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# SHORT-TERM COTTON YIELD FORECASTING IN EGYPT

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| | |
|---|---|
| ANOVA | Analysis of Variance |
| APRP | Agricultural Policy Reform Program |
| ARC | Agricultural Research Center |
| AERI | Agricultural Economic Research Institute |
| ATUT | Agricultural Technology Utilization and Transfer (USAID funded project) |
| CAAE | Central Administration for Agricultural Economics |
| CACU | Central Agricultural Coops Union |
| CAAP | Central Administration for Agricultural Planning |
| CBE | Central Bank of Egypt |
| DF or df | Degrees of Freedom |
| EAS | Economic Affairs Sector |
| ESA | Egyptian Survey Authority |
| FAO | Food and Agriculture Organization (UN) |
| GARPAD | General Administration for Reclamation, Projects, and Agricultural Development |
| GIS | Geographic Information System |
| GOE | Government of Egypt |
| GTZ | Deutsche Gesellschaft fur Technische Zusammenarbeit |
| IFPRI | International Food Policy Research Institute |
| MALR | Ministry of Agriculture and Land Reclamation |
| MOA | Ministry of Agriculture |
| MPWWR | Ministry of Public Works and Water Resources |
| MS | Mean Square |
| MTS | Ministry of Trade and Supply |
| MVE | Monitoring, Verification and Evaluation Unit |
| PBDAC | Principal Bank for Development and Agricultural Credit |
| PSU | Primary Sampling Unit |
| RDI | Reform Design and Implementation Unit (APRP) |
| SS | Sum of Squares |
| US | United States |
| USAID | United States Agency for International Development |
| USDA | US Department of Agriculture |

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# EXECUTIVE SUMMARY


The objective of this report is to assess the nature and quality of short-term cotton yield forecasting in the MALR and to recommend improvements to procedures and models that will enhance the precision and timeliness of forecasts.

The assessment team was comprised of MALR, ARC, university, expatriate and MVE experts. Fact finding began by reviewing all past reports, instructions, manuals, models, and data; information about forecasting procedures used in other countries; and past models used in Egypt and potential models used elsewhere. Visits and interviews were conducted in national, governorate and district offices. Nearly 100 persons were contacted. The team observed actual fieldwork in four governorates (Behira, Dakahlia, Beni Suef and Assiut) and was able to offer recommendations and assistance to make immediate improvements in field procedures. The team gathered extensive data on sample plots to assist in the assessment and to support the modeling effort..

**Survey Methods.** Crop-cutting and forecasting methods have been proven in more than one country; they give reliable indications of yield and production *when properly applied*. Crop-cutting indications can be valid around harvest time, while forecasting indications can be valid many months before harvest begins. Both crop forecasting and crop cutting surveys should be continued with greatly improved survey methods. After several years during which forecasting methods have proven themselves, the reduction of cotton crop-cutting samples could be considered.

**Sample Selection.** The purpose of sample selection is to provide a sample that will represent all of the cotton varieties planted in different governorates and in the nation, so that future estimates and forecasts will give a true yield. It is very clear that the number of forecasting samples currently used in Egypt is too small and does not give good representation of the cotton by varieties or governorates. Current sample selection is not random. Convenience factors (transportation, time, and costs) sometimes take precedence over statistical representativeness. The selection of crop-cutting samples is done in a more statistically acceptable manner.

- The sample selection process should be reviewed and optimum allocations should be computed for both the forecasting and crop-cutting surveys. Optimum sample size should be based on estimates of precision and costs. Samples should be drawn with probability proportional to the area of each variety in each district.
- Resources should be provided to bring the forecasting work up to an operational level. Stratification efficiency should be measured regularly.

**Survey Timing.** Maturity of cotton varied somewhat among the different areas of Lower Egypt.

- The forecasting survey should begin in Upper Egypt with the last 10 days of June and in Lower Egypt, the last 10 days of July.
- Research should be initiated to determine if there are other areas that are consistently early and where forecasting could begin earlier.

**Survey Procedures.** During observation by the team of field work procedures and counting methods, it was found that few enumerators had any training or written instructions before the work began. Virtually all of the errors observed could be corrected with proper training and better equipment.

- The survey procedures should be clearly defined with a manual of written instructions for enumerator use.
- A set of sample recording forms should be designed; some proposed forms and instructions are included in the report.
- Coding should be added on each form to facilitate data entry.
- Early layout of the plot might help better identify the plots.

**Forecasting Models.** Data gathered during the study were subjected to extensive analysis. The results give sets of parameters for use in the survival, regression, and maximum fruit models.

- EAS/MALR should make cotton forecasts yearly using these forecasting models. It should incorporate yearly data into the forecasting database so that improved parameters can be developed for future years. It should add ancillary data (temperature, humidity, and previous crop) to the database and update these each year to enhance forecasting model development.
- EAS/MALR should continue to develop improved models to forecasting cotton production.
- EAS/MALR should develop a computer program to handle all aspects of data processing and analysis using commercial software that is easily available.
- EAS/MALR should look into early forecasts, maybe using the Maximum Bearing Fruit model.

**Other Components for Forecasting.** Forecasting models are used to forecast the number of open bolls that will be present at harvest time, and laboratory work is used to forecast the weight of the cotton in the field. Another important component of production forecasting is the estimated area planted to each variety in each governorate. If there are major errors in these numbers, they will cause errors in the forecasting of production, even if the yield model is perfect. Other adjustments may need to be made to forecast plot area, like harvest loss or economic adjustments. These need to be verified before they are made.

**Training**. The enumerators were generally interested in doing a good job but needed proper training. For the success of the sample survey system, it is essential that non-sampling errors be minimized. This can be largely achieved through adequate training:

- Intensive training of field staff both classes and field training. (Appendices contain recommendations on a training program.)
- Training of field supervisors to ensure that uniform procedures are followed.
- Training the statistical analysis group in analytical techniques.
- Training for data entry into software applications at the governorate level and creation of a database and aggregation at the national level. Applications will need to be developed for these.

**Staff Composition.** The sampling office staff is largely senior in pay grade and age.

- The Government should find a way to attract younger staff to work in sampling offices.
- Perhaps an independent section should be established--a sample forecasting branch--within the Directorate of Sampling.

**Incentives.** The forecasting and crop cutting work is often performed under less than ideal conditions. Fortunately, the enumerators seem to be very interested in this improved, more scientific approach to forecasting yields. To keep up the interest and quality of work, some incentive system will need to be devised. The CAAE has started to provide incentives for those doing excellent work on the forecasting project.

**Laboratory Procedures.** The set-up and maintenance of a laboratory to dry and weigh cotton and other crops to be forecast has long been a problem. The team experimented with sun-drying cotton and testing it to determine the moisture content.

- MALR should conduct research to ascertain whether sun-drying procedures would be a valid replacement for the laboratory system.
- Good scales are needed in field offices to weigh the boll samples before and after drying.

**Supplies and Equipment.** There was a shortage of measuring tapes, boll gauges and many other supplies. Scales for weighing the cotton in the field were old, not very precise, and not appropriate for forecasting work.

- Adequate supplies should be obtained. Most of the items are relatively inexpensive.
- Existing scales should be replaced with durable modern ones, which will withstand the rigors of field conditions.

**Vehicles.** A common problem shared by all of the sampling office staff is the critical lack of vehicles for enumerators to do their job. Rental of cars during the peak workload times has been used. Motorcycles are much more practical for the field staff to use.

