed infection, Sargeant et al. (1961). Concealed damage caused by fungi is a serious damage and does extensive damage to farmers' crops if not carefully controlled.

Dickens and Khalasa (1967) have found less aflatoxin contamination when peanuts were combined from inverted windrows than from a random orientation. The percent germination decreased with an increase in moisture content of the pods and seed when combined.

CHAPTER II

LITERATURE REVIEW - PART TWO

2.2.1(a) Agricultural Engineering Technician Training

The importance of technicians for the success of any mechanized agricultural farming cannot be overlooked. The technical skills learned through the training programs in agricultural engineering are aimed at preparing workers to be employed in agriculture and its related services and industries. The agricultural, overall economic, and social development of Sudan will all benefit by this preparation, where benefits are part of the goal of, and in keeping with, the national development plan, Bashir et al. (1975).

Training technicians in the disciplines of agricultural engineering to serve production agriculture will be a big step forward in meeting the needs of the developing Sudan, Bashir et al. (1975).

Wilson (1968) emphasized the importance of skilled technicians by stating that it would be difficult to over-estimate the importance of the intermediate-level agricultural technician to agricultural programs in the developing countries. The technician is the key individual through whose work the results of research and technological progress are conveyed to the skilled labor and farmers and henceforth incorporated in the agricultural enterprises of every kind. If intermediate level staff are inadequate in number, or of low competence, then the agricultural services are wasted, Bashir et al., (1975). Depending on the stage of development and the principle types of agricultural practices, there is probably a need in developing countries for 5-10 times as many agricultural technicians as agricultural scientists. The technician training is fundamentally one of practical application. Not only must they be able to efficiently perform a number of skilled techniques associated with the various aspects of modern agricultural production, they must also understand the basic principles which underlie them.

2.2.2(a) The Effect of Mechanized Cropping on Training Needs

The extensive expansion of mechanized agricultural projects creates an urgent need for trained technicians and skilled labor to back up this important development change. Training programs have been started through sparcely financed facilities and inadequately programmed formats. This is the case in most of the developing countries.

In West Africa, Coulthard (1968) reports that,

> trained operators with mechanical "sense" are in short supply for the operation of tractors and machinery on present State and Research Farms. Training schools will need to be established for operators and servicemen prior to any large-scale mechanization program ... Education at all levels is one of the basic needs in all developing countries ... The elementary and secondary schooling requires considerable expansion and there is a great need for qualified teachers at this level ... there is a great need for technical scientific

> supplies and educational aids at the advanced level of education. There is a great need for skilled technicians and university trained scientists ... At the present time the greatest need is for technicians to operate the current scientific equipment, and that which is about to be introduced. Research scientists find much of their valuable time is consumed in performing routine tasks which could be carried out by skilled technicians, if they were available ... one could frequently note the lack of technical training in farm mechanization, and industry. Many schools offering science training at the secondary level and vocational or technical institutes at the advanced level are required.

In Sudan there has been a general accepted trend to introduce fairly complex and technically advanced mechanical devices in agriculture. This includes cotton pickers, peanut harvesters, and self-propelled combines. It could never be overstated that the success of such machines depends on the availability of technicians and skilled labor who will put them to an economically productive operation. Bashir et al (1975) reported that the area of technical education, should, however, be given more and special attention and empahsis if it is to play its legitimate role in development. Practically, the changes must include the curricula.

2.2.2(b) Training and Training Facilities

Kline et al. (1969) recommended the development of facilities and training in the use of farm machinery and supportive power units. They stated that the adoption of improved farming practices, including the new forms of farm power generally depends upon trained and careful operators.

Such training also plays an important role in reducing repair and maintenance costs. It is recommended, therefore, that extension services be regarded as the most appropriate training medium for small farmers, and that extension agents be provided with adequate training in agricultural mechanization. The training facilities can then be made available to farmers with adequate background to benefit from the experience.

In Sudan, facilities for training both farmers and farm operators are generally inadequate. Moreover, very few training programs are designed with due recognition of the farmer's traditional background or level of literacy, their lack of disciplined organization, or their lack of training in mechanical arts. Often extension workers are inadequately familiar with the farmer's way of life and have, themselves, insufficient knowledge about, or proper training on, improved mechanization tools and techniques.

Again it should be emphasized that training facilities in these areas can be efficiently grafted onto the operational organization of already established institutions. The burden of expensive adminstration can be avoided wherever an appropriate institution already is functioning.

Operational organizations, and/or agricultural projects now under full swing or production can be utilized for training and updating the required skills. It is also recognized that some projects are in a better position than others, and their advantage could be conveyed to other agricultural projects through training, E.L. Hassan et al. (1975).

2.2.3(a) The Need for Training

In summary, training in mechanical skills programs and agricultural machinery operation is needed because:

1. Sudan is an agricultural country and its development is based on agricultural production. There is a growing demand for qualified, experienced technicians and skilled machinery operators.
2. Technically advanced machinery was introduced in the country to backup the expanding agricultural production units. However, there are only a few schools organized to teach vocational technical skills.
3. Intermediate education is based on academic subjects and further schooling, and away from practical and occupational training.
4. Agricultural projects select their machinery operators from trainee drivers or truck drivers.
5. All machinery is imported and the cost of operation and maintenance of these machines is high because of under qualified operators, which results in frequent repairs, long delays and low productivity.
6. The life expectancy of machinery in Sudan is low because of neglect, indifference, and human deficiency in mechanical background. The lack of dealer support, scarcity of services, low operating

capital, plus a lack of understanding of the need and purpose of and preventive maintenance also contribute to this problem.

7. The availability of supplies and parts is low, and they are costly. Emergency shipments are very expensive because many must be imported. Turnover is slow, so low volume makes the cost of doing business high even though salaries and wages are low. Government licenses and regulations impede trade and discourage anything but minimal investment in sales and service facilities, and staff, to service the agricultural industry.

2.2.3(b) Facts Relating to Training Needs

1. Few people in Sudan have a mechanical background which prepares them for working with or understanding mechanical devices, machines, or gadgets so common in the life of people in the more developed countries.
2. Lack of opportunity has prevented most people from developing mechanical skills and aptitudes taken for granted in developed countries.
3. Lack of training and experience has kept people from learning the need for proper care and the value of preventive maintenance of machines.
4. Judgment and innate abilities regarding the use, selection, application, capability, and capacity of machines or devices have not yet developed.

5. Few skilled and qualified people are available to teach technicians the practical metal arts.
6. Very few skilled laborers are available who can service and repair agricultural machinery, engines and motorized equipment.
7. The inadequately trained mechanics do extensive damage when they perform major technical repair work, like engine overhaul. Sometimes it happens that they misfit a new part that will result in more damage and consequently more demand for parts; hence, frequent down time and the repair costs go up.
8. Supporting service groups such as service stations, petroleum distributors, electrical services and credit organizations are often very limited and few offer any kind of education or in-service training programs for agricultural workers. Bartlet, former director of training for the experiment station of the Sugar Association of South Africa, in answer to specific questions, made the following comments, Kline (1970):
    a) What types of training are needed?

       If it is illiterate peasant type labor which has had no previous contact with mechanized society, then the training should teach the operator only the basic elements and procedures of operating the machine.

b) What training should manufacturers or importers provide?

The local dealers should be able to have both their sales and service staff properly trained by the supply company. They, in turn, should be in a position to pass the information down the line. This training should follow the normal maintenance, operational, and service manuals provided by the manufacturers.

Training on peanut machinery should aim to improve the skills of labor, acquaint labor with the fundamentals of machinery operation, and show them how to adjust the machinery for efficient operation.

Generally, the purpose of the training program should be to educate technicians and labor of limited skill so they can attain high levels of agricultural machinery operation with minimum crop losses.

To farm more intensively and extensively the Sudan needs increased power and modern farming techniques. The key in such projects is the operator trained to use machines in ways that improve the final product.

The major problem faced by the Sudan as a developing country is that of modifying and adopting the general educational system to meet the aspirations, needs and local conditions. Sudan is mainly an agricultural country of very limited scope, and attention has not been given to educating technicians to participate in the changes which accompany mechanized agriculture.

There is a great need for intermediate technical training in agriculture. Wilson (1968) urged that skilled training be accompanied with adequate recognition for those who are qualified.

> Intermediate technical training in agriculture is meant to develop real skills in farm management, and the modern techniques of crop and animal production, etc. Let us aim to produce the skilled technician who stands in his own right as one of the indispensable elements of the agricultural profession and is not someone who is inferior to the graduate in agricultural science. Likewise, vocations training for the farmer, for rural women, for village craftsmen, and others needs to be accorded into distinctive character and dignity.

Mechanization of peanuts is fairly new to Sudan, but it is receiving more attention and high expenditures for equipment and machinery. Adequate manpower to cope with expansion is a limiting factor. The significance of this fact is clear when the efficiency of the usage and utilization of these machines is addressed. The harvest loss is high and very significant if compared to the United States, having in mind that both countries use the same type of farm machinery and most probably other similar factors prevail. Probably the main difference is the standard of skilled labor (in both countries) handling the machines. In 1975 a World Bank team of experts visited the Sudan as an advisory committee for the purchase of peanut production machinery. The following comment was made by the group leader, G.B Duke,

> ... the second greatest satisfaction I have on leaving Khartum, the capital of Sudan, was knowing that someone within the Rahad Corporation had full knowledge as to the weak link and what should be done to strengthen it. He

> and I are in full agreement that an intensive training program _must_ be initiated to train tractor operators, peanut digger and combine operators, and maintenance personnel. If this weak link is not fully developed, there will be limited profit realized from the peanut program because tractor and machinery costs will absorb the profit.

There is no documented data for the qualitative requirement of peanut production machinery training need for the future in Sudan. But, Mackson et al. (1967) describes the purpose of training as --

> The greatest problem in intelligently utilizing and applying farm machinery is adequately educating the operator. This means not only imparting knowledge and certain skills to him, but developing in him a proper attitude toward work and responsibility. He must have some understanding of why he should do certain things and why they must be done in a certain way.

2.2.4(a) _The Cost-Benefit Effects_

Mackson et al. (1970) reported that the cost and efficiency of a training program affects its ultimate adoption and its influence upon machinery operators. If trainees must be trained on an individual 1:1 basis, very few will receive training and the cost will be exorbitant. Training on-the-job adds to the cost of the production programs, but it is essential when that is the only way in which to reach an efficient standard of production.

2.2.4(b) _The Technical Program's Characteristics_

Graney (1967) pointed to five main points that characterize the nature of technical programs:

1. It is post-secondary.

2. It is essentially terminal.
3. It is related to the field of science and technology.
4. If offers intensive training in brief periods.
5. It relies heavily upon application.

2.2.4(c) Farm Mechanization Basic Training

It is suggested by many scholars and curriculum instructors, that for any practical courses it is important to limit classroom instruction to the minimum.

In a special report for FAO, Boshoff and Corbett (1965) advised that instructional media and blackboard instruction to a novice operator should be kept minimal. They emphasized more practical work, in the workshop and in the field, and to be spent in the most useful way. Learn-by-doing should be the main theme of the course work. This stresses the fact that the trainees carry out the operations themselves, rather than watching it be done. Evaluation and assessment of each trainee's progress can be obtained by proper tests.

As a conclusion for their report, Boshoff and Corbett (1965) stated that:

> More emphasis should be given to supervisor and instructor training ... and machinery manufacturers should be encouraged to assist in instructor training and to provide relevant instructional aids in the local language. More attention should be paid to training local instructors who give ad hoc and regular courses in machinery operation at the Farmer Training Centers and Farm Institutes.

2.2.4(d) Factors to Be Considered

1. All farm machinery is imported and cost hard currency.
2. Most of the spare parts and attachments are imported.
3. Proper upkeep and maintenance of the agricultural machinery is the basic rule to reduce the running cost.
4. The breakdown of agricultural machinery will decrease the production of agricultural projects.
5. Farmer and technician training is needed in machinery application, operation, maintenance and simple repair.
6. Facilities for technician and skilled labor training are both lacking and deficient.
7. The most efficient way to reduce maintenance and repair costs is to use well-trained and careful operators.
8. Very few training programs start at the laborer's or trainee's level and consider his traditional non-mechanical background and lack of disciplined training.
9. Present extension workers need practical in-service training on the selection, application and execution of planting through harvesting of crops.
10. Courses in vocational and technical schools are sometimes theoretical and have to be altered to fit the practical nature of the man in the field.

11. Established local training centers are needed for dealing with the problems of crop production and the practical aspects of using, managing, and caring for production farm machinery.

12. A comprehensive training program on the use and operation of farm machinery used to produce commercial crops should be required by project management as a basis for profitable production.

13. Farm machinery importers should be encouraged to conduct training sessions to promote the performance of their products.

14. The technician on the mechanized farms of Sudan, especially those farms that run on the tenancy basis, sometimes makes management decisions, especially during peanut digging and combining. This is due to the limited knowledge of the farmer and his frequent absence during harvest time.

15. Full mechanization of peanut production is a new technique that has been developed to reduce production expenses and overcome the bottleneck needs for hand-labor at peak of harvest.

2.2.4(e) <u>Training by Private and Semi-Private Groups</u>

Besides the official training school and vocational centers, the private sector is encouraged to have their own training centers. An example to be followed is that of the Gezira scheme in Sudan. In a special report, Pothecary (1967) states that:

> The Agricultural Engineer in collaboration with other authorities, should plan and direct specialist training facilities for managerial staff, supervisors, agricultural mechanics and tractor drivers. This training is of fundamental and vital importance to any mechanization program. Although there are many born operators, the complexity of the tractor driver's job soon reaches the stage where formal training pays off. Properly trained agricultural mechanics are equally essential ...

As mentioned earlier, properly trained supervisors and managerial staff are a basic necessity and the relative absence of training facilities for this class of personnel is a feature not only of Sudan, but of many other countries. It may be argued that training facilities exist in advanced countries for this class of personnel, but quite often the prevailing conditions there are very different from those encountered in the trainee's country of origin.

2.2.4(f) Farm Equipment Training Centers

An example of this method of training is the South American Farm Mechanization Training Center. Kline (1970) reported that in 1967 the South American Farm Mechanization Training Center (SAFMTC) was established at Buga, Colombia, under an agreement between a Colombia Government Agency, Servicio Nacional de Aprendizaji (SENA), the Massey Ferguson Company (MF) and the Food and Agriculture Organization of the United Nations (FAO). SENA assumed overall responsibiilty for the Center, while MF consigned instructional staff and equipment to FAO's "Freedom from Hunger" campaign. The project was designed to help Latin America overcome major problems in the shortage of skilled agricultural mechanization technicians.

In Sudan the facilities for training farm equipment are limited and training centers are few. Bashir (1977) reported that the centers for training of the middle level technicians and skilled labor are limited. Private and public institutions should be able to establish their own training and retraining and apprenticeship programs. This is especially needed when it is recognized that there is a continuing and rapid change in technology and systems of work.

At present there are 23 training institutions, schools and centers which cater for training in public and private sectors. These institutes provide training for all levels and specialization like industrial trades, banking, accounting, etc. But when the focus is restricted to just those involved with farm equipment, there is only one center that specializes in this trade and recently it was temporarily closed for funding reasons. This focuses more emphasis on local training efforts to be organized to solve the need for technicians and skilled labor.

2.2.4(g) Adoption of Innovations

Sudan is a developing country. New ideas and innovations are easy to accept for the management of agricultural schemes and project planners. The rate of adoption of agricultural technology is linked with progressiveness and the assurance for high returns and farm income. The aspiration of a nation for progress is a high motivation for adoption of innovations. The adoption theory conceptualizes that the use of new technology occurs in natural stages in the population depending on the new system of technology, values and other important traits of the farm population.

2.2.4(h) Investment in Human Resources

Interest in the subject of investment in human resources, particularly in the form of education and training, has become widespread within the past few years as a result of growth studies. Physical capital is usually defined to include structures, durable equipment, and commodity stocks.

Robert Baldwin (1972) added that:

> "one can broaden the concept of capital by also treating expenditures for education, job training, and health as investment outlays. Where education or health expenditures raise future earnings of the recipient, they represent investment outlays in the same sense as outlays for capital equipment. Schooling is an investment in human capital in the form of acquiring greater earning abilities.
>
> The main question that rises in treating education as an investment is whether there is a proper balance between investment in material capital -- farm machinery -- and investment in human capital -- (skilled labor and technicians). The rate of return to schooling and training can be measured in much the same way that the rate of return on a piece of capital equipment is determined. The rate of return to any schooling level can be computed by applying standard discounting procedures to the relevant cost and benefit figures. If the percentage rate of return on training is substantially higher than the percentage return earned on material capital business, then there is underinvestment in schooling and training.

Training in a developing country is the only way of improving the productivity of agricultural machinery. Mill (1948) stated that:

> the superiority of one country over another in a branch of production often arises only from having begun it sooner. There may be no inherent advantage on one part, or disadvantage on the other, but only a present superiority of acquired skill and experience. A country which has the skill and experience yet to acquire, may in other respects be better adapted to the production than those which were earlier in the field.

Currently, investment in human capital in the form of expenditures on general education, vocational training, and health is being stressed as a specially important requirement. This emphasis is particularly true because more and more developing countries are gradually breaking through the traditional barrier of very low rates of capital accumulation. As they do this, they are finding that a lack of trained personnel is one key issue that slows down their growth rate, Baldwin (1972).