**Future Research.** There are some areas where research or analysis would be beneficial:

- To determine the proper sample size and allocation. This should include studying the sampling frame, stratification process, and sampling process. This year's data from the study and the regular forecasting data are a good start on optimum allocation computations.
- To prove or disprove the adequacy of sun drying, or to devise an alternative procedure. Some additional laboratory work to derive a current conversion coefficient from seed cotton to lint cotton would be helpful.
- On alternative ways to locate forecasting plots in the field. The current "one meter from the crop-cutting plot" is causing damage to both plots. Field workers are standing in one plot while working on the other. Currently the crop-cutting plot has to be laid out in order to lay out the forecasting plot, so the plants in the crop-cutting plot are disturbed three months before they are needed.
- To determine fruit development patterns, timing, and survival rates. Experimental research plots for each variety could be established. This detailed research probably would best be done at experiment stations.

- To determine proper boll gauge size to distinguish between large boll status and small boll for each variety.
- To identify and quantify important factors affecting the growth and yield of cotton, and effective ways to capture them in surveys for use in the forecasting modeling.
- On changes in survey schedules to assure that observed differences are not just due to current weather, planting times, or other temporary factors. The use of maturity codes developed and used in the forecasting process might help in identifying plant development and maturation characteristics and in determination of the proper timing for forecasts and the parameters to include in the models.

# 1. INTRODUCTION

## 1.1 Objectives

The objective of this report is to assess the nature and quality of cotton forecasting in the MALR, and to recommend improvements to procedures and models that are expected to enhance precision and timeliness of forecasts.

## 1.2 Justification

The request to do this work came from the EAS of the MALR, who has had an interest in improvement of agricultural statistics for some time. Forecasts are very valuable to all those working in the cotton subsector special impetus was given no organization that tried to forecast the 1998 cotton production made an accurate forecast. This has been rationalized as due to pest control not being effective and high temperatures late in the season causing wilting and shedding of bolls. These are likely valid reasons for low production. However, a good forecasting program should include ways to identify these weather and insect problems when they occur and correct the subsequent forecasts to provide for these eventualities.

## 1.3 Background

Egypt has a long history of gathering statistical data, but the quality has been variable. Aprevious MVE report (Fawzy et al. 199 ) is recommended reading for those interested in detailed information. Prior to 1955, only subjective methods were used to estimate crop yields; for example, by talking to farmers and government field officers to obtain their personal judgements. Experience has shown that these estimation procedures are usually unreliable when subjected to a wide range of agricultural and economic conditions.

In 1955, Egypt began improving their estimates of crop production by moving towards more objective methods and sampling techniques. Mr. Koshal, FAO consultant, initiated crop-cutting experiments in Dakahlia for cotton and paddy on a pilot basis. In 1956, crop cutting was expanded nationwide for cotton, wheat and paddy. Crop cutting has continued through the years for cotton and some other crops with some success.

Forecasting began on a pilot basis for cotton in Kafr El Sheikh in 1984. This work was initiated and supported under the Data Collection and Analysis project of USAID with the MOA (now MALR) and AERI. During 1985 and 1986 data collection was expanded to Assiut, Dakahlia, and Minya. Changes in management brought all forecasting work to a standstill in 1986. A forecast was made in 1989. Attempts to forecast cotton have been made since 1991, though at a greatly reduced level. Details on the estimating and forecasting programs are given later in the report.

The development of these activities through the years has resulted in a large number of sampling staff being available, but other factors discussed in the report have reduced their effectiveness. Correction of these factors may enable improved forecasts and estimates to be obtained rapidly.

## 1.4 Review of Relevant Methods Used in Other Countries

Subjective methods to estimate crop production have long been used. Asking key people is a favorite method. Observation of crops in specific areas of the country and correlating their condition with final production is another method. Recently some countries have tried aerial or satellite remote sensing techniques to forecast crop production. These methods have been somewhat successful if ground truth information is also gathered. The expense and difficulties of these procedures have limited their use.

Objective methods were started by FAO in the 1950s with the first widespread effort to make crop-cutting experiments. Plots are laid out and the crop in the plot is harvested and weighed. From this an estimate of the yield per unit area is made. Variations of these crop-cutting methods are used in many developing countries.

The USDA in the early 1960s developed the objective forecasting techniques for major crops. The techniques and models were developed and improved through the years and are the mainstay of yield forecasts for the country.

Egypt uses crop cutting methods to estimate yield and production. They have tried using objective forecasting techniques, patterning their work after the US procedures. Economic and operational problems have hindered development.

## 2. METHODOLOGY AND IMPLEMENTATION

### 2.1 General Definitions (Forecast vs. Estimate)

The terms forecast, estimate and prediction are used in reports and in the news media. These words are often interchanged and misused. Therefore, let us define the correct usage that will be used in this report. We relate these definitions to crop production.

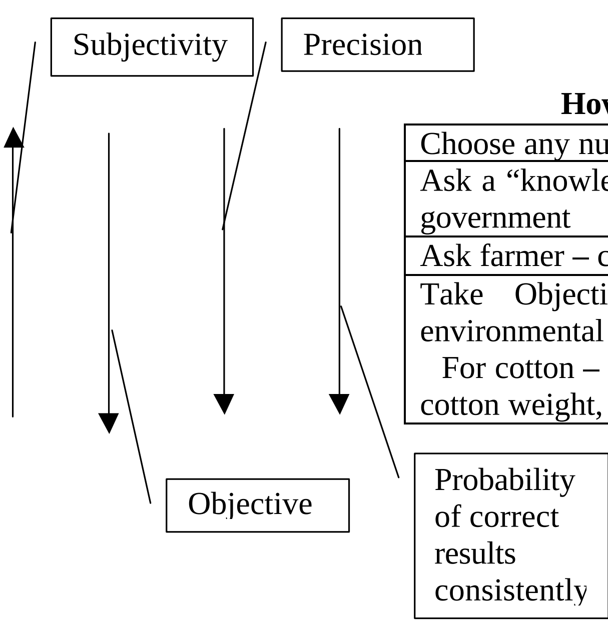
**Figure 1: Timing of Forecasts, Estimates and Predictions**

| Forecast | | Estimate | | Prediction |
|---|---|---|---|---|
| Crop planted | Growth and Maturation | Begin Harvest | End Harvest | |
| Current year's production | | | | Future Production |

Notice in the above diagram that the terms relate to the timing of the event. The event is the cotton harvest. The *estimate* is made just prior to and after the event (cotton harvest) begins. The number desired from the event is the final cotton production. A *forecast* is made earlier, before the event has begun to occur (before harvest begins). It is usually based on observations and measurements of the system under study (cotton production process). A *prediction* is a statement about expectations for future events (cotton production in future years). This is usually predicated on knowledge of past relationships and expectations of future conditions.

This paper will address only forecasts and estimates.

**Figure 2: How Forecasts and Estimates Can Be Made and Their Relative Value**




**How estimate or Forecast is made**

| |
|---|
| Choose any number out of the air |
| Ask a "knowledgeable" person in industry, business or government |
| Ask farmer – could use a statistical sample |
| Take Objective measurements on fields, plants, environmental factors<br>For cotton – number of plants, squares, bolls by sizes, cotton weight, moisture, quality |

Forecasts and estimates can and are made many different ways as seen above. Picking a number out of the air is very risky. A knowledgeable person can be a valuable source of accurate information. However, a person must really be "knowledgeable." There are many persons in positions promoting themselves as experts whose statements have shown otherwise. Statistical samples and objective measurements have been proven to provide precise and timely information in many countries of the world.

## 2.2 Overview of Yield Estimating Procedures

### 2.2.1 Crop Cutting Yield Per Feddan

Cotton crop cutting is a process that involves many plots randomly located throughout the cotton producing area. When the crop is mature and ready for harvest, all cotton is harvested from these sample plots by hand and weighed. These weights from the sample plots are expanded to the unit area level to give estimates of the weight of cotton per unit of area.

$$\left[\begin{array}{l}\text{Weight of cotton}\\ \text{in crop cutting plot}\end{array}\right] \times \left[\frac{4200\ m^2 / \text{feddan}}{10.5\ m^2 / \text{plot}}\right] = \left[\begin{array}{c}\text{Weight of cotton}\\ \text{per Feddan}\end{array}\right]$$

### 2.2.2 Forecasting Yield Per Feddan

Forecasts are made early in the season, before the cotton has matured and can be weighed. Therefore, the process of forecasting must rely on measurements and counts of the plants in the sample plots. A simplified representation of the process to determine the yield of cotton is given below. More detail will be given later on how these components are computed.

$$\left[\begin{array}{l}\text{Average number of}\\ \text{Bolls forecast per plot}\end{array}\right] \times \left[\begin{array}{c}\text{Average weight}\\ \text{per boll}\end{array}\right] \times \left[\frac{4200\ m^2 / \text{feddan}}{3\ m^2 / \text{plot}}\right] = \left[\begin{array}{c}\text{Weight of cotton}\\ \text{per Feddan}\end{array}\right]$$

The forecasts or estimates of the weight of cotton per feddan can be averaged together using cotton area weights to arrive at a variety, governorate or national estimate of yield. These yields can be multiplied by cotton area estimates to arrive at production estimates.

## 2.3 Forecasting Components to Be Assessed

The table below specifies three major aspects known to affect the accuracy of cotton estimates and forecasts, and how well they represent the true population.

**Table 2-1: Major Aspects of Cotton Yield Estimates and Forecasts**

| Major Aspects<br>And Some Specific Topics | Crop Cutting Surveys | Forecasting Surveys |
|---|---|---|
| **Sampling Procedures** | | |
| • Sampling Frame and Stratification | x | x |
| • Sample size determination and allocation | x | x |
| • Methods of sampling | x | x |
| • Field Selection and Identification | x | x |
| **Survey Procedures** | | |
| • Field Instructions and Data Recording Forms | x | x |
| • Field Selection and measurement | x | x |
| • Sample plot selection, lay-out and identification | x | x |
| • Counting procedures in plot | - | x |
| • Picking and weighing procedures | x | x |
| **Forecasting Procedures** | | |
| • Data entry, manipulation and summary process | - | x |
| • Forecasting models used - past and current | - | x |
| • Factors affecting growth and yield that might be utilized in forecasting models – plant growth characteristics, weather, cultural practices, economic conditions | - | x |
| • Potential model investigation – current data expansion, regression, survival, maximum bearing fruits, combinations of these or other possible models | - | x |

These areas of study are closely interrelated. One can argue the relative importance of each, but the failure or misuse of any one can render a forecast invalid.

## 2.4 Implementation of Assessment by MVE team

The following are the tasks undertaken by the MVE team:

- Selection of a team comprised of MALR, ARC, university, expatriate and MVE staff experts.
- Establishment of the goals for forecasting cotton.
- Review of all past reports, instructions, manuals, models, and data.
- Review of information about forecasting procedures used in other countries.
- Review of past models used in Egypt and potential models used elsewhere.
- Review of all available data and how they were used to make forecasts.

The team reviewed all materials that they could find related to the procedures used in the past by Egyptian agencies. Also a review was made of materials from external sources regarding techniques used in other countries to forecast or estimate crop production. An analysis of the materials obtained was done to determine the quality, strengths and weaknesses of past procedures in order to help the team plan their work and discover improved ways to forecast crop yield and production.

- Visits and interviews in national, governorate, and district offices.

  The team visited the four study governorates and sample districts. At each they interviewed the governorate leaders, especially the governorate sampling office heads and sub-office heads when appropriate. In districts they worked with the field staff and often had chances to interact with local officials who stopped by to learn what the teams were doing. The team asked the officials about the past and present procedures, their opinion about the accuracy of the methods, their problems and constraints in doing their work, their training level and what they felt was needed to improve the forecasts. The results of the discussions are given in the report. The detail of these discussions can be found in Appendices G and H. Also a listing of most of those persons visited or with whom the team worked is in Appendix G. Nearly 100 persons were contacted by the team.

- Observation of current fieldwork, documents and estimation process.

- Field observations of current procedures in crop cutting and forecasting plots

  The team felt that actual observation of the sampling procedures, data gathering methods and forecasting methods was critical to their assessment and recommendations for improvements. During interviews with officials they heard how the work was being done, theoretically. As they asked further detailed questions, they found that the actual methods were often different. Likewise, as they observed the work being done in the field, they saw methods used that were reducing the precision of the results. These practices were being done without the staff realizing the negative effects. The team helped correct some of these improper procedures during the initial visits and designed forms for recording the data for all subsequent visits. These improvements undoubtedly helped this year's forecasting to be more precise.

  Field procedures are critical to the estimation or forecasting process. The most sophisticated model or method for forecasting is of little value if the data put into the process are not reasonably precise and derived in the expected manner. When one considers that each plant or fruit in the sample plot represents 1400 others in a feddan, it becomes clear that accuracy in laying out the plot and making counts is very important. The importance of just one plant or fruit is often overlooked by the enumerator when counting in the field on a hot day. Thus it was important for the team researchers to observe just how the data were being gathered

- Testing of new procedures and forms

  The team has found that it is always important to suggest and test new procedures while the work is under way. During the gathering process, other questions arise which, when answered, give further insights into the process. Ideas for improvement are generated. When questions about the data arise during the assessment process, those involved in the data gathering process can better understand what is taking place.

While in the field the team's researchers can devise better methods, procedures and forms for future improvements to the MALR staff. These can also be tested under field conditions to determine how well they will work.

- Assessment of past and present procedures to determine those that might be used in the future.
- Assessment of how well the sample represents the cotton population.
- Identification of plant growth characteristics; how they vary by variety or location.
- Determination of how plant characteristics can be used to forecast yield.
- Analysis of past forecasts relative to other estimates and information.
- Recommendations of models for future forecasting work along with a schedule of implementation.
- Recommendations for improved sampling procedures.
- Recommendations of improvements to survey procedures and forms.
- Recommendations of procedures and models that should provide accurate, timely, cost effective forecasts and be manageable. If possible include an estimate of manpower, equipment and budget requirements.

### 2.5 Study Areas and Field Work

The MVE team chose four governorates based on their importance in cotton production and to provide dispersion geographically. The governorates are: Dakahlia, Behira, Beni Suef and Assiut. Within each governorate, two districts were selected, except in Behira, which had three. Each district in Lower Egypt had a different variety of cotton. In Upper Egypt, each governorate had different variety. This diversity of study areas enabled testing for differences by variety and locality.

The full team spent two days in each governorate interviewing and visiting forecasting fields. The team visited two to five sample plots in each governorate. To demonstrate the needed intensity and commitment, the team worked long days in the field, often until 7 PM. These efforts did provide broader knowledge.

Two researchers were assigned to supervise two governorates each. During July, August and September, they spent five days in their respective assignments. They spent long days visiting the sample plots and working with the local enumerators. In addition, a supervisory researcher worked with the two researchers to assist and verify work. New procedures were also tested during these times.