2.2.4(i) Development through Training

Mackson (1973) described the education and training for agricultural mechanization in developing countries. He stated that "the effective mechanization of agriculture is closely related to the economic growth of a developing nation. Economic development of the agricultural sector will be slow and indeed limited without progressive improvement of mechanization for agriculture." Mackson stressed the fact that effective education and training programs are essential parts of any successful mechanization of agriculture. Personnel must be trained for all positions, from that of machine operator to the supervising engineer.

2.2.4(j) Training Benefits and Costs

Social Economic Benefits

Hardin and Barus (1969) stated that society may undertake training activities in order to achieve a wide range of economic and noneconomic objectives. One important economic objective, which also means to broaden less clearly economic goals, is to increase the aggregate output of the nation. It is proper that training should be evaluated, at least in part, according to the contribution which it makes to this objective.

If training is successful in meeting its goal objective, it will, as a minimum, increase the annual national product. Accordingly it could be defined that the social economic benefits are the increase in product attainable from training, Hardin (1969).

Training activities use up resources which otherwise will, or at least can, be used in producing other goods and services.

The Learning Process

Proctor et al. (1961) stated that the chief function of technical training is to affect change -- change in people who subsequently bring about improvement in their own performance so that the organization's capability of attaining its goals is enhanced. The measure of any training program then is the amount of "change for the better that takes place as a result of that training."

2.2.5(a) Mechanization to Upgrade Production

In Sudan, mechanization is accepted as a major policy issue. Eicher (1982) commented on mechanization in Sudan as

> a country with only 18 million people, two-thirds the land area of India (with 670 million people) and few problems of unemployment. Since the clay soil throughout the country can be tilled by hand only with great difficulty, there is a technical case for tractor land preparation...
>
> Mechanized farming was highly subsidized in 1981 and the financial returns to farmers were reported to be high ... For a few countries such as the Sudan, tractor mechanization of all major tasks ... will probably be desirable from a national policy perspective in the 1980s and 1990s. It is generally agreed, however, that the relative scarcity of hand labor represented an inducement to adopt more capital-intensive methods in Sudan especially in the heavy clay soils.
>
> Mechanization is the path of technical development in Sudanese Agriculture.

The entire sequence of mechanization in peanut harvesting was to increase labor productivity. To the extent that any impact on land productivity was involved, it was a factor contributing to the extension of peanut production into the irrigated heavy clay soil where yields were lower than the western rain-fed sandy peanut producing regions.

Mechanization of peanuts is taken as an acceptable production function for quality, specially the harvesting of peanuts. The bottleneck of this production function is the skilled labor that operates these machines. The capabilities of labor are actually a produced means of production.

CHAPTER III

METHODOLOGY AND DATA COLLECTION FOR THE PEANUT HARVEST LOSSES IN THE 1982-83 SEASON

3.1 Methodology of Survey

Data was collected from a random sample of tenancies carried out in the harvest season of 1982-83. Samples were collected using a random sampling method to determine the existence and magnitude of the problem.

The Rahad project was chosen as the area that represents the mechanized farming trend typical of areas with irrigated heavy clay soils in Sudan (a stratified locality).

The Rahad project is completely mechanized for the production of cotton and peanuts. The project management provided funds and facilities for use in data collection, i.e., transportation, accomodation, enumerators and equipment.

The Rahad Research Station provided peanut fields, labs, and equipment to be used for the data collection.

3.2 The Design of the Study

The study was designed to obtain and use data from two kinds of sources -- Figure 3.1:

1. Questionnaires
2. Field data

The design of this study is supportive of the assumption

METHODOLOGY

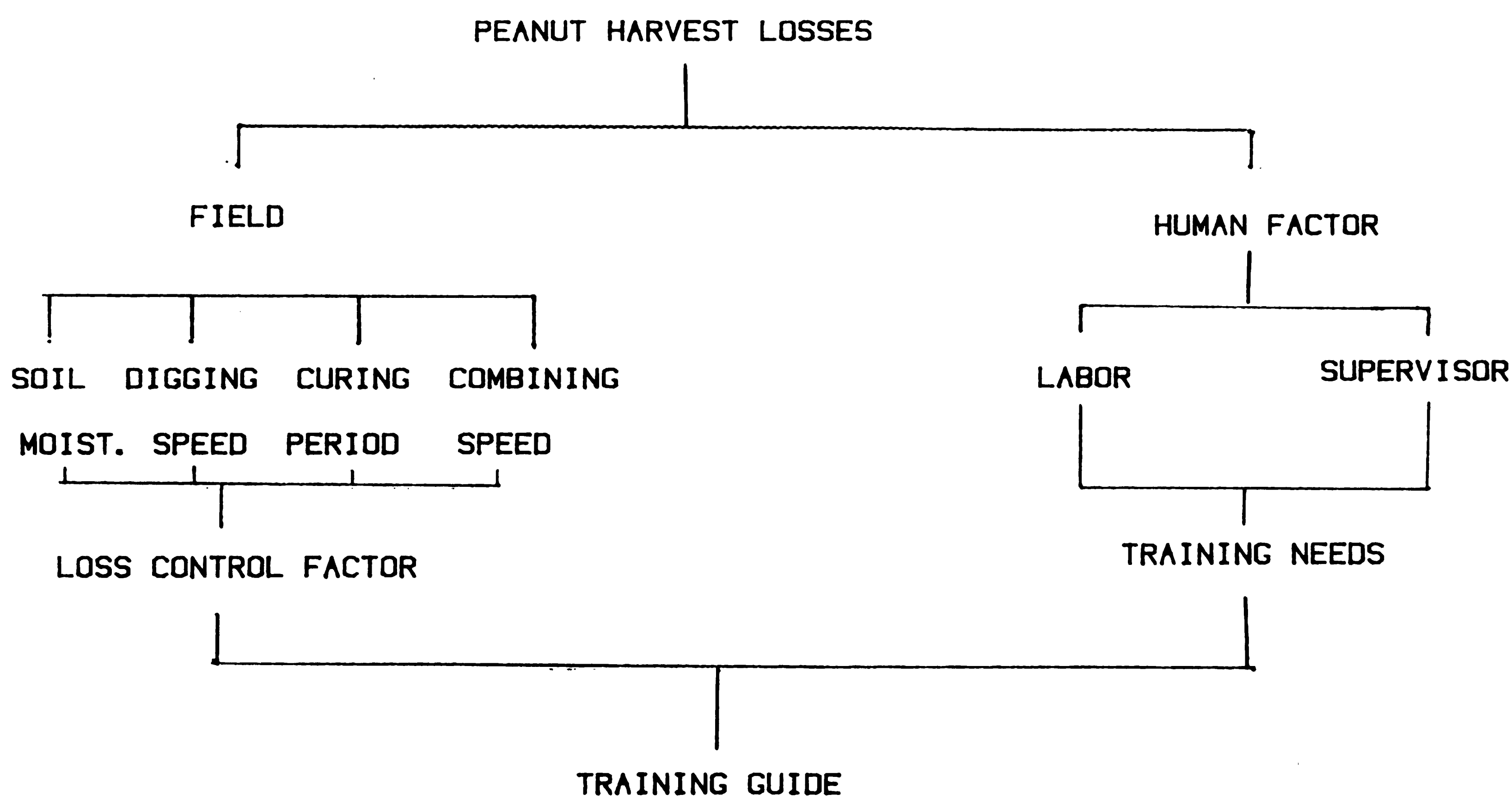

FIGURE 3.1.1. THE DESIGN OF THE STUDY FLOWCHART

that peanut harvest loss is contributed to by two main factors.

1. the humans who are responsible for the management and handling of farm machinery.
2. the field where the crop is grown. (Soil, weather, moisture, cultivars and maturity of the crop.)

The characteristics of the Rahad farms do compare closely to commerical farms. It is worth mentioning here that almost all the irrigated agricultural production schemes in Sudan are either government owned or semi-government owned -- i.e., corporations, and boards. This leads to the fact that all project technicians and skilled labor are government officials and are listed under the permanent staff of that project.

The findings of these studies will be used to construct the background for justification and recommendations in Chapter IV.

3.3 Instrumentation

For the first part of the study, (human factor) the instrument used was a delivered questionnaire (see Appendix A). There were special circumstances involved in this study which determined the type of data needed (see limitations of study, page 4).

This data required the development of an instrument designed to obtain both factual information about the respondents and their judgment about the competency needs of individuals in their position.

The main base of the questionnaires was developed from readings and agricultural engineering textbooks. There were also contributions to those questions from personal interviews the author conducted with one major U.S. peanut harvesting equipment manufacturer, The Lilliston Corporation, and one international agricultural machinery dealer, Openheimer Corporation.

The competency statements were revised and condensed and suggestions offered by the guidance committee. They are presented in Format A in Appendix A.

3.3.1 Questionnaire Design

1. The first part of the questionnaire dealt with the level of skill possessed by the respondent, and how the skill was obtained.
   - i) have not observed the skill
   - ii) have observed the skill
   - iii) have not performed the skill
   - iv) have performed the skill by training
   - v) have performed the skill by experience (variables four and five will be grouped later on to justify the technician as a leader and instructor for that skill.)
2. The second part of the questionnaire was based upon 66 statements describing occupational competency areas.

These areas were categorized under four main functional groupings:

1) Agricultural mechanics,

2) Crop production,

3) Farm management,

4) Soils.

An open ended response was allowed at the end.

A precoded response grid accompanying each of the four competency dimensions was another feature of this questionnaire. An example of the questionnaire format is in Appendix A.

Respondents were instructed to circle N for No or Y for Yes describing their best judgments or ideas.

3.3.2 Assumptions

1. It is assumed that the data for evaluation and build-up of a training proposal for farm machinery technicians would be meaningful if it were gathered to test the level of the farm skills taught. Consequently, it would add to the success in reducing the peanut harvest losses (accumulative effect).

2. It is assumed that the supervisor's reaction to the questionnaires will be the best indicator of the importance of the questions and goals.

3. It is assumed that the technicians in the peanut production areas are the best judges in this area to lead to improvement of training and consequently to better handling of farm machinery.

4. It is assumed that the technicians will be on-the-job trainers for other subordinate skilled labor. They are

the respondents representing the population who are knowledgeable in the use of farm machinery for peanut production.

5. It is assumed that the technicians are aware of the needed skills that should be incorporated in the training program.

6. It is assumed that the pooled judgment of a qualified Sudanese technician is a satisfactory and valid form of evaluation for farm machinery managment programs.

3.3.3 Reliability Measures

To measure the stability of the instrument, the consistency of the questions, and subsequent reliabilty of data, a second separate survey was conducted. This survey included the agricultural engineers who manage the applied engineering departments. They were mailed the same questions but in a different format. They were asked to rate the technicians in their blocks and estimate the percentage of those who know or perform the skill. Also, they were asked to judge and comment on the questions in general.

Question Format B is presented in Appendix A.

3.3.5 The Questionnaire Survey

The technicians:

Fifty respondents were selected for this study from the total labor force of the Rahad project. They were recommended by the project management as above average in their management ability.

In a second meeting between the researcher and the enumerators of the nine sections, where the survey was conducted, it was agreed that the questions should be handled in a formal manner. The agricultural enumerators were to be given the questionnaire forms and they should distribute them to the assigned technicians in their location (an average of six technicians in each section).

In most cases, they would have to read and translate the questions to Arabic (the native language) for the respondents.

On December 3, 1982, the questionnaires were given to the technicans and all answers were collected on the 5th. The questionnaires were given in a formal setting due to the nature and organization of routine agricultural operations. It was advantageous to use this manner because it saved time, effort, and guaranteed 100 percent response.

The first study was intended to identify the skills and competencies needed by supervisors and technicians producing peanuts in Sudan. The hypothesis and questions used were carefully planned in such a way as to relate these needs to the practical procedures used at the production site. The first study was fact finding, whereas, the second study was intended to define practical competency areas needed at the field site. The correlation between the two results should assist in reaching a useful outcome. It will reflect the priorities that need to be established as to which instructional materials and methods are more important than others.

Table 3.4

SUMMARY OF SAMPLE GROUPING INCLUDED IN THE STUDY

	Group No.	Blocks	Respondents
	1	1	5
		2	5
		3	6
	2	4	5
		5	6
		6	6
	3	7	6
		8	5
		9	6
TOTAL	3	9	50

3.4 Field Data

3.4.1 Methodology

In this part the author conducted practical investigatory findings in the field. These findings were carried out in two steps.

1. The first step was to determine the existence of the harvest loss problem. It was based on a general survey. This will be explained in detail in Section 3.4.2.
2. The second step was carried out in four field experiments to determine how peanut harvest losses are affected by:
   a) soil moisture content.
   b) digging and shaking speed.
   c) curing time and combining.
   d) combine cylinder speeds and curing time.

These four field experiments were conducted at the Rahad Research Station's experimental fields, and were conducted using a randomized block design. The layout and description are discussed in Section 3.5.2.

3.4.2 <u>Peanut Harvest Loss Survey</u>

The survey location was selected according to the stratified sampling method. Des Raj (1972) described stratification as the units in the population are allocated to groups or strata on the basis of information on a unit (peanut fields or tenancies.) An attempt is made to make the strata internally homogeneous by placing in the same stratum units which appear to be similar. By selecting a sample of a suitable size from each stratum it is possible to produce an estimate for the population characteristic (peanut mechanized fields of Sudan) which is considerably better than that given by a simple random sample from the entire population.

The Rahad area (120,000 hectares) was divided into three groups, each made up of three blocks. Group 2 was chosen randomly to be the survey site. Six tenancies (stratum) of 4 hectares each in Group 2 were chosen randomly, two from each block (the group is made up of three blocks). The peanut crop in the six tenancies was dug by a digger-shaker-windrower, and left in rows to dry for an estimated period of 7-21 days before it was combined.

Six combine samples were collected from each tenancy area, according to the procedure outlined below. They were then averaged together.

3.4.2 Combine Peanut Loss Assessment

This method was adopted from the Lilliston Corporation where it is used to evaluate the losses at their test areas in Albany, Georgia. (The author visited the Lilliston Corporation in November 1982).

A windrow was chosen at random. The sampling and recovery techniques were designed to classify the loss into one of two categories associated with the harvesting operation, as follows:

1. Digging Loss
   a) Cut off -- peanuts left in the ground because the digger was run too shallow.
   b) Shaken -- peanuts shaken off during shaking -- found on soil surface.
2. Combine Losses
   a) Header losses -- peanuts pulled off as the combine picked up the windrow.
   b) Tail loss -- peanuts blown out of combine with the trash.

The area from which losses were recovered consisted of a rectangle of 4.8 m^2 area (two rows, each 0.8m x 3m) centered over the windrow and extending across the original two rows from which the windrow was formed.

Cut off and shaking losses were collected ahead of the combine by removing a section of the windrow. Header losses were collected by placing a plastic sheet under the windrow and combining over it at normal speed. After the combine rear wheels passed over the sheet a second sheet was spread behind the combine to collect the tail loss from the rear of the combine (for an equal area of distance -- 4.8 m).

The results from the six randomly chosen windrows were averaged to represent the final result for that particular tenancy. Findings of the survey are presented in Table 3.4.2.(c).

Table 3.4.2(c)

Location	Average Combine Loss, %
Tenancy (1) Block One	30.5
Tenancy (2) Block One	45.4
Tenancy (3) Block Two	32.9
Tenancy (4) Block Two	33.6
Tenancy (5) Block Three	39.6
Tenancy (6) Block Three	35.4
Overall	36.2

The total yield for the tenancy was estimated by samples from the windrow picked up by hand, to give an approximate yield per hectare. The result of the survey indicated the serious loss problem as shown in Table No. 3.4.2(c).

The high percent loss shown supported the aim and the ultimate goal of this research -- the reduction of peanut harvest losses. The documented magnitude of losses also laid the foundation for the next expanded field loss investigation, undertaken in the harvest of 1982-83 at the Rahad Experiment Station.

The goal of the expanded field loss survey was to identify the factors responsible for high peanut loss. The possibility of minimizing these losses then could be examined by linking them to the proficiency of skilled labor and proper handling of harvesting machinery.

3.5 Expanded Field Loss Survey

Note: All results and field findings were based on tests conducted during the normal harvest season. All tests were conducted either 7 days, 14 days, or 21 days after the last crop irrigation.

3.5.1 Evaluation of Digging and Shaking Losses

The parameters that affect the performance of the digger shaker:

a) Depth of digging.

b) The layout of field -- flat or on ridges and the shape of ridge at time of digging.

c) Chain speed.

d) Conveyor inclination.

e) Number and spacing of pick-up fingers.

f) Overall mechanical condition of digger shaker.

The digging loss was the dependent variable and all data was converted to percent of the total production.

3.5.2 Evaluation Design

A randomized block design experiment with four treatments and four replications was used. The plot size consisted of two ridges, each 0.80 m wide (the standard ridge at Rahad) and 40 m long.

Samples were obtained at the time of digging to obtain soil moisture content and digging losses. A soil auger was used to collect four samples, 10 m apart along the block, from the bottom of the ridge. The soil samples were oven dried at 100°C for 24 h. The moisture content was calculated on a dry basis. Data for soil moisture and digging losses are given in Table 1, Appendix A.

3.5.3 Tractor Forward Speed (Digging Speed)

The tractor speed was checked on-site over a 100 m distance. The range was determined for the gears, first high, third low, and third high to obtain approximate speeds of 4.0, 4.8, 5.6 km/h (Massey Ferguson Tractor).

Total yield data was collected for each experiment. A sampling frame was used to obtain this data. The sampling frame was a 0.7 m x 0.6 m rectangular form of No. 10 gauge wire, having a total area of 0.42 m^2. This frame was thrown along the tested area four times and the average was calculated for the total yield per hectare.

3.6.1 Digging Speed Versus Soil Moisture Content

A randomized block design experiment with four treatments and four replications was carried out. The field setup was laid out in a plot that was scheduled for three irrigation intervals; 7 days, 14 days, and 21 days from the last irrigation. This was intentionally done to allow for a gradient of moisture content of different levels.

The depth of digging was considered constant at a range of 10-15 cm. The soil samples were oven dried and percentages were calculated on a dry basis.

3.6.2 Combine Losses Versus Curing Time

To determine the most suitable curing time, five field surveys were carried out.

1. No curing: The combining of peanuts was done directly after digging.
2. Three days curing.
3. Seven days curing.
4. Ten days curing.
5. Fourteen days curing.

The loss samples for the combine were collected, according to the method used in loss assessment in Table 3.4.2. All combine samples were sun dried for three days and weighed. Percent loss was calculated and data is presented in Appendix A.

3.6.3 Combine Losses Versus Combine Cylinder Speeds

Two cylinder speeds were selected, 68 rpm and 80 rpm.

This experiment was intended to demonstrate the importance of varying the cylinder speeds with changes in windrow moisture.

A randomized block design experiment with four treatments and four samples was conducted. The combine cylinder speed tests were carried out in the curing time fields to obtain the necessary gradient of windrow moisture content.

The set up and tables are shown in Table 3, Appendix A.

The losses collected from the combine were collected according to the method outlined in 3.4.2.

3.7 Identification of Training Areas and Topics

The results of the three needs assessment procedures which were followed in this study are presented as:

A. The field experimental findings.

B. The supervisors questionnaire results.

C. The skilled labor questionnaire results

The field experimental findings indicated the main areas and factors that significantly contribute to the peanut harvest losses. These factors are given 100 percent rank in the list of topics to be considered in the training programs. If the need assessment in the supervisors and skilled labor indicated that; then, the correlation between the three results determine the selection of and inclusion of that particular topic in the curriculum.

Tables 1-3 in Appendix B show the ranking of questionnaires and the results.

3.7.1 Procedure Followed for Areas and Topic Selection

The questionnaires were ranked to portray the results of the experimental findings. The factors that influenced the peanut losses were determined from the conclusions of the findings. Accordingly, the areas that contribute to these factors were identified, selected and given a 100 percent rank to be sure that they are included in the list to be ranked against the supervisors' list.

The supervisors' list was used as a base for area selection being the management judgment. Those areas marked or graded low (higher priority) by supervisors will be included in the curriculum as areas to receive special attention.

CHAPTER IV

4.0 Results and Discussion

In this chapter the data, results of the experimental findings, and questionnaire survey are analyzed and discussed in light of the six main objectives outlined on page 10.

4.1 Strategy for the Analysis

The field data which was designed to follow the field plot experimentation, demanded the use of statistical analysis. To examine the nature of the statistical relations, the strategy followed was to employ an analysis of variance. First, to study the effect of the independent variables on the dependent without restrictive assumptions on the nature of the statistical relation, and then to use regression analysis to exploit the quantitative character of the independent variables.

4.2 Design of Statistical Analysis

The three experimental set ups were analyzed by statistical models. The hypotheses in the study were organized to reflect the objective of this study -- the areas that should be investigated to minimize the peanut harvest losses.

4.3 Experiment One

To determine the effect of soil moisture and the digging speed on peanut losses (digging losses).

Digging losses are influenced by several agronomic factors and conditions, such as soil moisture, plant maturity, weeds, and plant disease. However, this experiment was planned to evaluate peanut digging losses as affected by digging speeds and soil moisture. The experiment was set up as described in Chapter III, Section 3.6.1.

4.3.1 Data Analysis

The experimental design required the analysis of the data to follow a two factor analysis of variance.

A. The soil moisture gradiant factor. This factor contains seven levels that cover the soil moisture gradiant (wet basis) from low through high recorded during the digging period. The levels were categorized in percentages as follows:

1. 5.01 to 10.00
2. 10.01 to 15.00
3. 15.01 to 20.00
4. 20.01 to 25.00
5. 25.01 to 30.00
6. 30.01 to 35.00
7. 35.01 to 40.00

Samples from soils with more than 40 percent moisture were excluded, being too wet to dig in heavy soils.

B. The digging speed factor. Digging speed equals the tractor forward speed. This factor has three levels, low, medium and high, to represent the range of trafficability in the heavy soil conditions. The three speed levels were as follows:

1. high = 5.6 km/h.
2. medium = 4.8 km/h.
3. low = 4.0 km/h.

C. The digging losses were treated as the dependent variable.

4.3.2 The Analysis of Variance

Table for losses by speed and moisture.

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif. of F.
Main Effects	6195.520	8	774.440	64.772	.001
Speed	729.919	2	364.960	30.524	.001
Moist	5526.585	6	921.098	77.038	.001
2-Way Interaction					
Speed/Moist	705.859	12	58.822	4.920	.001
Explained	6901.379	20	345.069	28.860	.001
Residual	2044.552	171	11.956		
Total	8945.932	191	46.837		

1. Reference to the Anova Table 4.3.2. The factor speed was highly significant with an F value of 30.524 and a

significant level of .001. This result shows the direct association of the speed factor to the total percentage of digging losses. This leads to the conclusion that any changes in digging speed will have a direct response in the percentage of peanut losses in the field.

2. The Soil Moisture Factor level. From Table 4.3.2, the soil moisture factor was significant with an F value of 77.038 and a significant level of .001. This result reflects the absolute association of soil moisture to the digging losses.

3. The interaction effect which expresses the joint effect of speed and moisture is shown to be highly significant with an F value of 4.920 and a significant value of .001. This result rejects the null hypothesis and supports the fact that soil moisture and digging speeds are associated and have a direct effect on the percentage of peanut losses.

Table 4.3.3 The Average Loss per Factor Level

a) Loss vs Speed

Speed	5.6	4.8	4.0
Average Loss	19.68	15.90	15.55

b) Loss vs Soil Moisture Content

Moisture	(5-10)	(10-15)	(15-20)	(20-25)	(25-30)	(30-35)	(35-40)
Average Loss	30.55	22.74	14.96	10.25	15.58	15.90	16.77

From Table 4.3.3 (a), the average peanut losses increases as the speed increases. This result reflects the direct effect of speed on losses, and supports the fact that the higher the speed the more losses to expect, as represented in Figure 4.3.3

This is true since excessive ground speed tends to strip the pods from the plant, however, soil will not flow properly if speed is low. excessive speed in combination with excessive shaking will tend to shatter the pods, 4.3.3 (a).

From Table 4.3.3 (b) it is noticed that the peanut digging losses are affected by the soil moisture. The response is quadratic in this case. The average losses were high at low soil moisture (5.01-10.00 percent), and low at medium soil moisture (20-25 percent). This result shows that peanut losses will increase as soil moisture decreases below 20 percent. this argument agrees with the conclusions of many researchers. the lowest percentage of losses were noticed at level 4 (20-25 percent soil moisture content).

The losses from level 4 through level 7 (35-40 percent), increase as soil moisture increases, the increase was at a decreasing rate. This could be attributed to the clay soil effect and the high digging-shaking speeds. (Figure 4.3.4).

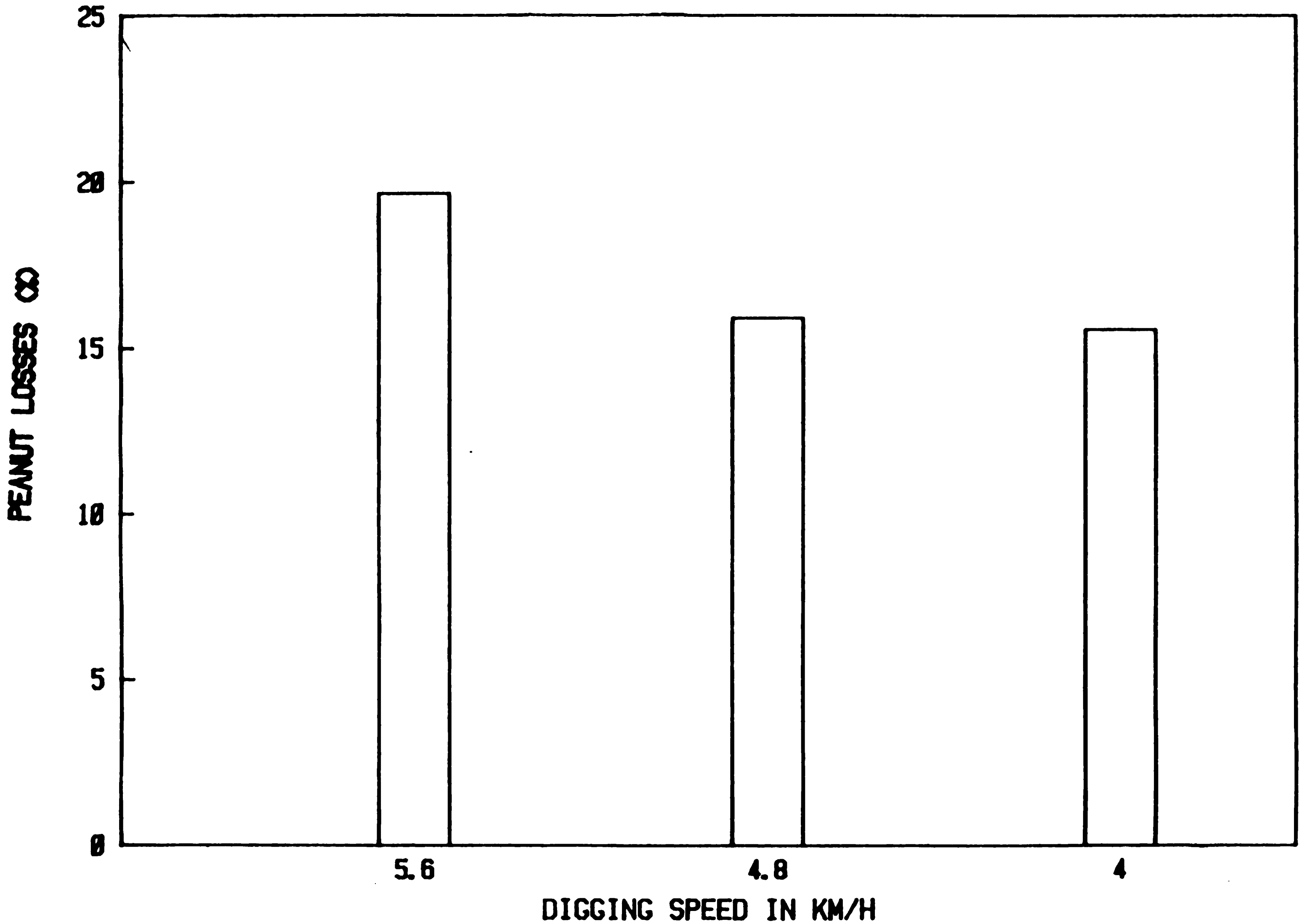

Figure 4.3.3. The effect of digging speed on digging losses.

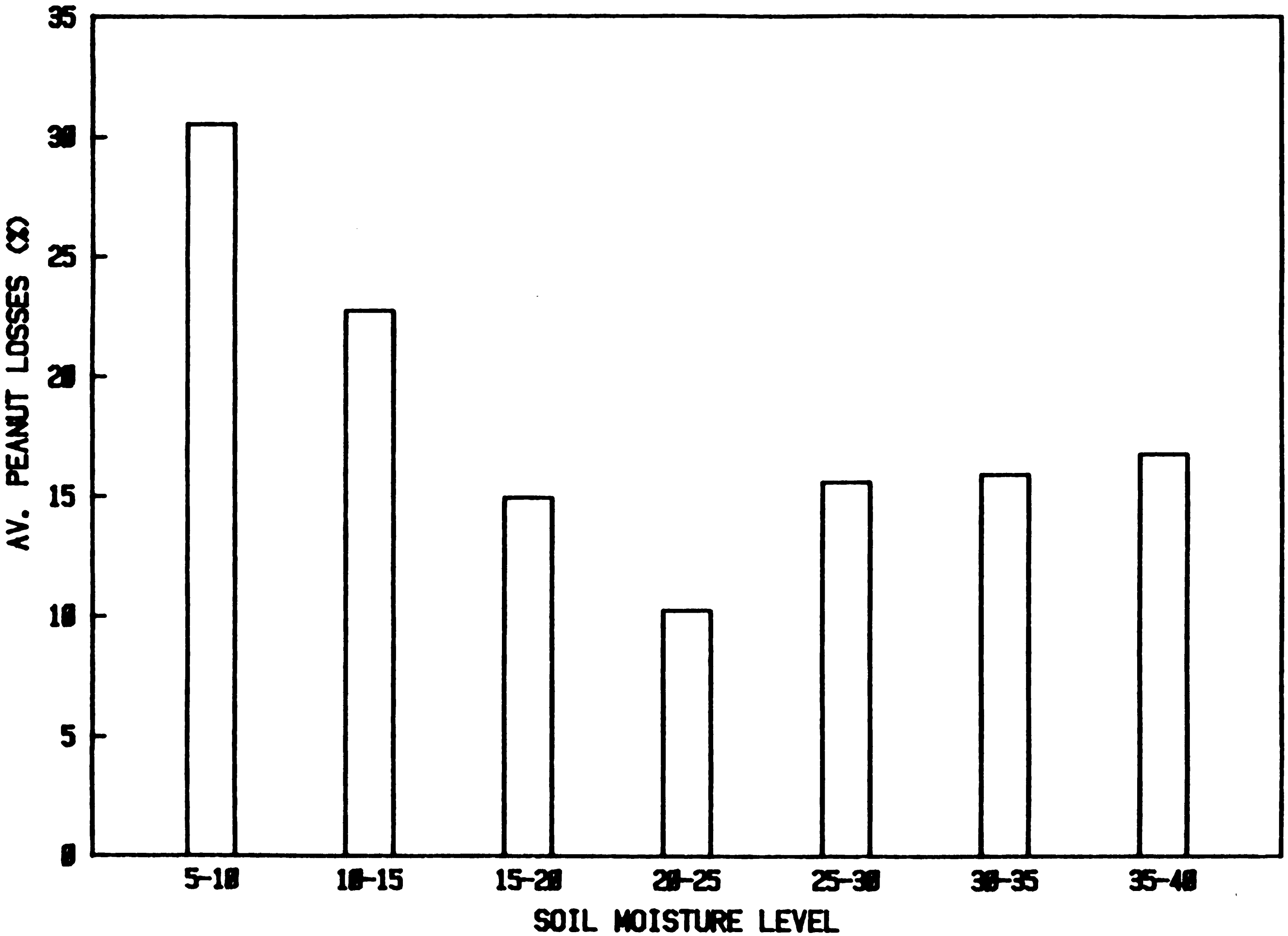

Figure 4.3.4. The effect of clay and soil moisture on losses.

Table 4.3.4 The Speed and Moisture Interaction

Speed/Moist	1	2	3	4	5	6	7
1	30.11	26.65	18.05	12.63	16.93	16.15	16.73
2	29.59	25.54	12.61	9.26	14.58	15.51	17.49
3	24.23	17.23	14.61	6.13	15.91	15.98	16.36

From the figures in Table 4.3.4 and Figure 4.3.5 a, b, c, respectively, it is clear that level 4 (20-25 percent soil moisture) is the best level of moisture to minimize losses in all three speeds. A low of 6.13 percent was achieved for the slowest speed of 4 km/h. However, in all speed and moisture combination levels it is also clear there is a quadratic decrease in losses from high at level 1 to a minimum at 4, then an increase in losses from level 4 to 7, but at a decreasing rate. However, the overall result shows that within the different levels of moisture and speed there is a certain minimum percentage of digging losses that could be achieved. This is quite noticeable in the plotting of the three levels of speeds through the seven levels of moisture gradiant, figures 4.3.5 a, b, c.

This argument leads to the conclusion that by adjusting the speed to fit the moisture trend in the field, an operator can minimize the digging losses in a wide range of soil moisture conditions.