Many difficulties were encountered in the field during the visits, ranging from irrigation to village feud problems. Operational problems were encountered from equipment to transportation. The details of the visits are given in Appendices G and H, with summaries in the report.

# 3. ASSESSMENT OF SHORT-TERM FORECASTING PROCEDURES

## 3.1 Sampling Procedures

The purpose of sampling is to select samples that will properly represent the cotton varieties in governorates and the nation so that estimates and forecasts will give a true yield. Sampling procedures include the sampling frame, stratification methods, sample allocation methods, and the sample selection process. This section describes the sampling procedures used for crop cutting and forecasting to get down to the selected field. The procedures used once one gets to the field are discussed in the next section.

### 3.1.1 Background

For crop cutting, stratified multi-stage sampling was usually adopted by MALR for the estimation of the yield ratio, the districts, and agricultural units within districts. It is constituted as strata, a cluster of hodes of about 200 feddans as primary sampling unit in which the experiment plots are located in three additional stages of sampling. For the maximum economy of yield work and supervision, it was described that as far as possible, the experiments for at least three crops which are cotton, maize and paddy, are to be conducted in the same cluster in summer, and of wheat, beans and onion in winter. The same "frame" of clusters is therefore used for the whole year and appropriate number of clusters in the order of random selection are obtained for each crop. The selection of common clusters for crop sampling work is a unique feature in Egypt to maximize economy.

Within each selected cluster, two growing parcels of the crop were selected out of all parcels. This constitutes the second stage of sampling. In each selected parcel, a field is selected at random out of all fields, and this forms the third stage of sampling.

The fourth and the last stage of sampling consists of locating the plot of prescribed dimensions (7m x 12m) for cotton, within the selected field, and (6m x 7m) for wheat and paddy. After 1970, they started to decrease the plot size to be (6m x 7m) 1/100/feddan for cotton, and finally (3.5m x 3m) 1/400/feddan, and (2m x 2m) for wheat and paddy).

Crop cutting samples are sub-sampled to obtain the forecasting samples. A stratified multi-stage sampling procedure is usually used for all crop cutting work. The sampling procedures have not changed much over the years, and the sample size has not increased with the survey coverage area (reference Table 3.1). The crop cutting samples are reasonably representative of the cotton population. However, there should be an analysis of survey data to obtain an optimum allocation.

### 3.1.2 Intended Sampling Procedures for Cotton Forecasting Survey

The forecasting survey has always been related to the cotton population through the crop cutting sample distribution. During the pilot work, forecasting surveys were made in 50% of the crop cutting samples. This was certainly a representative sample for the pilot governorate.

**Table 3-1: Cotton Crop Cutting and Forecasting Sample Sizes 1990-1998**

| Governorate | Crop Cutting Sample Size | | | | | | | | | Forecasting Sample Size |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1990** | **1991** | **1992** | **1993*** | **1994** | **1995** | **1996** | **1997** | **1998** | **1990-1998** |
| **Behira** | 380 | 350 | 350 | | 430 | 430 | 430 | 430 | 430 | 90 |
| **Gharbia** | 374 | 350 | 336 | | 274 | 330 | 314 | 314 | 314 | 40 |
| **Kafr El Sheikh** | 392 | 395 | 385 | | 400 | 400 | 356 | 360 | 360 | 50 |
| **Dakahlia** | 456 | 410 | 394 | | 318 | 334 | 382 | 366 | 366 | 66 |
| **Damietta** | 88 | 80 | 80 | | 70 | 270 | 78 | 102 | 102 | 20 |
| **Sharkia** | 426 | 416 | 386 | | 344 | 356 | 360 | 334 | 328 | 75 |
| **Menofia** | 266 | 254 | 250 | | 206 | 214 | 230 | 250 | 250 | 40 |
| **Qalubia** | 168 | 160 | 158 | | 120 | 160 | 170 | 140 | 140 | 30 |
| **Beni Suef** | 210 | 200 | 200 | | 198 | 220 | 250 | 246 | 246 | 35 |
| **Fayoum** | 180 | 176 | 164 | | 188 | 190 | 190 | 138 | 138 | 25 |
| **Menya** | 330 | 320 | 332 | | 316 | 324 | 320 | 280 | 280 | 53 |
| **Assiut** | 286 | 262 | 258 | | 216 | 238 | 250 | 220 | 220 | 55 |
| **Sohag** | 232 | 224 | 232 | | 112 | 140 | 154 | 124 | 124 | 49 |
| **Total Egypt** | **3788** | **3597** | **3525** | **3698** | **3192** | **3606** | **3484** | **3304** | **3298** | **628** |

Source: MALR, Central Administration for Agricultural Economics, Department of Sampling, unpublished data.
*Details are not available.

However, as the forecasting work expanded into other governorates, budget considerations and changes in priorities were given as reasons for such drastic changes in forecasting sample representation. In the late 1980s the sample size was just over 500, which was about every 6th crop-cutting sample. In the 1990s, forecasting samples were limited to one per stratum. This meant an average of only about 5 forecasting plots per district even though the areas of cotton varied drastically between districts. This distribution of samples was far from representative of the actual cotton area. Table 3.1 shows that the number of forecasting samples, at the national level, has been 628 during the period 1990-1998, while coverage of governorates increased.

Table 3.2 shows the governorates and districts in this study. Total cotton area, sampled areas and distributions are given. The team selected study areas to give broad coverage of geographic areas, with two in the Delta and two in Upper Egypt. The purpose was to cover diverse varied, climatic and operational conditions. The desire was to cover all possible operational problems and potential modeling constraints. Detailed reports for individual governorate work are in appendices G and H.

**Table 3.2: Cotton Districts, Varieties, Area, and Forecasting Sample Distribution, 1999**

| Governorate | District | Variety | Total Area (feddans) | Sample Area (feddan) | No. of Strata | No. of Forecasting Plots | No. of Team Supervised Plots |
|---|---|---|---|---|---|---|---|
| **Behira** | Abu Homos | G 70 | 69,000 | 34,482 | 11 | 11 | 3 |
| | Damanhour | G 89 | 80,000 | 23,017 | 8 | 8 | 3 |
| | Rahmania | G 88 | 1,059 | 1,059 | 1 | 5 | 3 |
| **Total** | | | **150,059** | **58,558** | **20** | **24** | **9** |
| **Dakahlia** | Belkas | G 86 | 49,271 | 30,187 | 7 | 6 | 3 |
| | Manzala | G 85 | 47,810 | 20,436 | 4 | 6 | 3 |
| **Total** | | | **97,081** | **50,623** | **11** | **12** | **6** |
| **Beni Suef** | Wasta | G 80 | | 2,480 | 5 | 5 | 3 |
| | Ahnasia | G 80 | | 5,871 | 5 | 5 | 3 |
| **Total** | | | **26,800** | **8,351** | **10** | **10** | **6** |
| **Assiut** | Abu Tig | G 83 | | 2,085 | 4 | 6 | 3 |
| | Abnob | G 83 | | 3,861 | 1 | 5 | 3 |
| **Total** | | | **25,983** | **5,946** | **5** | **11** | **6** |
| **Grand Total** | | | **299,923** | **123,478** | **46** | **57** | **27** |

Source: Collected by the study team.

### 3.1.3 Observed Sampling Procedures

The team did not observe the crop cutting or forecasting sample selection process. This was completed before the team began their work. The process was explained to the team. The ministry staff expressed strong concern about the selection process for the forecasting samples.