In summary, it is evident that we must reject the null hypothesis, that losses are not affected by speed or soil

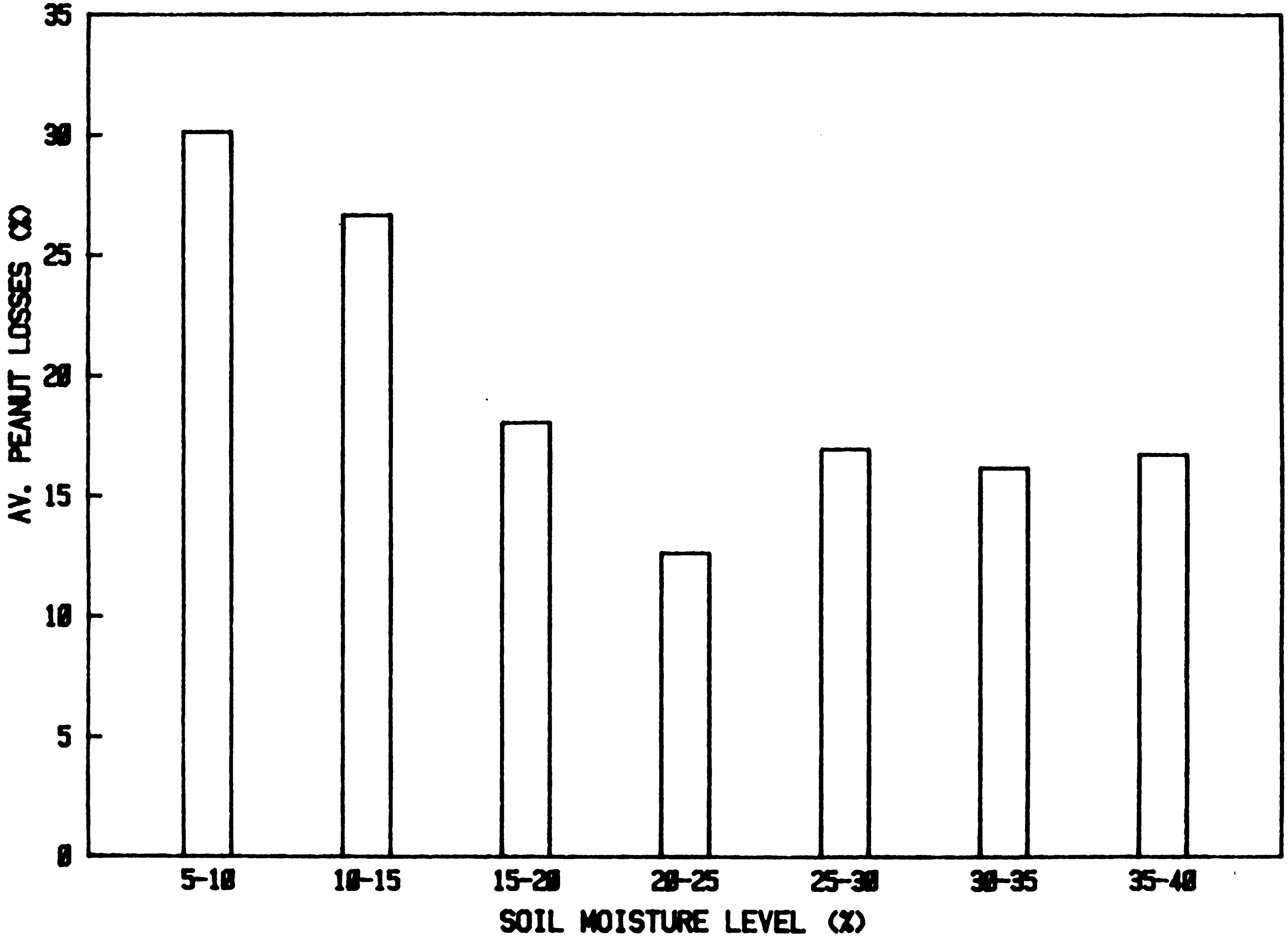

Figure 4.3.5.(a) The effect of soil moisture on losses (high digging speed)

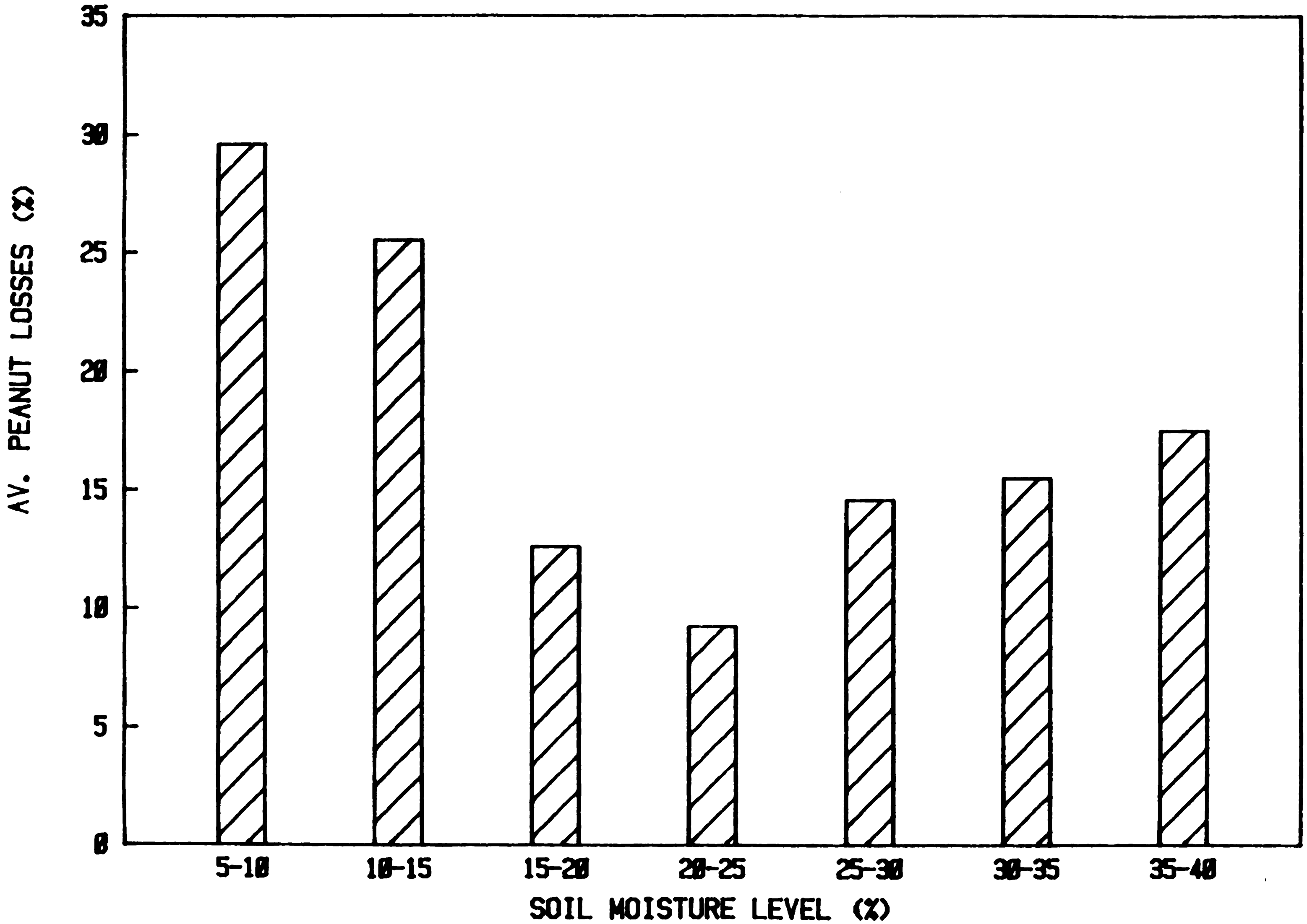

Figure 4.3.5.(b) The effect of soil moisture on losses (medium digging speed)

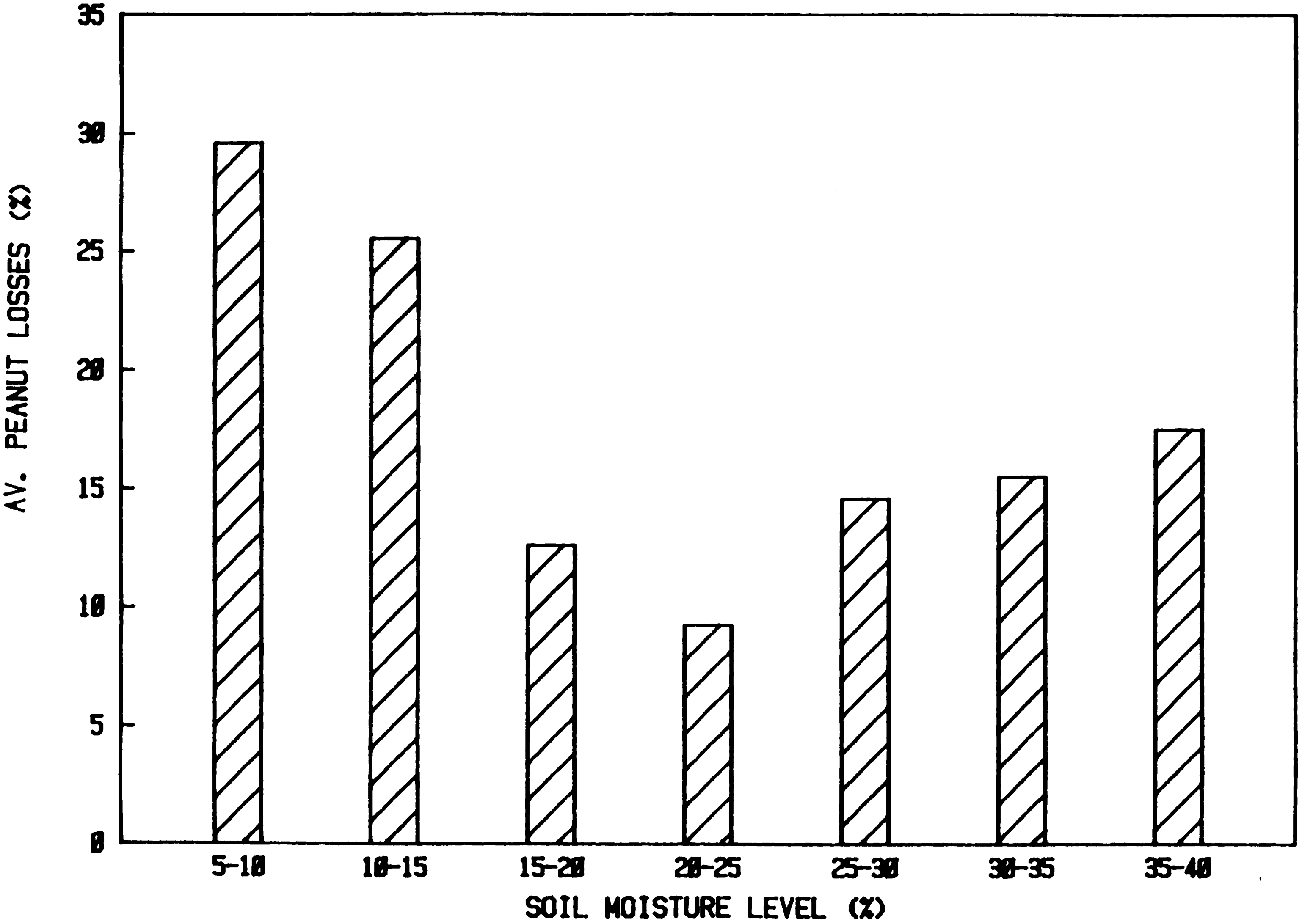

Figure 4.3.5.(b) The effect of soil moisture on losses (medium digging speed)

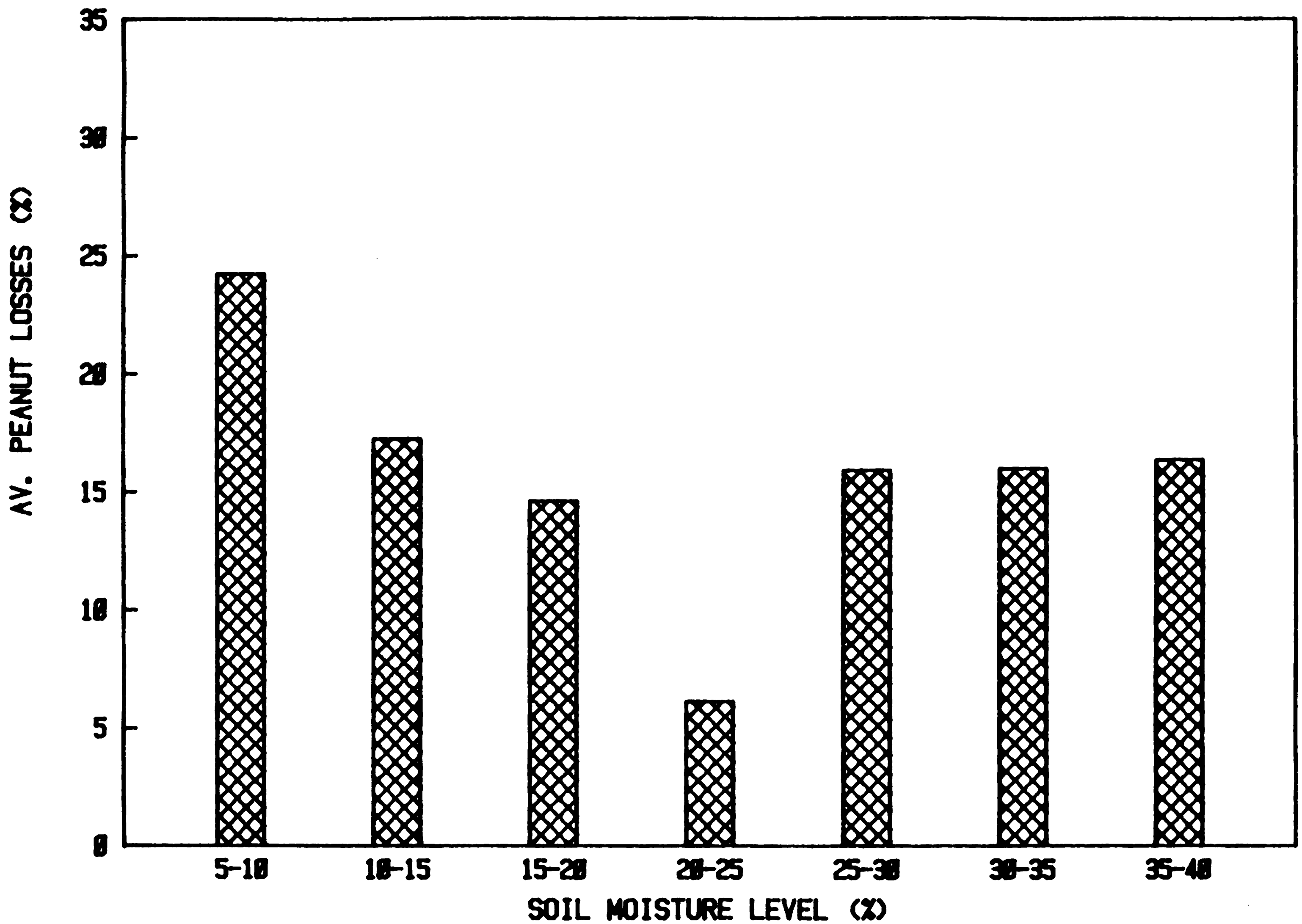

Figure 4.3.5.(c) The effect of soil moisture on losses (slow digging speed)

moisture, and accept the alternative, that both speed and soil moisture affect digging losses. Additional factors that may contribute to losses are improper pitch of the digging blades, use of dull blades, and the improper peripheral speed of the shaking chain. The combination of these factors cause excessive loose kernels. When speeds are slow and the digger operated deep, excessive amounts of soil and vines are moved that hinder proper shaking, inversion and windrowing. Consequently, the curing of crop will be affected. However, when excessive speed is combined with deep digging, there is more strain on the blades and digger frame, i.e., a plowing action, and consequently, increased cost of the digging operation.

4.4 Experiment Two

To find the suitable harvest period in days following the last irrigation.

The peanut digging operation is a very important step in the harvest of peanuts. The quality and quantity of the pods depend on the success of digging a mature crop at the right time and following proper procedures to preserve the quality of the harvested pods. The general problem of when to dig is to be answered through the analysis of this experiment.

The data for this experiment is presented in Table 2 of Appendix A.

The field data designed to follow the field plot analysis and were analyzed by statistical procedures. The statistical package for social sciences was used to obtain the results for the analysis of variance and the extended regression and plotting.

4.4.1 Data Analysis

The experimental data was analyzed by a two factor analysis of variance. Two independent variables were used:

1. The number of days in the harvest period.
2. The soil moisture.

A. The number of days factor (NOD); four harvesting periods. This is the period from the last irrigation date. The four periods were as follows:

Period One = 7 days

Period Two = 10 days

Period Three = 14 days

Period Four = 21 days

The extended period over 21 days from the last irrigation date was excluded as being too dry to dig.

B. The Soil Moisture Gradiant Factor (Moist).

This factor is made up of seven levels of soil moisture percentages during the extended period of 21 days.

The soil moisture levels were categorized in percentages as follows:

1. 5.01 through 10.00
2. 10.01 through 15.00
3. 15.01 through 20.00
4. 20.01 through 25.00
5. 25.01 through 30.00

6. 30.01 through 35.00

7. 35.01 through 40.00

Samples from soil with less than 5 percent moisture were excluded as being too dry to dig; and samples from soils with more than 40 percent moisture were excluded as being too wet to dig.

C. Peanut Losses in Percent at Time of Digging; Taken as the Dependent Variable.

The soil moisture gradiant is an important pattern to consider to determine the best period to dig the peanut crop. The soil moisture gradiant is a function of the weather pattern (temperature and relative humidity of the environment), soil type, soil cover and time.

The number of days following the last irrigation is an easy method for a farmer and machinery operators to use to determine a reasonable time to dig the peanut crop. This experiment was intended to select the best time period for digging schedules.

4.4.2 Hypothesis Tested

1. There is no relation in harvest period following last irrigation date and the percentage of peanut losses.

2. There is no relation between the soil moisture and the number of days following the last irrigation date.

Table 4.4.1 The Analysis of Variance Table

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif. of F.
Within Cell	8956.805	9	995.201	66.713	.001
No. of Days	331.834	3	110.611	7.415	.001
Moisture	618.005	6	103.001	6.905	.001
2-Way Interaction					
NOD/Moisture	48.796	2	24.398	1.636	.197
Explained	9005.601	11	818.691	54.881	.001
Residual	3624.601	243	14.918		
Total	12630.570	254	49.727		

From the figures in the Anova Table; the number of days (NOD) factor with four levels proved statistically to have a significant effect on the percentage of peanut digging losses, with an F value of 7.415 and a highly significant level of .001.