### 3.1.4 Assessment of Sampling Procedures

Forecasting plot samples were originally taken in 50% of the crop-cutting samples This gave a good representation for the population in the forecasts. However, the current procedures for sample allocation and sample size are clearly inadequate. Now around five forecasting samples are selected per district, regardless of the number of feddans in that district. For example, one sample is taken in a stratum whether it has 100, 300 or 4,000 feddans. Clearly this is not going to give a very representative forecast. Also, the selection of the one sample is usually done for convenience, which is often the first selected name of the first randomly selected cluster in the stratum.

### 3.1.5 Findings and Recommendations for Sampling Procedures

The sample size and allocation are not adequate for good forecasting results. The *1999 sample allocation* process was completed early in the season before this study was initiated. The current allocation and selection procedures tie the forecasting sample directly to the crop-cutting sample. This was done for efficiencies in fieldwork and to enable comparison of results during the pilot phase. There are some good arguments for having the samples drawn independently, but that is not advocated because of the increased expenses. If the crop cutting sample is representative of the cotton population and the forecasting sub sample is also representative, then the process is adequate. However, the current sub sample taken for the forecasting survey is not at all representative.

The population *sampling frame* should be reviewed to assure that stratum definitions and boundaries are realistic. The team believes strongly that the whole sample allocation should be reviewed. An optimum allocation of the crop cutting survey data and the forecasting data need to be computed. There should be a sufficient number of year's data for crop cutting allocation. The 1999 CAAE forecasting data and the team's data may help for forecasting allocation.

## 3.2 Survey Procedures

### 3.2.1 Intended Survey Procedures

This section will discuss the intended survey procedures that are theoretically used by MALR to gather data for the respective estimates or forecasts. These are generally the procedures studied under previous projects. Some of the key factors to be discussed are:

- The plot size, shape, location.
- The measurements and layout of the plot.
- The measurements and counts taken within the plot.
- Quality checks and verification methods.

Crop cutting plot size and shape have changed through the years from large to smaller rectangular shape and then to nearly square (7 x 12 to 3 x 3.5). Plots are randomly located based on field measurements. Plots are laid out according to specific instructions, which have changed throughout the years. Within the plots, all cotton is picked from plants and off the ground. The total weight of cotton is recorded. The work in the plot has remained the same throughout the years. Details for the crop cutting procedures are covered in Appendix A.

**Plot size, shape and location.** The plot size is very important. A large plot is expensive and difficult to work, but is tolerant of small errors in field techniques. While small plots are inexpensive to work, they are extremely sensitive to small errors in technique. For example, in a small plot the inclusion or exclusion of just one cotton boll in the data can cause a large error in the forecasting. So the researcher must determine the proper plot size to minimize the cost and maximize the precision. The shape of the plot is important for reducing potential errors by enumerators as they gather data, and to minimize disruption to plant growth and maturation. The procedures for locating the sample plots should be done in such a way as to assure that all possible parts of the field have a chance to be included. With proper location of sample plots in sufficient numbers, the survey results should closely represent all growth and cultural conditions in the country, and the forecasting will be precise.

As a result of research in other countries, the forecasting sample plot has always been targeted to be 3 $m^2$ and the expected shape was to be 1 x 3 meters. The actual dimensions have varied due to the location and lay-out procedures. The size, shape and location of the forecasting plot were a concern of the team and will be addressed later.

**Measurements and layout of the plot.** Proper measurement and layout of sample plots is mainly a function of good training and quality of field staff. The concepts and techniques are not difficult, but do require that staff follow procedures correctly even under less than optimum conditions. These operations are important because they affect precision of survey data and the resultant forecasting. The finding of the team will be discussed in a later section.

**Measurements and counts taken within the plot.** For the crop cutting survey, the work within the plot involves picking and weighting all cotton, but is done only once at harvest time.

In order to provide forecasts many months before harvest begins, the forecasting process is more complex and requires many counts and measurements within the plot. The following data are gathered during the last ten days of July, August and September plus a final harvest visit (usually October):

Number of Plants
Number of Large open bolls
Number of Damaged open bolls (infected bolls)
Number of Partially open bolls
Number of Large unopened bolls
Number of Small bolls
Number of Blooms
Number of Squares

- Pick and weigh up to 20 open bolls

  Forecasting enumerators picked 2 separate batches of open cotton in the sample plots each of the 3 months the plots were visited. The first, picking of up to 20 open bolls, starting from the bottom of plants in odd numbered samples and the top of the plants in even numbered samples. The first batch, containing up to 20 open bolls, was weighted in the field and sent to the laboratory.

- Send picked bolls to laboratory, to dry and weigh

  In the laboratory, the cotton was oven dried and re-weighted. The dry weight divided by the pre-dried weight gave a drying ratio, which expressed how much of the weight of field seed cotton would remain after the moisture was removed.

- Pick and weigh all remaining cotton in the sample plot

  The second batch of cotton picked by the enumerators was weighed in the field. Adding the field weights of the two batches of cotton together gives a field weight of cotton in the sample plot. Multiplying this field weight by the drying ratio gives an estimated dry weight of cotton in the sample plot. Also, dividing the field weight by the total number of bolls gives an average field weight of seed cotton per boll.

Each month the burrs from picked cotton and any damaged fruit are removed and carried away from the unit.

**Quality checks and verification method.** If one is to know how the data is really collected and the quality of the data, there must be some monitoring of fieldwork and a data verification process. To often this is the first operation eliminated when budgets get tight, and many organizations "talk" quality control but few actually do it. It is a waste of money and effort to make an estimate or forecasting if one does not have assurance that the data is of good quality and reliable. The team heard many statements questioning the quality and reliability of the data and procedures.

Quality checks can be built into the survey procedures. A sample of an enumerator's plots can be checked by a supervisor. The enumerator does not know which one will be checked so must do all of his work well. Field forms can be designed to assist and check for valid data. Data checks can be built into the computer processing.

### 3.2.2 Observed Survey Procedures

The actual procedures used now differ greatly from the above theoretical procedures and have gone through several changes. The forecasting plot location, measurement and layout have always been closely tied to the crop-cutting plot. This was originally done to make comparisons of the two survey results easier. There are a few advantages to having them closely related, but many disadvantages. These will be revealed in discussions later.

Targeted plot size $3m^2$ and shape 1 x 3 have been constant, theoretically. However, changes in layout instructions and difficulty in properly performing plot layout has resulted in too much variation in plot size. Some of these were recognized and an attempt to correct the data mathematically was made. Much improvement can be made and some alternatives are suggested later in the report.

The biggest changes have come about in the counting procedures and survey frequency. During 1991 to 1996 only two monthly visits were made. In 1997 and 1998 only the August visit was made. During this August visit only the number of large bolls and small bolls were counted. Work was done during the last 10 days of August. The reason given for these procedural changes was lack of incentives, equipment, transportation and training. (In the 80's they received 30 LE/month which is like 300 LE now.).

The forecasting procedure requires having a laboratory in which to weigh and dry cotton (and other crop) samples. The laboratory location was originally in Cairo in cramped facilities run by the national office personnel. Obtaining and maintaining the equipment has always been a big problem. Trying to get equipment out of customs has been a major problem, sometimes taking 3-4 months and thus delaying the work tremendously. Finding a location and obtaining proper electrical and ventilation for the facility has been a problem. In the past, conflict between leaders over who should be responsible for the laboratory has delayed the work. Half of the equipment may have disappeared and some of what is available is not functional.