Table 4.4.2 shows the direct relationship of higher losses as the period was extended from 10 days onward. This showed that minimum digging losses occurred during the second period, which was 10 days from the last irrigation date. The losses averaged 7.83 percent. The highest average losses of 23.89 percent was seen to occur in the fourth period, i.e., 21 days after the last irrigation date. This general rule rejects the null in this respect and accepts the alternative hypothesis with a 99.9 percent confidence that the lowest digging losses occur during the period 10 days following the last irrigation date.

Table 4.4.2 The Average Losses by Number of Days

Period in Days	7	10	14	21
Average Loss in Percent	14.43	7.83	15.10	23.89

According to the average percent losses in Table 4.4.2 it is seen that the losses increased with time from period two onward. This is clearly indicated in Figure 4.4.1 that a direct relationship exists between the average loss and the number of days following the irrigation date. this result is in agreement with many researchers. the average losses will vary with different structures but generally will increase with an elapse of time. the weather is a variable that may also affect the NOD factor.

In Table 4.4.2 the 14.43 percent losses encountered in the first period (7 days) was higher than the average loss in the second period (7.83), and lower than the average loss in the third period (15.10). It was considered as a feature to fit the losses in clay soils. The peanut crop in this experiment was dug with a constant 4.8 km/h speed and a constant shaking speed. The reason for getting high losses in the first period of 14.43 may be due to digging on a wet clay soil with higher digging and shaking speeds. This mass of soil when shaken with the vines causes excessive pod

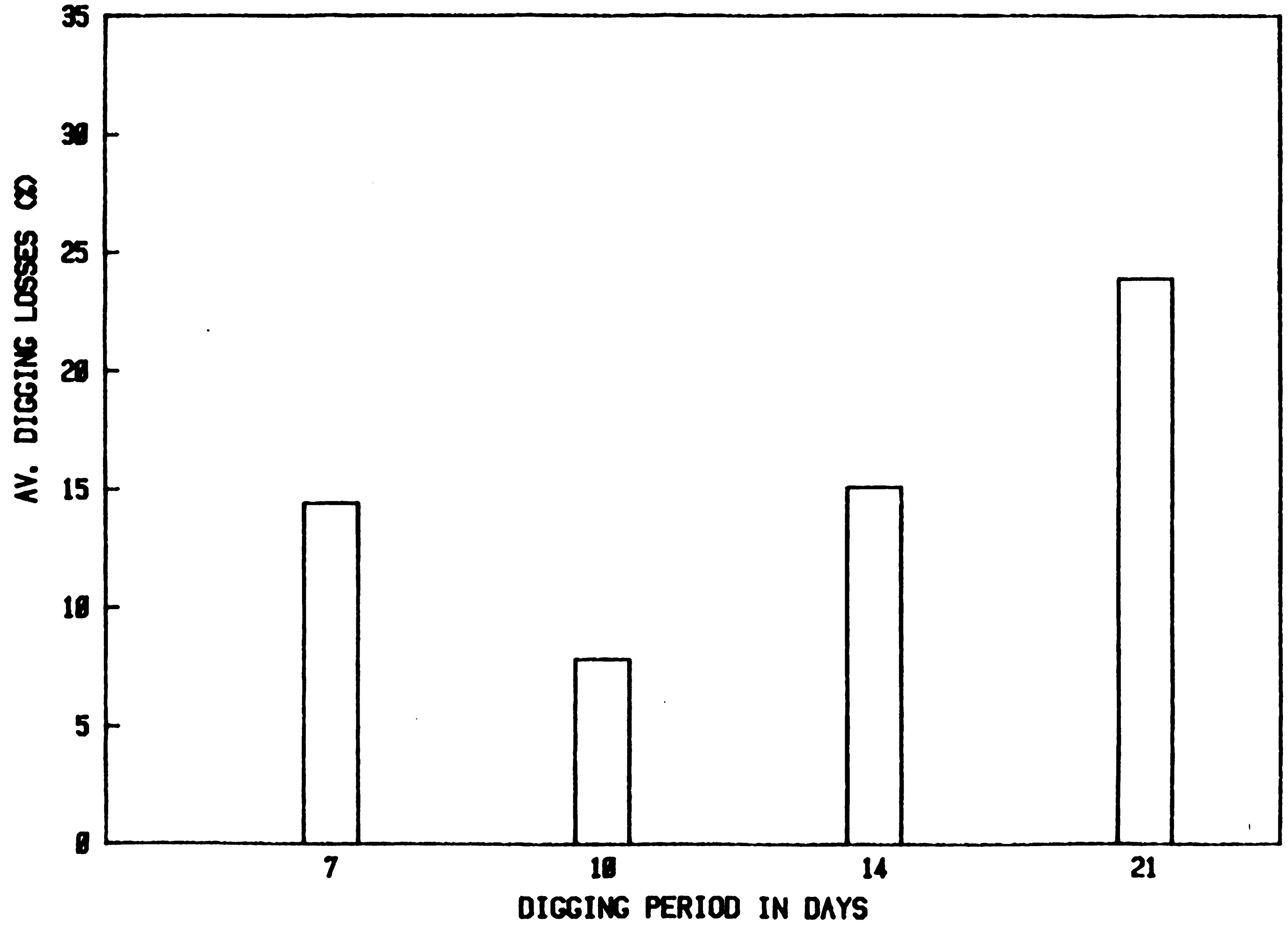

Figure 4.4.1. The effect of digging period on losses.

loss. It is noticeable in Table 4.4.2 that the percentage of losses decreased from a high of 14.43 in the first period to a low of 7.83 in the second. This was a 54 percent decrease. This result supports the results of Experiment One where digging speed and soil moisture were shown to be determining factors in peanut losses.

Digging during the 7-day period will generally affect the curing and combine losses.

4.4.3 The Soil Moisture Factor

The soil moisture factor (moist) with seven levels proved to have an F value of 6.905 and a high significant level of .001, (Table 4.4.1).

Table 4.4.3 The Average Percent Losses per Soil Moisture Level

Moist Levels	5-10	10-15	15-20	20-25	25-30	30-35	35-40
Average Percentage Loss	29.19	22.75	15.57	8.34	10.86	14.82	14.86

According to the figures in the above table and Figure 4.4.2, there is a relationship between soil moisture and the percentage of peanut digging losses. There is an inverse relation between soil moisture and digging losses from level 1 (5-10 percent soil moisture) through level 4 (20-25 percent soil moisture).

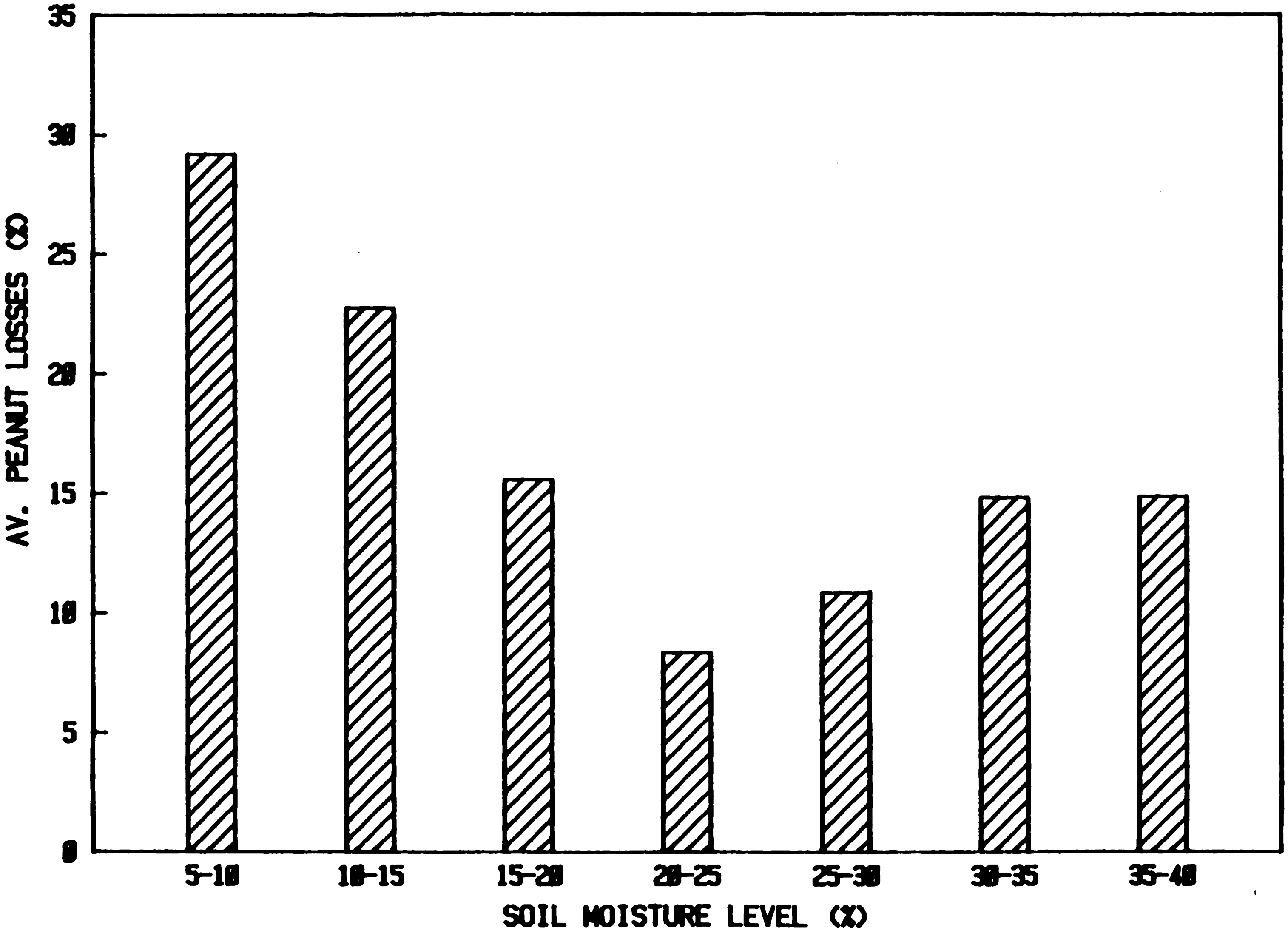

Figure 4.4.2. The effect of soil moisture on digging losses.

The average losses dropped from 29.19 percent to 8.34 percent in a soil moisture change from 5 to 25 percent. This result supports the results in Experiment One -- the lower the moisture level the higher the losses. But, there was a positive correlation between soil moisture and digging losses from level 4 (20-25 percent soil moisture) through level 7 (35-40 percent soil moisture). The percent of losses increased from a low of 8.34 at level 4 to a high of 14.84 at level 7.

This was attributed to the digging and shaking speed which was held constant and considered high for these levels of moisture. This finding supported the results of the digging speed experiment.

Table 4.4.3 shows that the lowest percent of losses occur at level 4 with soil moisture from 20 to 25 percent. This result rejected the null hypothesis and supported the alternative that soil moisture can be used to indicate the best digging period. It can be concluded that the best soil moisture range to dig peanuts was within the range of 20 to 25 percent soil moisture, and this range occurred on the average at 10 days from the last irrigation date.

The analysis of Variance Table 4.4.1 of the two-way interaction, for the number of days and soil moisture, had an F value of 1.63 with a level of significance of .197. This low level of significance for the interaction was assumed to be a resultant of digging wet soil in the first period with the wrong digging and shaking speed.

4.5 Experiment Three

4.5.1 Effect of Curing Time and Combine Cylinder on Peanut Losses

Hypothesis tested: Curing period and combine cylinder speeds have no effect on peanut harvest losses in clay soils.

Peanuts, when dug, have a high moisture content ranging from 60-50 moisture, Wright (1968). They are left on the windrow to dry to improve the threshing and quality of the pods. The effect of the curing period and the variation of cylinder speeds on pod losses was tested in this section.

4.5.2 The Variables of the Test

The independent variables in the test were:

1. The curing period in days with four levels; 0, 3, 7, 10 days following the digging date.

2. The peanut combine cylinder speeds, with two levels 68, 80 RPM.

The combine forward speed (the feed rate) was maintained constant, approximately 2 km/h to eliminate the effect of this variable.

4.5.3 The Analysis of the Test

The SPSS package was used for the statistical analysis and the multivariate results are given in Table 4.5.1.

Table 4.5.1 Analysis of Variance Table

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif. of F.
Main Effects	6130.512	4	1532.628	277.193	.001
Curing Days	5599.998	3	1866.666	337.608	.001
Cylinder Speed	537.917	1	537.917	97.289	.001
2-Way Interactions					
Curing/Speed	93.184	3	31.061	5.618	.001
Explained	6223.696	7	889.099	160.804	.001
Residual	2781.134	503	5.529		
Total	9004.831	510	17.657		

The curing period indicates a high association with losses, having an F value of 337.608 and a high significance level of .001. This result reflects the direct relationship of curing time and its effect on influencing the combine losses.

Table 4.5.2 Average Losses per Curing Period in Percent

Period in Days	0	3	7	10
Average Loss in Percent	12.31	7.59	3.97	4.53

From Table 4.5.2, the minimum average losses of 3.97 percent were shown to occur during the third period (7 days from the digging date). The highest losses in this range

12.31 were shown to occur in the first period (0 days from the digging date). This result contradicts some results obtained at Tidewater Research Center, Virginia, Wright (1979), when the results for 0 curing days resulted in minimum windrow losses and resulted in some researchers recommending the direct harvesting procedure.

In the heavy soils a high loss was found in the first 0 day period. This was attributed to the high percentage of heavy clods attached to the vines and adhering to the pods at time of digging. The excessive soil clods, when fed in the combine, caused heavy shelling and probably seed damage. It was also noticed that some of the heavy soiled vines were not picked up by the pick-up springs, and were eventually left in the field and counted as losses.

Figure 4.5.1 shows the plotting of the average losses. There was a noticeable decrease of 32.25 percent losses from the first period of 0 days to the third period (Table 4.5.2). The extended curing time causes higher losses as seen in period 4 (10 days from digging date).

Curing is a field drying process. If the peanuts are exposed to an environment for which the equilibrium moisture content of the peanuts and vines is less than the surrounding moisture content, then moistue will be transferred away from the peanuts to the environment. The magnitude of the difference between the peanut moisture content and the equilibrium moisture content affects the rate of moisture transfer. This rate is high in Sudan at the time of harvest (dry weather).

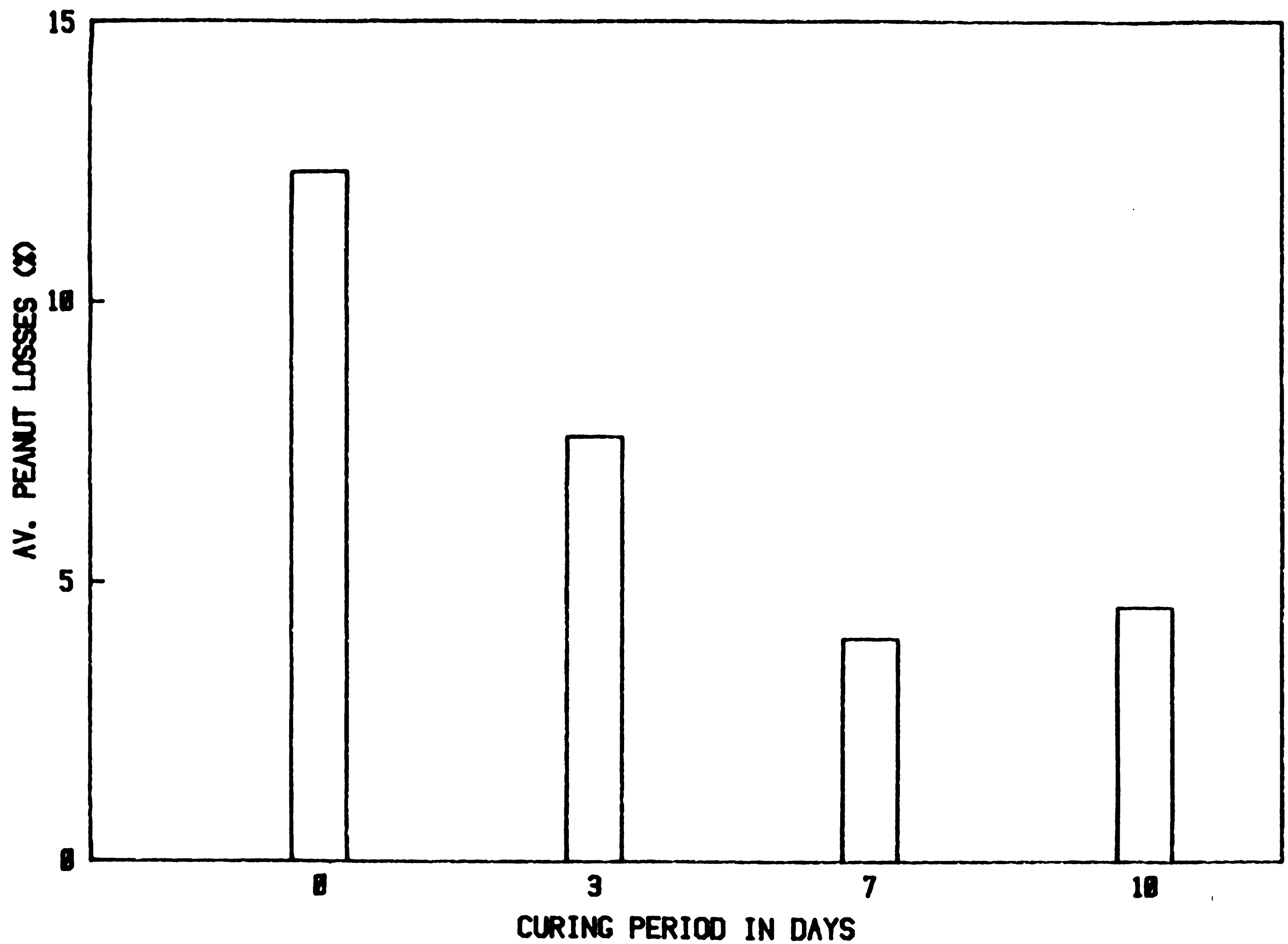

Figure 4.5.1. The average losses per curing time.

This result supported the findings by Ishag (1982) and explained why some farmers in Sudan experience 40 percent losses when the crop was left on the windrow for extended periods before it is combined. In Table 4.5.2 the losses tend to increase with extended periods and was equal to 14.1 percent in three days between the two periods (3 and 4). This was attributed to the shatter loss of the brittle dry crop.

4.5.4 The Combine Cylinder Speed

The association of the cylinder speed with losses was significant with an F value of 97.289 and high significance level of .001 (Table 4.5.1).

Table 4.5.3 Losses as Affected by Combine Cylinder Speed

Cylinder Speed in RPM	68	80
Average Losses in Percent	6.05	8.09

This result shows that a significant difference exists between the two cylinder speeds. The low speed of 68 RPM resulted on the average in less losses.

Table 4.5.4 The Average Losses as Affected by Cylinder Speed and Curing Period

Curing Period Levels		Speed Levels	
		1 (68 RPM)	2 (80 RPM)
1	0 days	10.98	13.62
2	3 days	6.95	8.22
3	7 days	2.36	5.50
4	10 days	3.94	5.11

The average losses shown in Table 4.5.3 and Figure 4.5.2 indicate that the low cylinder speed produced less losses in the four curing periods. Losses are a minimum at the third period and begin to increase. This result supports the result obtained by Wright, (1968).

The interaction effect of curing and speed, Table 4.5.1, shows an F value of 5.618 and a high significance level of .001. This indicates a combine effect of the curing time and cylinder speeds with losses. This result rejects the null hypothesis and supports the alternatives that curing time and combine cylinder speeds have a combined effect on peanut losses.

4.6 Questionnaire Results

The office of research consultation (O.R.C.) at the College of Education (Michigan State University) and statistical consultants at the computer center were consulted about the analysis procedures. All questionnaires were

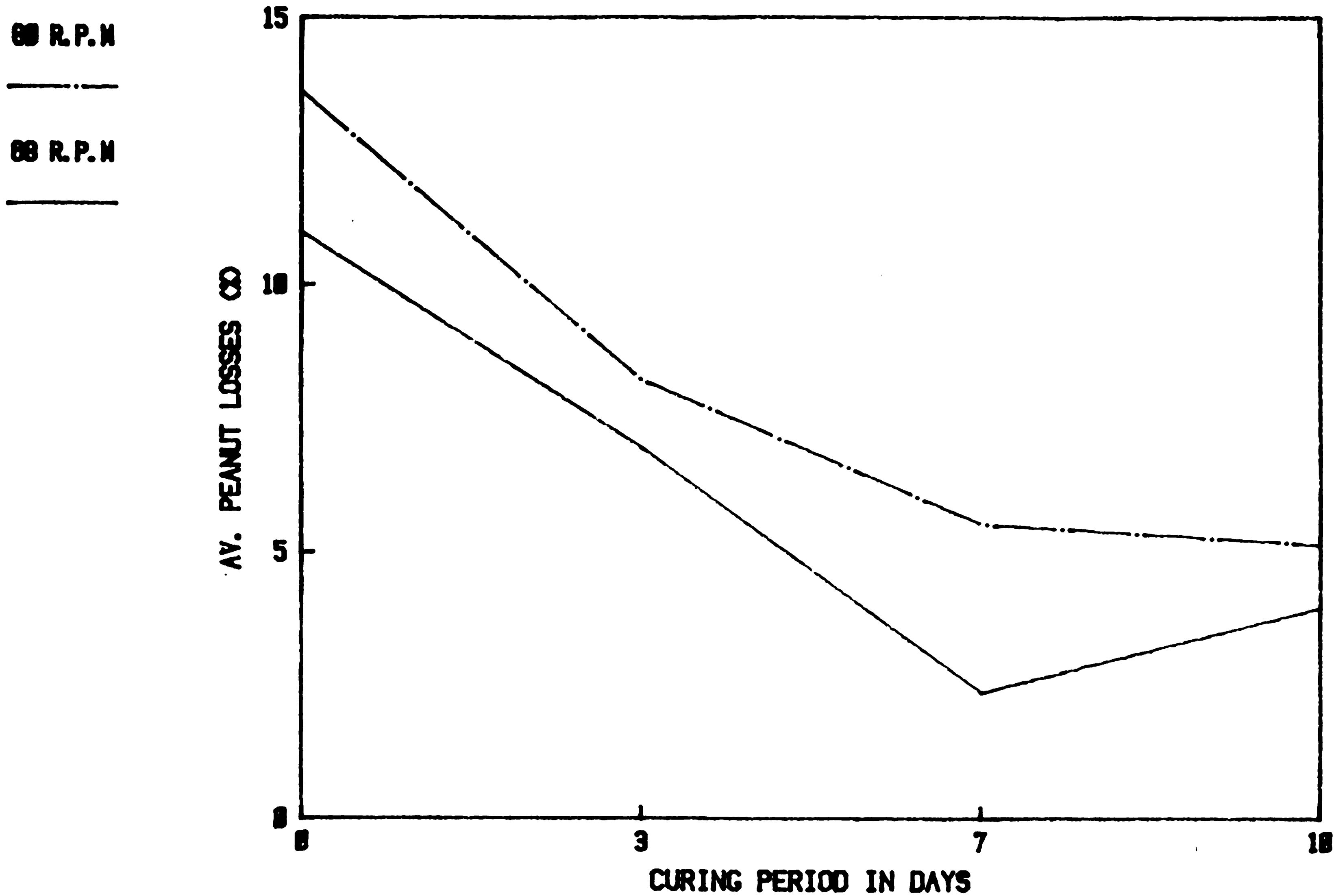

Figure 4.5.2. The effect of combine cylinder speed on losses.

coded and the data key-punched on cards as the responses were received. A computer was used to process the cards and tabulation was done through the SPSS package. The frequency counts and percentages are presented.

4.6.1 The Skilled Labor Response

There was a 100 percent response as expected due to the formal procedure followed and a general appreciation for methodology used. The rating was uniform and areas of weakness were easily identified. The results were tabulated in Appendix B.

The area of weakness was identified as the agricultural mechanics field. The percentage of the response rating was low for most of the questions as shown in Appendix B. Selected main topics from the skilled labor response are presented in Table 4.6.1.

Table 4.6.1 Selected Skill Labor Response

Topics Number	Topic Title	Response in Percentage
10	Soil moisture effect on losses	26.0
12	Identify causes of losses	33.0
21	Calibrate planter	23.0
27	Check and calculate losses	32.0
30	Can perform combine adjustment	45.5
39	Check combine cylinder speed	27.0
54	Understand why peanuts are cured	45.0
69	Identify mechanical damage	32.0

The above results show a very low knowledge rating of main areas that are assumed to be main skill areas for reducing peanut losses. It was noticed that the percent of trained labor was very low (25-33 percent) depending on areas (soils, farm mechanics, farm management and crops), and the majority gained their skill through experience.

This result strengthens the argument in support of the need for training programs.

4.6.2 The Supervisors' Response

The results from the supervisors' questionnaire responses were considered as the main indicator for areas of weakness that are given priority in training programs (the management response). Table 2 in Appendix B shows the response result. There was a 70 percent response to the survey and the average ratings were generally similar for all respondents except for one supervisor who noticeably rated very high; (averaged 85 percent in all questions). The 70 percent response was a good feedback.

There was a very close relation between the supervisors' and skill labor responses. This agreement was used to identify the area of agricultural mechanics as the area recommended for training proposals. The supervisors' responses pointed out the areas of weakness of their labor. There was a general agreement that most of the labor gained their knowledge through experience and that a very limited number have had formal or systematic training.

Table 4.6.2 The Supervisors' Percentage Rating for Selected Topics

Topics Number	Topic Title	Response in Percentage
10	Soil moisture effect on losses	27.1
12	Identify causes of losses in combine	26.8
21	Calibrate planter	22.0
27	Check and identify losses	24.3
39	Check combine speed	50.4
69	Identify mechanical damage	11.7

This low rating was a very clear indicator for a need for training. The topics in Table 4.6.2 were important areas identified to minimize peanut losses.

Table 3 in Appendix B shows the selected areas that were chosen from the field findings and given a 100 percent ranking rate. They fall in two main field activities:

A. Planting.

B. Harvesting.

CHAPTER V

TRAINING GUIDE

5.1 The Mechanized Farming Approach to Inservice Education in Agricultural Mechanics

This program is an inservice training program specially constructed to improve the ground labor skill in farm mechanics with particular emphasis on skills for peanut planting and harvesting activities. It is to be conducted on the basis of a supervised inservice occupational experience program. This program provides the "learning by doing" process through which the skilled labor reinforce learning and apply skills and knowledge learned.

It is recommended that this program be conducted during the growing season of peanuts. This arrangement will give the trainees the opportunity to enforce and practice their skill.

5.1.2 Characteristics of a Well-Planned Occupational Experience Program

A. It should be of sufficient high standards and scope to be challenging.

B. It should provide for development of a large number of needed abilities essential to success in peanut production.

C. It should contain productive and/or work experience projects of a size that will allow the trainee to make satisfactory contributions.

D. It should result in the adoption by the trainee of a considerable number of approved practices.

1. Trainee Benefits.

   A. Development of practical skills and team work.

   B. Opportunity for greater in-depth knowledge.

5.2 Selecting the Course Material

It should be emphasized that although we are using the peanut harvesting equipment operators training programs as an example that the procedures in the selection of the course material will be similar for all agricultural mechanization training courses. Trainees are to be selected by agricultural project management. The trainees should be those who are directly involved in farm machinery operation and are expected to teach others.

5.2.1 Training Program

This program is centered around two main clusters of farm mechanics in peanut production.

A. Planting Equipment.

B. Harvesting Equipment.

5.3 Training Outlines

1. Planting Equipment.

   A. Types.

   B. Use.

C. Upkeep and maintenance.

C. Calibration.

2. Harvesting Equipment.

A. Peanut Diggers.

1) Types.

2) Use.

3) Maintenance and upkeep.

B. Peanut Combines.

1) Types.

2) Adjustment and upkeep.

5.3.1 <u>Training Lessons</u>

Planters [Row Planters]

Unit I

Main function:

A. Prepare the soil.

B. Meter the speed.

C. Position the seed in soil.

Unit II

Planter main parts and function:

A. Frame.

B. Hoppers and metering devices.

C. Drive mechanism.

D. Arrangement on tool bar.

E. Row markers.

Unit III

Practical Skills (1):

A. Pulleys, sprockets and gears.

B. Belts and chains.

C. Bearings.

1) Roller.

2) Ball.

3) Bushings.

D. Use line diagram for spacing.

E. Marker set up.

Unit IV

Practical Skills (2):

A. Principles of combining.

1) Field curing.

2) Field drying.

3) Bagging.

4) Mold and aflatoxins (general).

5) Peanut field common pests [termites] rodents and [birds].

6) Field safety.

7) Field losses.

8) Quality seed production.

a) Mechanical injury to seed, impact to seed, splitting, skinning and effect on germination.

5.4 Lesson Plans

Example One:

Activity or subject: Agricultural mechanics.

Estimated time : 10 hours.

Problem area : Understanding the basic requirement of peanut harvesting and equipment.

Student objectives :

A.

1. State the basic requirements of peanut harvesting.
2. Describe the function of the basic requirement.
3. Know why the basic requirements are important.
4. Describe the basic requirement and productivity.

B.

1. State principle function of digger-shaker-windrow.
2. Describe the main parts of digger.
3. Know the function of each component.
4. Know why it is important to correct and adjust components.

C.

1. Know the field operating conditions.
2. Describe function of the important factors to look for in field.
3. Describe soil moisture effect and last irrigation date.
4. Know why it is important to know the soil moisture at digging time.

5. State the results of digging at high and low soil moisture.

6. Know how to estimate soil moisture.

D. Know the mechanics of digging peanuts.

1. Explain the depths of digging.

2. Know the effect of shallow and deep digging.

3. Explain the shaking principle.

4. Know the recommended digging and shaking speeds.

5. Know the result of slow and fast digging.

6. Know the result of slow and fast shaking.

7. Know the principle of digging in heavy and light soils.

8. The principle of digging.

   a. Dense crop.

   b. Weedy crop.

   c. The maturity of the crop and the shell-out method.

   d. Proper inversion and windrow.

   e. The principle of curing peanuts.

Interest Approach:

1. Keep working groups small.

2. Promote practical practices.

3. Present transparencies and slides and other aids.

4. Always refer to operator's manual.

5. Promote safety procedures and practices.

EXAMPLE 1:

Key Questions/ Summary of Content	Suggested Teaching Techniques
State the basic requirement for peanut harvest.	
1. Levelled fields	Discuss the use of levelling use charts
2. Well established crop	Slide presentation of a well established crop
3. Mature crop	Discuss maturity and the shell-out methods
4. Minimum weeds	Show slides and discuss and list troubles
5. Proper soil moisture level	Invite suggestions and list effects
6. Well maintained equipment	Preventive maintenance list uses
7. Well trained labor	Invite discussion
8. Adequate supply of fuel and parts	Be ready for the harvest season
9. Supplies and transport	Discussion and suggestions
Why is levelling important?	Present slides Have students discuss the importance of levelling a. for irrigation b. for drainage c. water logging and its after effects
What is a well-established crop?	
1. Plant population	Discuss and list high production estimates per hectare
2. Proper planting	
3. Cultural practices and crop upkeep	
4. Proper field management	

Key Questions/ Summary of Content	Suggested Teaching Techniques
How to estimate maturity?	Invite suggestions
1. Shell-out method	
2. Color of inner hull	
3. Days after planting	
4. Rule of thumb 77% dark inner hull	
What are the effects of weeds on performance of diggers and combines?	Show slides List suggestions
a. They compete with crop	
b. Weeds and down time	
1. Weeds choke combines	
2. Weeds slow equipment operation	
EXAMPLE 2:	
1. What is the principle function of the digger-shaker-windrow?	Show slides and digging diagrams
a. Lifts the plant from soil	
b. Shakes dirt from plant	
c. Inverts plant	
d. Deposits plant in a windrow	
2. How is the plant lifted?	Invite suggestions and list their feedback
a. Sharp blades cut plant below soil surface	
b. Conveyor reel picks cut plant and moves it up	

Key Questions/ Summary of Content	Suggested Teaching Techniques
c. Digging speed is important	
3. How is the plant shaken?	Show pictures and refer to operator's manual
a. Shaking conveyor shakes dirt off	
b. The shaking speed is critical to minimize losses	

EXAMPLE 3:
Lesson Plan for practical skill. Will include duty A to E.

Duty: Establishing Crops

Duty No.: A
Task No.: 1

Task: Determine crop selection and management using appropriate data to maximize profit.

Achievement indicators: The learner:

	Yes	No
1. Identified 10 samples of crops or plants -	___	___
2. Indicated the proper stage of maturity of crops -	___	___
3. Selected the proper harvesting and storage moisture content -	___	___
4. Identified the crop use -	___	___
5. Indicated the method of harvest, storage and drying method -	___	___

Criteria: Competence in the task will be recognized when the tasks are completed according to indicators and/or farm supervisor's recommendation.

Tools and Equipment:

Resources:

Duty: Establishing Crops

Duty No.: A
Task No.: 2

Task: Plan a correct management program using appropriate data to maximize profit.

Achievement indicators: The learner:

	Yes	No
1. Selected crops to raise -	___	___
2. Determined optimum planting time -	___	___
3. Determined optimum row width -	___	___
4. Determined optimum seeding rate -	___	___
5. Calculated the best depth of seed -	___	___
6. Determined optimum fertilizer placement -	___	___

Criteria: Competence in the task will be recognized when the tasks are completed according to indicators and MSU bulletins.

Tools and Equipment:

Resources:

Duty: Establishing Crops

Duty No.: A
Task No.: 3

Task: Calculate crop acreage using appropriate measuring tools to provide proper management.

Achievement indicators: The learner:

	Yes	No
1. Measured length and width of field -	___	___
2. Used proper formulas to determine square footage or irregular shaped fields -	___	___
3. Divided square footage by 43,560 to find acres -	___	___

Criteria: Competence in the task will be recognized when the tasks are completed according to instructor's standards.

Tools and Equipment:

Resources:

Duty: Planting Crops

Duty No.: B
Task No.: 1

Task: Plant seed using plate-type planter

Achievement indicators: The learner:

	Yes	No
1. Selected proper seed plate -	___	___
2. Unscrewed thumb screw that removes plate cut off - cotton spider -	___	___
3. Installed false ring as recommended in operator's manual (ridge up or down) -	___	___
4. Installed seed plate -	___	___
5. Installed plate cut off fastened with thumb screw -	___	___
6. Adjusted depth of planting which is controlled by press wheel and gauge shoe -	___	___
7. Placed sprockets of recommended size on jackshaft and on hopper (drill shaft) -	___	___
8. Adjusted row width along tool bar -	___	___
9. Set up marker -	___	___
10. Operated tractor. Set desired planter seed as required in manual -	___	___

Criteria: Competence in the task will be recognized when seed is planted at the spacing and depth recommended for the crop.