### 3.2.3 Assessment of Survey Procedures

The following tables give some information gleaned from the visits. Table 3-3 gives an overview of the workload of the governorate sampling offices. It shows the area in feddans in the crops and the number of crop cutting samples in each. They do have many samples to take.

**Table 3-3: Sample Size and Area of Crops for Crop Cutting Experiments at the Governorate Level, 1999**

| Crop | Behira | | Dakahlia | | Beni Suef | | Assiut | |
|---|---|---|---|---|---|---|---|---|
| | Area/ Feddan | Sample Plot | Area/ Feddan | Sample Plot | Area/ Feddan | Sample Plot | Area/ Feddan | Sample Plot |
| **Wheat** | 219235 | 470 | 240350 | 572 | 114020 | 280 | 132158 | 322 |
| **Beans** | 52931 | 144 | 69453 | 190 | 2698 | 18 | 18888 | 48 |
| **Lentils** | 0 | 0 | 61 | 6 | 0 | 0 | 3828 | 24 |
| **Homos** | 125 | 4 | 0 | 0 | 56 | 4 | 18593 | 12 |
| **Onion** | 8224 | 46 | 5873 | 72 | 13936 | 94 | 6533 | 50 |
| **Kamon** | 0 | 0 | 0 | 0 | 0 | 0 | - | 22 |
| **Garlic** | 3964 | 52 | 0 | 0 | 5561 | 32 | 519 | 12 |
| **Cotton** | 155906 | 340 | 97081 | 340 | 26877 | 200 | 25983 | 200 |
| **Rice** | 184055 | 440 | 421260 | 519 | 604 | 4 | 0 | 0 |
| **Maize** | 124832 | 330 | 64175 | 547 | 10560 | 180 | 85513 | 176 |
| **Sorghum** | 0 | 0 | 0 | 0 | 1002 | 14 | 140339 | 188 |
| **Peanuts** | 4315 | 28 | 0 | 0 | 377 | 8 | 3510 | 24 |
| **Sesame** | 378 | 10 | 0 | 0 | 624 | 12 | 4615 | 32 |
| **Soybeans** | 72 | 6 | 25 | 4 | 2520 | 24 | 648 | 14 |
| **Sunflower** | 545 | 32 | 307 | 12 | 297 | 16 | 119 | 8 |
| **Potato** | 13207 | 270 | 18511 | 298 | 0 | 0 | 0 | 0 |
| **Barley** | 0 | 0 | 195 | 5 | 0 | 0 | 0 | 0 |
| **Kanola** | 0 | 0 | 70 | 5 | 0 | 0 | 0 | 0 |
| **Tomato** | 11885 | 55 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Millet** | 7415 | 32 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | **787089** | **2259** | **917361** | **2570** | **179132** | **886** | **441246** | **1132** |

Source: MALR, Central Administration for Agricultural Economics, Department of Sampling, unpublished data.

Table 3-4 shows the vehicles available to do the work, giving present and future requirements.

**Table 3-4: Transportation (Owned and Rented) for Sampling Offices, Present and Future Requirements, (Study Governorates, 1999)**

| Variety | Dakahlia | | Behira | | Beni Suef | | Assiut | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Present State | Future Require -ments | Present State | Future Require-ments | Present State | Future Require-ments | Present State | Future Require-ments | Present State | Future Requir-ements |
| ***Owned*** # Cars | 2 | 4 | 2 | 2 | 2 | 2 | 3 | 2 | 9 | 10 |
| # Motor-cycles | 25 | 30 | 13 | 10 | 8 | 7 | 18 | 5 | 61 | 27 |
| ***Rented*** Days/Year | 30 | - | 66 | - | 80 | 120 | 60 | 20 | 186 | 80 |
| **Cost/Day (L.E)** | 40 | - | 45 | - | 45 | 45 | 35 | 35 | 45 | 85 |

Total: Present + future requirements - present need repairs or renew.
Source: Study team interviews & investigations.

Table 3-5 gives the number of years that our survey governorates have been doing the work.

Table 3-6 shows the past training of staff and future requirements. Clearly there is a strong need for formal and field training!

**Table 3-5: History of Forecasting in the Sample Governorates**

**(Number of Years)**

| Crop | Dakahlia | Behira | Beni Suef | Assiut |
|---|---|---|---|---|
| **Cotton** | 15 | 10 | 13 | 15 |
| **Wheat** | 0 | 0 | 0 | 1 |
| **Maize** | 0 | 0 | 0 | 0 |
| **Rice** | 0 | 0 | 0 | 0 |
| **Citrus** | 0 | 1 | 0 | 2 |

Source: Study team interviews & investigations.

**Table 3-6: Number of Staff Having Completed Training on Forecasting, by Governorate, 1984-1988**

| State | Dakahlia | | Behira | | Beni Suef | | Assiut | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Internal Training | External Training | Internal Training | External Training | Internal Training | External Training | Internal Training | External Training | Internal Training | External Training |
| **Present State** | 24 | 1* | - | 1* | - | - | - | 1* | 24 | 3 |
| **Future Requirements** | 40 | 10 | 50 | 5 | 15 | 5 | 35 | 5 | 140 | 25 |
| **Total** | 64 | 11 | 50 | 6 | 15 | 5 | 35 | 6 | 164 | 28 |

* Retired
Source: Study team interviews & investigations.

Table 3-7 gives numbers of staff by job classification. Notice that many staff are senior, and many are reaching retirement age.

**Table 3-7: Number of Employees in Study Sampling Offices According to Job Classification, 1999**

| Class | Dakahlia | | Behira | | Beni Suef | | Assiut | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % | No. | % |
| **1st Class** | 62 | 60 | 51 | 45 | 14 | 51 | 18 | 23 | 145 | 45 |
| **2nd Class** | 11 | 11 | 9 | 8 | 6 | 22 | 37 | 47 | 63 | 19 |
| **3rd Class** | 15 | 15 | 19 | 17 | 1 | 4 | 12 | 15 | 47 | 15 |
| **4th Class** | 4 | 4 | 6 | 5 | 1 | 4 | 8 | 10 | 19 | 6 |
| **5th Class** | 3 | 3 | 7 | 6 | 5 | 19 | 3 | 4 | 18 | 5 |
| **6th Class** | - | - | 1 | 1 | - | - | 1 | 1 | 2 | 1 |
| **With Contractors** | 7 | 7 | 21 | 18 | - | - | - | - | 28 | 9 |
| **Total** | **102** | **100** | **114** | **100** | **27** | **100** | **79** | **100** | **322** | **100** |

Source: Calculated from the surveyed area of the study.

Observation during fieldwork indicated a great need for training of the staff. There were many problems and constraints facing the sampling staff during fieldwork on each visit. Also, there were no clear instructions to follow and forms on which to record data. The supervision was not effective. There was no incentive for the enumerator to do the extra work. We can summarize the problems and constraints from the field visits and supervision as follows:

**First visit (last 10 days of July).** With regard to locating and measuring cotton forecasting plots, the team found:

- The crop forecasting plots are usually located in relation to their respective crop cutting plots, usually the corner opposite to the southwest corner by one meter. In many cases we found the plot at other corners or parallel to the crop-cutting plot.

- Stakes were not placed exactly in the middle of the furrow bottoms and measurements of plot sides were not correctly made.

- Most of the enumerators do not have calculators to compute the plot length ($3m^2$/ width of plot).

- Measurements to locate the plot were not taken precisely.

- Measurements were taken over the plants instead of near the ground. This made 5 – 10 cm differences in the measurements.

- The planted furrows are not always parallel and therefore plot lengths/shapes could be other than rectangular.

- Enumerators often measured only three sides of the plot supposing that the remaining side of the plot was equal its opposite side and thus the plot area was exactly $3 m^2$.

- No diagonal measurements of the plot were taken to check on correct plot area.

- Planting patterns differed from one field to another. Clear instructions need to be given to enumerators on how to layout the plots for each cropping pattern.

- Some plots included two rows and the others included only one.

- No diagram was drawn for the field and sample plot locations.

The location and measurement problems discussed above affect the accuracy of the plot size that is supposed to be $3m^2$. Tables 3-8 & 3-9 show the deviations observed by the MVE team.

**Table 3-8: Accuracy of Forecasting Plot Areas for Cotton Study 1999 Percentage of Errors and Coefficient of Adjustment, Behira – Dakahlia**

| Governorate | District | Village | Number of Rows | Plot Area ($m^2$) | Coefficient of Adjustment | Error (%) |
|---|---|---|---|---|---|---|
| Behira | Damanhour | Bastara | 2 | 3.063 | 0.9795 | +2.00 |
| | | Sanhour | 2 | 3.308 | 0.9070 | +9.30 |
| | | Emaria | 2 | 3.075 | 0.9756 | +2.40 |
| | Abu Homos | Besentway | 2 | 3.240 | 0.8694 | +13.03 |
| | | Nakhla Baharia | 2 | 3.067 | 0.9782 | +2.18 |
| | | B. Ghatas | 2 | 3.000 | 1.0000 | 0.00 |
| | Rahmania | Semokhrat N | 2 | 3.187 | 0.9412 | +5.88 |
| | | Semokhrat A | 3 | 3.000 | 1.0000 | 0.00 |
| | | K. Ghoneim | 2 | 3.000 | 1.0000 | 0.00 |
| Dakahlia | Manzala | Mershak | 2 | 3.290 | 0.9120 | +8.80 |
| | | Amara | 2 | 2.945 | 1.0187 | -1.87 |
| | | K. Gamalia | 2 | 2.970 | 1.0100 | -1.00 |
| | Belkas | Basandila | 2 | 3.325 | 0.9020 | +9.80 |
| | | Tal Amara | 2 | 3.210 | 0.9345 | +6.55 |
| | | Demelash | 2 | 3.315 | 0.9050 | +9.50 |

Source: Calculated from the surveyed area of the study.

**Table 3-9: Accuracy of Forecasting Plot Areas for Cotton Study, Percentage of Errors and Coefficient of Adjustment, Beni Suef and Assiut, 1999**

| Gover-norate | District | Village | No. Rows | Width | | Length | | Area ($m^2$) | Coeff. | Error (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 1 | 2 | | | |
| Beni Suef | Wasta | M. Aboseir | 1 | 0.80 | 0.80 | 3.55 | 3.55 | 2.84 | 1.0533 | -5.3 |
| | | A. Malak | 1 | 0.80 | 0.75 | 4.00 | 4.05 | 3.12 | 0.9615 | +4.0 |
| | | K. Aross | 1 | 1.00 | 1.00 | 3.00 | 3.00 | 3.00 | 1.0000 | 0.0 |
| | Ahnasia | M. Omara | 1 | 0.70 | 0.70 | 4.22 | 4.25 | 2.965 | 1.0120 | -1.2 |
| | | K. Abu S. | 2 | 1.20 | 1.20 | 2.55 | 2.55 | 3.06 | 0.9804 | +2.0 |
| | | Kolla | | 1.10 | 1.10 | 2.73 | 2.73 | 3.00 | 1.0000 | 0.0 |
| Assiut | Abu Tig | Abu Tig A | 1 | 0.80 | 0.80 | 3.75 | 3.75 | 3.00 | 1.0000 | 0.0 |
| | | Dwina | 2 | 1.27 | 1.25 | 2.35 | 2.36 | 2.967 | 1.0110 | -1.1 |
| | | Abu Tig S | 1 | 0.70 | 0.70 | 4.25 | 4.28 | 2.986 | 1.0050 | -0.5 |
| | Abnob | S. Abnob | 1 | 0.70 | 0.70 | 4.00 | 4.00 | 2.80 | 1.0714 | -7.0 |
| | | B. Ibrahim | 1 | 0.70 | 0.75 | 3.95 | 3.90 | 2.864 | 1.0476 | -3.5 |
| | | S. Abnob | 1 | 0.65 | 0.75 | 4.52 | 4.52 | 3.164 | 0.9432 | +5.1 |

Source: Calculated from the surveyed area of the study.

Note that supervisors or enumerators that were better trained than most took these measurements and there were still sizable area differences. From the above tables we see that:

- In Behira governorate 6 out of 9 plots supervised by the team were greater than the standard plot size ranging between +2% to +13%.

- In Dakahlia governorate 4 plots exceeded $3m^2$ by +6.5% to +9.8%, while two plots were under size by 1% and 1.8%.

- In Beni Suef, the plot areas fluctuated between –5% and +4%.
- In Assiut, the plot area deviated between –7% and +5%.

With such variation in plot sizes, it is necessary to adjust all counts and measurements within a sample plot to a standard $3m^2$ plot.

The team observing the field procedures quickly recognized many changes to improve the fieldwork. The field staff had no written instructions or forms on which to record data, and showed signs of lack of training. They had only old equipment and many did not have boll gauges. In the traditional method, the enumerator has to count within the $3m^2$ plot the number of plants; burrs; infected, open, partially open, large green, small green bolls; squares, and blooms.

The team observed the following problems and constraints within the plots:

- Different procedures were used for counting bolls.
- Enumerators did not use boll gauges to distinguish between large and small bolls.
- Rough handling caused damaged plants and broken branches
- Some double counting occurred between small and large bolls.
- Lack of training was evident.

The team suggested some improved procedures for counting. It also designed a new form for counting and recording data by hills and by plants within the hill. A copy of the form and instruction are included in Appendix C. Instructions were developed also. The team began to train enumerators in the field and began encouraging supervisors for the fieldwork.

Advantages of the improved methods are:

- More precise counts. If one gets distracted or forgets a count, he only has to recount that plant instead of the whole plot.
- Ease of supervision. Can check counts by individual plants. Could use sub-samples of plants for supervision and quality control.
- Possible data analysis for survival ratio development.
- Provides information on infections and insect attacks.

The new procedure was tested during this season and seems to be applicable and simple. Only a little more time is required for counting (about 10 minutes more per sample than the traditional method). It was easy to train enumerators.

The team, after observing the traditional method, suggested the new form and applied it under supervision. All the enumerators used the new form and started to apply the new procedures during the first visit in the last 10 days of July 1999. The team supervised at least 2 fields for every selected district.

**Second visit (20 –31 of August).** During this visit, the traditional Method was not used. The team suggested the following improved methods:

- The team wrote new instructions for enumerators and supervisors. The new forms included space for a field diagram and plot dimensions.

- The supervision was extended to include 3 sample plots for every selected district in the four governorates.

- Every supervisor had to write a report after each visit discussing:

  - Cotton plot conditions: boundary and treatment effects on plants and bolls due to previous visits; observations on boll counting procedures; status of cotton crop.
  - Checks made on the measurements of the plots.
  - Completed data that was not collected during the first visit such as:
    - Date of cotton planting.
    - Previous crop in field.
    - Inter-planting of other crops among the cotton, if found.

- Weather condition and humidity.
- Irrigation status
- Important factors affecting cotton yield
- Crop rotation pattern
- Planting pattern
- Expected data of harvest.