Tools and Equipment:

Resources:

Duty: Planting Crops

Duty No.: B
Task No.: 2

Task: Plant seed using air type planter.

Achievement indicators: The learner:

	Yes	No
1. Selected proper seed drum -	___	___
2. Installed seed drum -	___	___
3. Selected correct size sprockets for jack-shaft and drill shaft to obtain desired plant population -	___	___
4. Checked all air motors for each unit to see that it was operating properly -	___	___
5. Cleaned motors daily when conditions were dusty -	___	___
6. Operated tractor at desired planter speed as required in manual -	___	___

Criteria: Competence in the task will be recognized when the seed is planted at the row and in-row spacing and at the depth recommended for the crop planted.

Tools and Equipment:

Resources:

Duty: Planting Crops

Duty No.: B
Task No.: 3

Task: Plant seed using a no-till row crop planter.

Achievement indicators: The learner:

	Yes	No
1. Acquired tractor with planter attached -	___	___
2. Checked the following field adjustments:		
a. Row spacing -	___	___
b. Depth -	___	___
c. Seed spacing -	___	___
3. Checked planter for proper operation -	___	___
a. Checked colter for proper cutting of sod -	___	___
b. Checked furrow opening for proper seed depth and spacing in soil -	___	___
c. Checked press wheel for proper firming of soil over the seed -	___	___
4. Planted crop -	___	___

Criteria: Competence in the task will be recognized when the crop is planted evenly, thoroughly covered with soil, and planted to a correct depth depending upon factors such as soil characteristics, terrain, moisture content, temperature, size of grain, and time of season, as specified by instructor.

Tools and Equipment:

Resources:

Duty: Planting Crops

Duty No.: B
Task No.: 4

Task: Plant row-crop seed using a grain drill.

Achievement indicators: The learner:

	Yes	No
1. Placed seed in grain drill -	___	___
2. Adjusted drill for planting -	___	___
a. Calibrated the grain drill -	___	___
b. Checked discharge openings for clearance -	___	___
c. Set discharge tubes for proper depth. (Note: depth will be determined by variety of seed, soil condition, and time of year.) -	___	___
3. Planted seed -	___	___

Criteria: Competence in the task will be recognized when the seed is planted uniformly, considering the following factors: 1) amount of moisture available in the soil; 2) depth required; 3) variety of row crop; 4) row spacing desired; 5) time of seeding (season); 6) soil fertility; and 7) locality, as specified by the instructor.

Tools and Equipment:

Resources:

Duty: Planting Crops

Duty No.: B
Task No.: 5

Task: Plant seed using a precision, small seed-type planter.

Achievement indicators: The learner:

	Yes	No
1. Attached tool bar -	___	___
2. Attached planters -	___	___
3. Selected and inserted plate -	___	___
4. Set depth -	___	___
5. Set press wheel -	___	___
6. Set row markers -	___	___
7. Planted -	___	___

Criteria: Competence in the task will be recognized when seed is planted in straight rows and at the recommended number of seeds per drop.

Tools and Equipment:

Resources:

Duty: Planting Crops

Duty No.: B
Task No.: 6

Task: Conduct seed germination test using appropriate supplies to determine seed quality.

Achievement indicators: The learner:

	Yes	No
1. Counted out 100 seeds -	___	___
2. Moistened paper -	___	___
3. Placed seeds on paper -	___	___
4. Rolled paper tightly and placed in plastic bag or container and sealed -	___	___
5. Placed in warm area -	___	___
6. Determined percentage germinated -	___	___

Criteria: Competence in the task will be recognized when indicators are met and according to seed industry standards.

Tools and Equipment:

Resources:

Duty: Planting crops

Duty No.: B
Task No.: 7

Task: Calibrate planter using appropriate tools and equipment to insure correct population per acre.

Achievement indicators: The learner:

	Yes	No
1. Put small amount of seed in planter (peanuts) -	___	___
2. Drove planter at desired speed for 100' -	___	___
3. Counted seed in 100' and applied factor for row width -	___	___
4. Calculated population per acre -	___	___

Criteria: Competence in the task will be recognized with the achievement indicators are performed according to instructor's satisfaction.

Tools and Equipment:

Resources:

Duty: Harvesting Peanuts

Duty No.: C
Task No.: 1

Task: Dig peanuts using mechanical digger shaker-windrower.

Achievement indicators: The learner:

	Yes	No
1. Selected digger -	___	___
2. Adjusted tractor wheel spacing -	___	___
3. Adjusted conveyor chain -	___	___
4. Levelled implement -	___	___
5. Checked digging blades (sharp) -	___	___
6. Dig peanuts (for 100') -	___	___
7. Adjusted depth -	___	___
8. Adjusted coulters -	___	___
9. Adjusted conveyor reel pick-up -	___	___
10. Adjusted invertor rods -	___	___

Criteria: Competence in the task will be recognized when the field is dug with minimium dirt on vines and complete inversion.

Tools and Equipment:

Resources:

Duty: Harvesting Crops (Peanuts)

Duty No.: C
Task No.: 2

Task: Harvest peanuts with a combine to maximize combine efficiency.

Achievement indicators: The learner:

	Yes	No
1. Acquired the combine and read the appropriate operator's manual -	___	___
2. Checked the combine for proper setting and made these necessary adjustments:		
a. Separator -	___	___
b. Header -	___	___
c. Strippers -	___	___
d. Cleaning -	___	___
e. Grain tank -	___	___
3. Checked digging loss -	___	___
4. Checked belts for proper tension -	___	___
5. Checked moving parts for tightness and clearance -	___	___
6. Harvested the crop at proper speed -	___	___
7. Checked combine loss (head and tail) -	___	___

Criteria: Competence in the task will be recognized when the harvested peanut is free of foreign material and meets a minimum of peanut loss and shelling. Note: peanut grading depends on 1) sound mature; 2) percent other kernels; 3) percent splits; 4) percent damage, et cetera.

Tools and Equipment:

Resources:

Duty: Harvesting Crops **Duty No.:** C
Task No.: 3

Task: Check yeild loss using appropriate tools and equipment to determine crop loss.

Achievement indicators: The learner:

	Yes	No
1. Marked off area in field (small grains 1 sq. ft. and corn, beans, soybeans, 2 1/2' x 4') -	___	___
2. Counted seeds -	___	___
3. Caculated loss using chart:	___	___

Kernels per Unit Area that Equal
One Bushel Loss per Acre

Crop	Kernels per 1 sq. ft.
Oats	10-12
Soybeans	4-5
Barley	13-15
Rye	21-24
Wheat	18-20
Peanuts	1-2

Crop	Kernels/Beans per 10 sq. ft.
Corn	18-20 (Area: 20" x 6') (30" x 4')*
Navy Beans	32 (Area: 28" x 4' 3 1/2")*
Pinto Beans	16
Kidney	11

Criteria: Competence in this task will be recognized when crop is calculated correctly.

Tools and Equipment: **Resources:**

CHAPTER VI

SUMMARY AND RECOMMENDATIONS

6.1 Conclusions

1. Peanut harvest losses were high in the mechanized farm of the Rahad Project.

2. The labor technical skill ratings and scores were low.

3. Lack of training was documented. This lack has kept labor from learning the need for proper care and value of machinery adjustment as means to reduce losses.

4. Soil moisture was a determinant factor in the percent of peanut losses. Digging losses were minimum in the range of 20-25 percent soil mositure. This range is approximately 7-10 days following last irrigation.

5. Digging losses were high at low soil moisture (clay soils).

6. Digging in heavy wet soil will increase losses, affect curing, and stain the nuts.

7. Digging losses increase with digging speeds.

8. Direct combining -- digging and combining -- in the heavy clays will add to the losses.

9. Fast combine cylinder speed (80 RPM) added to combine losses. Low combine cylinder speeds reduced combine losses.

6.2 Summary of Conclusions

Peanut harvesting is a complex operation requiring timely and precise practices. As the harvesting becomes more highly-mechanized, greater care is needed. Mechanization of Sudanese peanut farms has resulted in lower labor requirements, increased capital investment and an increase in the technical knowledge requirement.

Good peanut production practices can often be negated by improper harvesting practices. The harvesting operation has its impact on the final quality and quantity of the farmers' stock with respect to milling requirement, mold development, quality of oil and germination of the seed.

The indeterminate characteristics of the peanut plant demand careful managerial decisions during the harvesting period. Harvesting includes all operations involving the uprooting of the plant, separating from the soil and vine, cleaning and placing in a bin. The sequence of peanut harvesting will demand field and equipment preparations, before the harvest starts. The harvest operation will usually include digging, shaking, inversion, windrowing and combining.

The peanut plant reproduces in the soil and to harvest it most efficiently, digging must be done at the optimum soil moisture. Optimum soil moisture for digging peanuts is generally regarded as an important factor in all sequential harvesting practices.

6.2.1 Soil Moisture

Moist heavy clay soil is difficult to separate from the pods and roots. The uprooted crop will have heavy clods adhering to the vines which will affect the curing and combining operation. On the other hand, soils with optimum moisture crumble readily and the pods will be cleaner and cure better. If the soil is too dry and hard, penetration by the digger blades is difficult. Blades tend to dull easily and rise or be thrust into the pod zone, resulting in heavy pod losses. The implement draft is affected by the soil moisture and soil resistance. In the heavy soils, peanut digging can cause a high percentage of the total losses incurred during harvesting. Digging losses are influenced by several conditions. These include plant density, plant disease, soil moisture, maturity and equipment mechanical conditions. Upkeep and maintenance of equipment is important. The operation and digging speed is a major part in controlling the losses. Conditions that may cause excessive losses are improper pitch of blades, use of dull blades, improper depth and incorrect digger-shaker speeds. Excessive shaking and ground speed tend to strip the pods from the plant, however, soil will pile up on the digger if too deep a cut or slower speed is used.

High losses are incurred in heavy soils that are too wet or too dry. The range of speeds and soil moisture levels to produce minimum digging losses is rather narrow.

6.2.2 The Combine Losses

The timing of combining and the mechanical upkeep of combines are important factors in controlling the peanut combine losses. The optimum time for combining is when the soil moisture reaches a level of 20-25 percent. In order to minimize losses in the headers, it is important that the pickup speed be synchronized with the ground speed so that the windrow flow continuously. Fast cylinder speeds tend to tear apart vines, strip the pods and cause damage to seeds and increase losses. The adjustment of cylinder speeds and clearance can have a major affect on picking, threshing efficiency and the losses which result. Excessive clay soil fed with the vines tend to cause excessive shelling and a splitting action and high losses. The proper curing of the vines can reduce the amount of clay soil in the vines.

6.2.3 Field Curing

This is the practice which reduces moisture content of peanut plants and enhances threshing and high quality of pods. While moisture removal is the most apparent result, other chemical and physiological processes continue during curing that affect flavor and quality of the pods. Curing time is severely restricted by quality and loss considerations. In heavy soils minimum curing time adds to the combine losses. Heavy clay clods adhering to vines and pods disrupt the flow of vines into the combine. Extended curing time causes the vines to overdry and become very fragile with heavy losses at headers and sometimes tend to roll in

front of the combine. Overdrying causes excessive pod splitting and seed damage.

The curing time is a very critical period for the control of fungi (mold) which will affect the quality of the peanuts. After invasion of the seed the mold may, under favorable conditions, form alfatoxins which are very harmful to humans and animals. Preventing alfatoxins is a vital concern to peanut producers. Using careful harvesting practices are one way of reducing the spread of mold. The number of days from the last irrigation date proved to be an acceptable method for a peanut producer to estimate the proper time for digging and combining. This period is approximately 9-10 days following irrigation for digging, and 7-10 days following digging before combining. Both of these time periods are subject to weather conditions.

6.3 Recommendations

Based on the findings of this study, the following recommendations are suggested for future research and development to reduce peanut losses, and improve the skill of labor.

Reasearch needs to be conducted to:

1. Determine the effect of predigging operations, i.e., vine clipping, coultering and their effect on reducing losses in heavy irrigated soils.

2. Determine the cost of harvesting peanuts and the energy requirements in Sudan.

3. Define methods to be followed to introduce an extension information program to educate the newly-settled farmers to the utilization of farm machinery.

4. Evaluate the national vocational training programs and incorporate farm machinery and power in their curriculum to reduce costs and losses in crops.

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"APPENDIX"

QUESTIONNAIRE

PEANUT HARVEST SKILL INVENTORY

DIRECTIONS:-

This inventory contains skills or competency statements selected to represent the range of performance activities a farm machinery technician should be familiar with. Your practical experience background will be compared to what has been determined as a desirable experience background for a beginning skillful labor.
This is not a right or wrong answer test. Do not be concerned about your score, provide the most accurate picture of yourself by responding appropriately to all items. You will be less experienced in some of the (four) skill areas, but complete each item because missing data will result in your inventory being inaccurate.

Read each skill statement carefully. In the left hand column labeled "HAVE OBSERVED", circle the appropriate response: N for NO if you have not observed the skill being performed. If you respond yes move to the right hand column labeled "HAVE PERFORMED", Circle the appropriate response:

1. NO - you have not performed the skill
2. With supervision - you have performed the skill with the presence of your supervisor.
3. Without supervision - by experience through the years.
4. Well enough - you have performed the skill well enough to instruct others.

EXAMPLE:-

HAVE OBSERVED			HAVE PERFORMED			
NO	YES		NO	By training	By experience	Well enough to teach it
N	Y		1	2	3	4
N	Y		1	2	3	4

HAVE OBSERVED				HAVE PERFORMED			
NO	YES			NO	By training	By experience	Sufficient skill to instruct
AGRICULTURAL MECHANICS							
N	Y	1.	Operation and adjustment of land plane	1	2	3	4
N	Y	2.	Field plowing	1	2	3	4
N	Y	3.	Field ridging	1	2	3	4
N	Y	4.	Measurement of area in acres (fedans)	1	2	3	4
N	Y	5.	Use of field level	1	2	3	4
N	Y	6.	Tillage with a one way plow	1	2	3	4
N	Y	7.	Operation of a ridger	1	2	3	4
N	Y	8.	Planting with a planter	1	2	3	4
N	Y	9.	Marker setting for precise planting, ridging, etc.	1	2	3	4
N	Y	10.	Calibration of a planter and seed drill	1	2	3	4
N	Y	11.	Operation of peanut digger	1	2	3	4
N	Y	12.	Assembly of a planter	1	2	3	4
N	Y	13.	Operation and adjustment of a row crop cultivator	1	2	3	4
N	Y	14.	Operation and adjustment of a peanut combine	1	2	3	4
N	Y	15.	Assembly of a peanut combine	1	2	3	4
N	Y	16.	Checking and calculation of losses	1	2	3	4
N	Y	17.	Checking of combine speed	1	2	3	4
N	Y	18.	Checking and installation of proper belts in combine	1	2	3	4

HAVE OBSERVED				HAVE PERFORMED			
NO	YES			NO	By training	By experience	Sufficient skill to instruct
N	Y	19.	Checking and identification of after effects of combine cylinder speeds	1	2	3	4
N	Y	20.	Checking and identifying the after effect of pick-up and header auger speeds	1	2	3	4
N	Y	21.	Identify causes of losses	1	2	3	4
N	Y	22.	The selection of the best depth of digging	1	2	3	4
N	Y	23.	Identification of the proper digging speeds	1	2	3	4
N	Y	24.	Identification of proper digging depth	1	2	3	4
N	Y	25.	Estimation of digging speeds/hr	1	2	3	4
N	Y	26.	Identification of proper soil moisture for digging	1	2	3	4
N	Y	27.	Calculation of production/hr	1	2	3	4
N	Y	28.	Estimation of combine speed/hr	1	2	3	4
N	Y	29.	Tractor hydraulic lift operation	1	2	3	4
N	Y	30.	Self unloading wagon operation	1	2	3	4
N	Y	31.	Operator manual use (combine)	1	2	3	4
N	Y	32.	Parts ordering for equipment	1	2	3	4
N	Y	33.	Electric arc welding operation	1	2	3	4
N	Y	34.	Acetyline welding operation	1	2	3	4
N	Y	35.	Service and maintenance of engine	1	2	3	4

HAVE OBSERVED				HAVE PERFORMED			
NO	YES			NO	by training	by experience	sufficient skill to instruct
N	Y	36.	Fuel pump priming (diesel engine)	1	2	3	4
N	Y	37.	Installation and adjustment of belts and chains	1	2	3	4
N	Y	38.	Installation and adjustment of bearings and seals	1	2	3	4
N	Y	39.	Service of slip clutch (safety clutch)	1	2	3	4
N	Y	40.	Safety rules for combine operation	1	2	3	4
N	Y	41.	Curing of peanuts	1	2	3	4
N	Y	42.	Combine dealer demonstration	1	2	3	4
N	Y	43.	Calibration of sprayer (insecticide & herbicide)	1	2	3	4

CROP PRODUCTION

N	Y	44.	Identification of common weeds	1	2	3	4
N	Y	45.	Identification of common insect damage	1	2	3	4
N	Y	46.	Identification of common pests damage	1	2	3	4
N	Y	47.	Chemical application	1	2	3	4
N	Y	48.	Plant population count per acre (fedan)	1	2	3	4
N	Y	49.	Yield checks of peanuts	1	2	3	4
N	Y	50.	Identification of peanut maturity	1	2	3	4
N	Y	51.	Identification of cotton maturity	1	2	3	4
N	Y	52.	The shellout method to determine maturity	1	2	3	4

HAVE OBSERVED				HAVE PERFORMED			
NO	YES			NO	by training	by experience	sufficient skill to instruct
SOILS							
N	Y	53.	Identification of common soil type (clay, sand, sandy clay)	1	2	3	4
N	Y	54.	Identification of water logging	1	2	3	4
N	Y	55.	Identification of type of erosion	1	2	3	4
N	Y	56.	Determination of approximate percent of moisture	1	2	3	4
N	Y	57.	Determination of land slope with land level	1	2	3	4
FARM MANAGEMENT							
N	Y	58.	The reading of a farm map	1	2	3	4
N	Y	59.	Transposing notes to farm map	1	2	3	4
N	Y	60.	Planning working pattern or plan	1	2	3	4
N	Y	61.	Scheduling of operation in the field	1	2	3	4
N	Y	62.	Identification of mechanical damage (peanuts)	1	2	3	4
N	Y	63.	Identification of peanut mold	1	2	3	4
N	Y	64.	Usage of card inventory	1	2	3	4
N	Y	65.	Ordering of fuel	1	2	3	4
N	Y	66.	Determination of distance by use of farm level, pacing, chain and taping	1	2	3	4

TO THE SUPERVISORS IN BLOCKS:-

AGRICULTURAL MECHANISATION
PEANUT HARVEST SKILL INVENTORY

DIRECTIONS:-

This inventory contains skills or competancy statements selected to represent the range of performance activities a farm mechanisation technician should be familiar with. Your practical experience and background in your block will be the basic criteria to write the percent of skilled labor.

Feel free to comment at the back of the questionnaire pages.

Thank you.

NUMBER OF SKILLED LABOR: - (   )

PLEASE GIVE THE PERCENTAGE OF THE SKILLED LABOR IN YOUR BLOCK WHO KNOW OR CAN PERFORM THE SKILL IN QUESTION. THANKS.

LAND PREPARATION

1. Operate and adjust land plane
2. Plow field
3. Ridge field
4. Measure area (in acres)
5. Use field level

CROP PRODUCTION

6. Identify common seeds and plants
7. Identify maturity of cotton
8. Identify maturity of peanuts
9. Identify common insect damage
10. Know how to estimate soil moisture
11. Apply chemicals
12. Calculate harvest losses for peanut combine
13. Count plant population per acre
14. Make yield checks of peanuts
15. Know the shellout method (combine damage)
16. Know the use of the shell-out method

AGRICULTURAL MECHANICS

17. Operate one way plow
18. Operate a ridger
19. Operate a planter
20. Can set marker for precise planting, ridging, etc.
21. Calibrate planter and seed drill
22. Operate peanut digger
23. Know how to put together a planter
24. Operate a grain drill

PLEASE GIVE THE PERCENTAGE OF THE SKILLED LABOR IN YOUR BLOCK WHO KNOW OR CAN PERFORM THE SKILL IN QUESTION. THANKS.

25. Operate and adjust a row crop cultivator
26. Operate a peanut combine
27. Check and calculate losses
28. Check for speed of combine
29. Can select and install proper belt in combine
30. Can make combine adjustments
31. Identify causes of losses
32. Can tell the best depth of digging
33. Identify proper digging speed
34. Identify proper digging depth
35. Can estimate speed/hr of digging
36. Identify proper moisture for digging
37. Can estimate speed/hr for tractor
38. Can measure production/hr
39. Can estimate speed of combine per hour
40. Familiar with tractor hydraulic lift adjustment
41. Operate combine standing (threshing)
42. Operate self unloading wagon
43. Perform combine adjustments
44. Read operator manual
45. Order parts for equipment
46. Operate electric arc welder
47. Can service and maintain engine
48. Can prime fuel pump (diesel engine)
49. Install and adjust belts and chains
50. Install and adjust bearing and seals
51. Service slip clutch (safety clutch)
52. Know safety rules for combine operation
53. Know curing time
54. Know why cure peanuts
55. Know why dry peanuts before storage
56. Attended a combine dealer demonstration

PLEASE GIVE THE PERCENTAGE OF THE SKILLED LABOR IN YOUR BLOCK WHO KNOW OR CAN PERFORM THE SKILL IN QUESTION. THANKS.

FARM MANAGEMENT

57. Can read the farm map
58. Transpose field notes to farm map
59. Use card inventory
60. Order fuel
61. Can identify termites damage
62. Know peanut mold
63. Know the effect of nematodes
64. Plan working pattern or plan
65. Can schedule operations in the field
66. Can calculate cost/hr
67. Can figure cost/acre
68. Can calculate cost/man-hr
69. Identify mechanical damage (peanuts)
70. Identify insect damage

SOIL

71. Identify soil type (clay, sand, sandy loam)
72. Identify water logging
73. Identify type of erosion
74. Determine roughly percentage of soil moisture
75. Determine land slope with land level
76. Determine distance by use of farm level, pacing chain and taping
77. These are useful questions

TABLE 1

The skilled labor survey results presented in over all percentage

AGRICULTURAL MECHANICS	Those who performed by experience & training
1. Operation and adjustment of land plane	64
2. Field plowing	46
3. Field ridging	100
4. Measurement of area in acres (fedans)	30
5. Use of field level	32
6. Tillage with a one-way plow	64
7. Operation of a ridger	100
8. Planting with a planter	100
9. Marker setting for precise planting, ridging, etc.	32
10. Calibration of a planter and seed drill	56
11. Operation of peanut digger	70
12. Assembly of a planter	30
13. Operation and adjustment of a row crop cultivator	32
14. Operation and adjustment of a peanut combine	66
15. Assembly of a peanut combine	34
16. Checking and calculation of losses	32
17. Checking of combine speed	34
18. Checking and installation of proper belts in combine	76
19. Checking and identification of after effects of combine cylinder speeds	32
20. Checking and identifying the after effect of pick-up and header augger speeds	38
21. Identify causes of losses	32

		Those who performed by experience & training
22.	The selection of the best depth of digging	98
23.	Identification of the proper digging speeds	86
24.	Identification of proper digging depth	62
25.	Estimation of digging speeds/hr	42
26.	Identification of proper soil moisture for digging	26
27.	Calculation of production/hr	14
28.	Estimation of combine speed/hr	44
29.	Tractor hydraulic lift operation	42
30.	Self unloading wagon operation	26
31.	Operator manual use (combine)	24
32.	Parts ordering for equipment	30
33.	Electric arc welding operation	24
34.	Acetyline welding operation	28
35.	Service and maintenance of engine	44
36.	Fuel pump priming (diesel engine)	58
37.	Installation and adjustment of belts and chains	68
38.	Installation and adjustment of bearings and seals	56
39.	Service of slip clutch (safety clutch)	16
40.	Safety rules for combine operation	18
41.	Curing of peanuts	76
42.	Combine dealer demonstration	2
43.	Calibration of sprayer (insecticide & herbicide)	8

Crop production	Those who performed by experience & training
44. Identification of common weeds	50
45. Identification of common insect damage	88
46. Identification of common pests damage	76
47. Chemical application	52
48. Plant population count per acre (fedan)	4
49. Yield checks of peanuts	10
50. Identification of peanut maturity	32
51. Identification of cotton maturity	84
52. The shellout method to determine maturity	92
Soils	
53. Identification of common soil type (clay, sand, sandy clay)	10
54. Identification of water logging	60
55. Identification of type of erosion	28
56. Determination of approx. percent of moisture	20
57. Determination of land slope with land level	16
Farm Management	
58. The reading of a farm map	60
59. Transposing notes to farm map	66
60. Planning working pattern or plan	46
61. Scheduling of operation in the field	2
62. Identification of mechanical damage (peanut)	32

	Those who performed by experience & training
63. Identification of peanut mold	62
64. Usage of card inventory	6
65. Ordering of fuel	58
66. Determination of distance by use of farm level, pacing, chain and taping	52

TABLE 2

NUMBER OF SUPERINTENDENT RESPONSE: - (7)
This response represents (70%)

Percent rating of each superintendent and over all average rating of competencies

LAND PREPARATION	1	2	3	4	5	6	7	AVG
1. Operate and adjust land plane	100	18	-	90	-	50	36	42
2. Plow field	100	100	-	92	-	80	54	60
3. Ridge field	100	100	-	-	-	70	54	46
4. Measure area (in acres)	100	5	-	-	-	10	36	21
5. Use field level	80	-	-	-	-	20	-	14.2
CROP PRODUCTION								
6. Identify common seeds and plants	100	45	-	80	-	10	54	41.2
7. Identify maturity of cotton	100	18	-	95	-	70	54	48.1
8. Identify maturity of peanuts	100	9	-	70	-	80	54	44.7
9. Identify common insect damage	80	40	-	70	-	-	-	27.1
10. Know how to estimate soil moisture	70	18	-	30	-	10	9	19.5
11. Apply chemicals	30	0	-	90	-	0	18	26.8
12. Calculate harvest losses for peanut combine	50	0	-	56	-	15	-	17.2
13. Count plant population per acre	60	9	-	-	-	5	45	17
14. Make yield checks of peanuts	80	14	-	20	-	10	-	17.7
15. Know the shellout method (combine damage)	80	14	-	10	-	0	-	14.8
16. Know the use of the shell-out method	80	9	-	0	-	0	-	12.7
AGRICULTURAL MECHANICS								
17. Operate one-way plow	80	50	-	100	-	40	18	41.1
18. Operate a ridger	100	75	-	100	-	60	54	55.6
19. Operate a planter	100	70	-	90	-	75	54	55.6
20. Can set marker for precise planting, ridging, etc.	100	70	-	70	-	50	36	39.4

		1	2	3	4	5	6	7	AVG.
21.	Calibrate planter and seed drill	100	9	-	14	-	40	36	22
22.	Operate peanut digger	100	91	-	100	-	65	36	56
23.	Know how to put together a planter	60	75	-	4	-	50	54	34.7
24.	Operate a grain drill	100	70	-	60	-	10	18	36.9
25.	Operate and adjust a row crop cultivator	75	18	-	50	-	20	36	28.4
26.	Operate a peanut combine	100	70	-	100	-	70	36	54.7
27.	Check and calculate losses	60	9	20	-	40	5	36	24.3
28.	Check for speed of combine	100	4	30	2	80	10	18	34.9
29.	Can select and install proper belt in combine	100	54	70	2	60	5	18	44.1
30.	Can make combine adjustments	80	27	90	2	80	20	18	45.3
31.	Identify causes of losses	60	18	85	2	60	10	36	38.7
32.	Can tell the best depth of digging	90	45	95	-	60	15	36	48.7
33.	Identify proper digging speed	100	18	90	-	80	10	36	47.7
34.	Identify proper digging depth	80	18	85	-	60	20	18	40.1
35.	Can estimate speed/hr of digging	80	27	90	-	80	30	54	51.6
36.	Identify proper moisture for digging	70	45	85	-	60	20	54	48
37.	Can estimate speed/hr for tractor	80	36	70	-	80	30	9	43.6
38.	Can measure production/hr	80	9	2	-	40	30	9	24.3
39.	Can estimate speed of combine per hour	80	45	80	4	80	10	54	50.4
40.	Familiar with tractor hydraulic lift adjustment	100	91	90	70	80	80	36	78.1
41.	Operate combine standing (threshing)	100	72	95	-	60	70	-	56.7
42.	Operate self unloading wagon	90	9	90	60	80	60	18	58.1
43.	Perform combine adjustments	90	18	85	-	80	40	5	45.4
44.	Read operator manual	80	5	5	20	80	10	5	29.3
45.	Order parts for equipments	80	27	2	5	80	5	5	29.1
46.	Operate electric arc welder	90	18	1	80	40	10	18	36.7
47.	Can service and maintain engine	95	14	20	95	40	25	18	43.9

		1	2	3	4	5	6	7	AVG.
48.	Can prime fuel pump (diesel engine)	95	4	40	90	60	40	9	48.3
49.	Install and adjust belts and chains	100	54	95	0	100	30	9	55
50.	Install and adjust bearing and seals	100	45	93	70	80	20	5	59
51.	Service slip clutch (safety clutch)	90	9	97	90	40	20	18	52
52.	Know safety rules for combine operation	95	100	98	70	100	15	5	69
53.	Know curing time	80	27	60	75	80	5	-	47
54.	Know why cure peanuts	90	18	10	95	100	-	5	45
55.	Know why dry peanuts before storage	95	9	97	0	60	-	5	38
56.	Attended a combine dealer demonstration	100	72	-	70	80	-	-	46

<u>FARM MANAGEMENT</u>

		1	2	3	4	5	6	7	AVG.
57.	Can read the farm map	100	27	-	15	100	10	-	36
58.	Transpose field notes to farm map	80	18	-	-	100	5	-	29
59.	Use card inventory	70	9	2	6	80	-	-	23.8
60.	Order fuel	80	18	2	6	80	5	-	27.3
61.	Can identify termites damage	90	9	60	7	40	-	-	29.4
62.	Know peanut mold	60	4.5	20	40	-	-	-	17.8
63.	Know the effect of nematodes	60	0	60	6	-	-	-	18
64.	Plan working pattern or plan	80	9	2	3	60	-	-	22
65.	Can schedule operations in the field	90	9	3	6	60	10	-	25.4
66.	Can calculate cost/hr	60	-	-	20	20	-	-	14.2
67.	Can figure cost/acre	60	-	-	10	20	-	-	12.8
68.	Can calculate cost/man-hr.	60	-	-	2	20	-	-	11.7
69.	Identify mechanical damage (peanuts)	80	8	90	90	60	5	-	47.6
70.	Identify insect damage	75	45	93	6	-	-	-	25.5

SOIL		1	2	3	4	5	6	7	AVG.
71.	Identify soil type (clay, sand, sandy loam)	90	72	100	100	20	90	-	69.4
72.	Identify water logging	60	27	60	75	-	60	-	40.3
73.	Identify type of erosion	90	9	20	60	-	5	-	26.3
74.	Determine roughly percentage of soil moisture	70	4.5	10	-	-	20	-	14.9
75.	Determine land slope with land level	90	9	-	-	-	-	-	14.1
76.	Determine distance by use of farm level, pacing, chain and taping	100	36	-	90	100	-	-	46.6
77.	These are useful questions	100	100	70	90	100	50	-	72.9

TABLE 3

AREAS FOUND TO HAVE SIGNIFICANT
EFFECT ON PEANUT HARVEST LOSS
AND THE RATINGS OF:-

1. The Experimental findings--significance in percents.
2. The Management overall average rating.
3. The skill labor overall self-rating.

AGRICULTURAL MECHANICS	Experiment Result	Management	Skill Labor
1. Operation and adjustment of land plane			
2. Field plowing			
3. Field ridging			
4. Measurement of area in acres (fedans)			
5. Use of field level			
6. Tillage with a one-way plow			
7. Operation of a ridger			
8. Planting with a planter	100	55.6	46
9. Marker setting for precise planting, ridging, etc.			
10. Calibration of a planter and seed drill	100	22	56
11. Operation of a peanut digger	100	56.8	70
12. Assembly of a planter	100	55.6	30
13. Operation and adjustment of a row crop cultivator			
14. Operation and adjustment of a peanut combine	100	54.7	66
15. Assembly of a peanut combine	100	59	34
16. Checking and calculation of losses	100	24.3	32

		Experiment Result	Manage-ment	Skill Labor
17.	Checking of combine speed	100	34.9	34
18.	Checking and installation of proper belts in combine	100	44.1	76
19.	Checking and identification of after effects of combine cylinder speeds	100	45.3	46
20.	Checking and identifying the after effect of pick-up and header auger speeds	100	24.3	38
21.	Identify causes of losses	100	45.3	32
22.	The selection of the best depth of digging	100	48.7	98
23.	Identification of the proper digging speeds	100	47.7	86
24.	Identification of proper digging depth			
25.	Estimation of digging speeds/hr			
26.	Identification of proper soil moisture for digging	100	48.0	26
27.	Calculation of production/hr			
28.	Estimation of combine speed/hr	100	50.4	44
29.	Tractor hydraulic lift operation			
30.	Self unloading wagon cperation			
31.	Operator manual use (combine)	100	29.3	24
32.	Parts ordering for equipment			
33.	Electric arc welding operation			
34.	Acetyline welding operation			
35.	Service and maintenance of engine			

	Experiment Result	Management	Skill Labor
36. Fuel pump priming (diesel engine)			
37. Installation and adjustment of belts and chains	100	55.1	58
38. Installation and adjustment of bearings and seals			
39. Service of slip clutch (safety clutch)			
40. Safety rules for combine operation			
41. Curing of peanuts	100	45	76
42. Combine dealer demonstration	100	46	2
43. Calibration of sprayer (insecticide & herbicide)	100	51	37
Crop Production			
44. Identification of common weeds			
45. Identification of common insect damage			
46. Identification of common pests damage			
47. Chemical application			
48. Plant population count per acre (fedan)	100	45	31
49. Yield checks of peanuts			
50. Identification of peanut maturity			
51. Identification of cotton maturity			
52. The shellout method to determine maturity	100	14.8	92

SOILS	Experiment Result	Management	Skill Labor
53. Identification of common soil type (clay, sand, sandy clay)			
54. Identification of water logging			
55. Identification of type of erosion			
56. Determination of approx. percent of moisture	100	14.9	20
57. Determination of land slope with land level			
Farm Management			
58. The reading of a farm map			
59. Transposing notes to farm map			
60. Planning working pattern or plan			
61. Scheduling of operation in the field	100	64	49
62. Identification of mechanical damage (peanuts)	100	47.6	32
63. Identification of peanut mold	100	51	46
64. Usage of card inventory			
65. Ordering of fuel			
66. Determination of distance by use of farm level, pacing, chain and taping			