During this visit there was a high percentage of large green bolls and small bolls in Lower Egypt while a high percentage of opened bolls was found in Upper Egypt. These areas were definitely in two different stages of maturity. Other observations include the following:

- Identification of mature boll size for different cotton varieties needs more study. Boll gauge size of 2.25cm does not seem to be suitable for all varieties. Some enumerators used a 2.5-cm boll gauge to determine large bolls. The majority of enumerators did not have a boll gauge and used only their personal judgement.
- Enumerators had difficulty in detecting infected or damaged green bolls. Enumerators need training.
- Some forecasting plots seemed to have their growth affected by the field procedures used during the previous visit.
- Some enumerators did not follow the instructions for collecting the 20 bolls for the laboratory drying weight. This was felt to be due to lack of training.
- Laboratory facilities and equipment were hard to obtain and maintain. Transportation of samples to the one laboratory facility was very difficult. The pressure of getting samples processed in this facility in a short time was great. There were some indications that the difficulties caused many samples to not be completely processed and the data was lost.

The team did some tests by using the sun to dry cotton instead of ovens. One experiment conducted in Assiut by the team indicated that drying cotton samples in the sun could be applicable in Egypt. If approved, sun drying could be done in each district office with only a sensitive scale required. The process would eliminate the transportation time and the maintenance of the ovens.

A procedure to identify the order that plants or hills were counted during the previous month's visit would be very helpful. Perhaps a copy of the count form of the first visit could be used to help identify hills and plants in the plot. Detailed counts from previous month should not be included on the form, as it might tempt the enumerator to try and make the current month's data match. Another idea is to print only the ID portions of the first visit on subsequent visit forms.

**Third visit (21-30 September "First Pick").** There was no original instruction sheet for this visit, and no instructions for picking the cotton plot before harvest. Therefore, the team made new instructions for the third visit and before picking. They included:

- Use the second visit form for identifying hills & plants.
- In September except for two all sample plots supervised on the second visit had been picked.

The main problems during the picking visits were:

- The yard steel balance scales used are not accurate. Many of them have been tested and weighing errors of 20 – 80 grams were found. These balances are not sensitive enough for forecasting crop weights.
- The enumerators are not well trained in using a balance.
- Some farmers start picking before informing the enumerators of harvest date.
- In Upper Egypt, many open bolls dropped to the ground under the plants. The farmers like to pick cotton only once and leave the remainder unpicked.

### 3.2.4 Findings and Recommendations For Survey Procedures

Clearly there is a great need for training of staff at all levels, especially at the field level. Written instructions and recording forms were lacking. Field scales are very old and not very accurate. Other equipment was in poor repair, and boll gauges were not available to many. Staff training and support in the form of better equipment and incentives would go a long way to improving the forecasting and estimation work. Specific recommendations follow.

- Starting times of surveys should vary to meet the differences in crop growth. Upper Egypt should begin in the last 10 days of June. Lower Egypt should begin in the last 10 days of July.
- Open cotton should be picked during each visit, counted and weighed. These counts and weights can be accumulated throughout the season so they can be included in the final data.
- Burrs and damaged bolls should be counted, clipped from the plants, numbers recorded and then discarded away from the sample plot.
- Plants must be handled with care by enumerators. A maximum of two persons should work inside the field: one counts, and the other writes.
- If there are many infected (damaged) bolls, then one should count, pick and weigh cotton from these bolls separately. This will help determine the portion of damaged bolls, reduced quality and reduced production.
- Observing and estimating infection percentage for every variety and location would help specialists improve procedures and give early warning of infestations and yield loss.
- Scales for field weight need to be replaced or upgraded.
- MALR should test procedures to use sun drying of cotton sample instead of the cumbersome laboratory procedures.
- MALR should use new forms for recording counts and weights (see appendix), and improve and automate use of these forms.

The following diagram gives a recommendation for improving the plot location in future years.

**Figure 3: Proposed Forecasting Plot Size & Location**

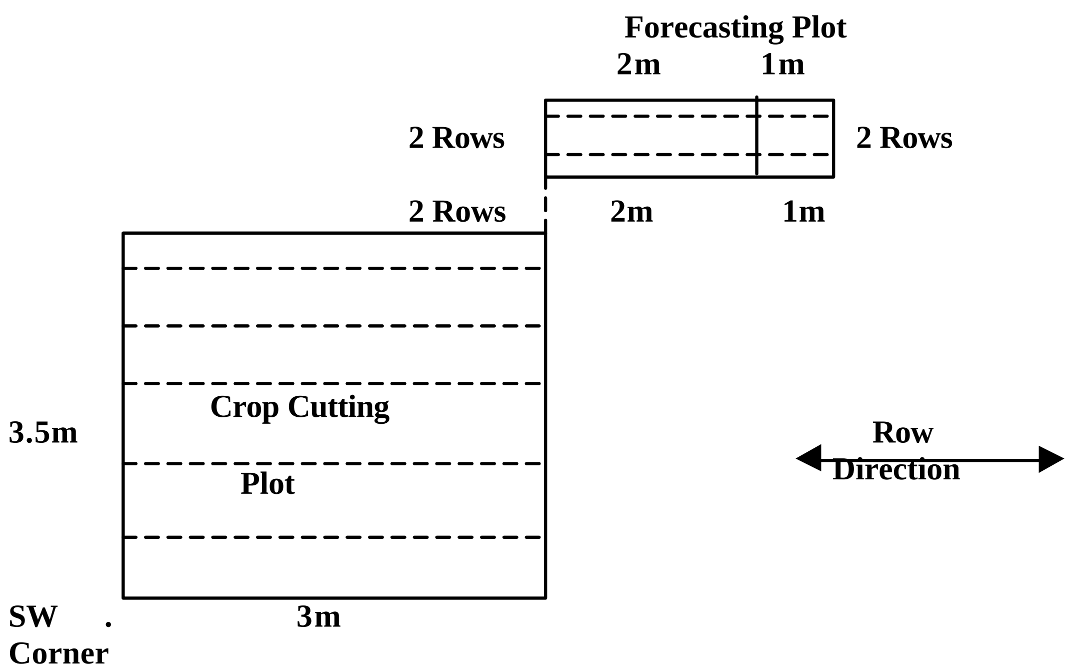



Figure 3 is a proposed forecasting plot size and location that might be used. The forecasting plot is beyond the opposite corner of the crop cutting plot by 2 rows. Plot size will depend on distance of 2 row widths from furrow bottom to furrow bottom. The plot is split into a 2 meter length and a one meter length. The enumerator has to measure all four sides of every sub-plot following the instructions.

Advantages of this plot:

- Greatly reduces border bias because it takes rows into consideration.
- Layout is easier without any calculations needed.
- Use 2 row X 2m sub-plot for counting only plants, hills, large bolls. This should reduce damage to squares, blooms and small bolls from excessive handling.
- Use 2 row X 1m sub-plot for counting plants, hills, squares, blooms, and all boll types and sizes.
- Easy to Count data plant by plant for enumerators. Easy to adjust data to $3m^2$ equivalent.
- Potential for good regression models for each visit.

## 3.3 Forecasting Procedures

### 3.3.1 Past Forecasting Methods

When the pilot work began in 1984, a US cotton forecasting model was used as the initial model to save years of development time. California was the US area that most nearly matched Egypt's climate and cotton varieties. It was thought that this model could not be directly applied in Egypt, but it was a good starting point. During the pilot and initial work, procedures have changed slightly, especially with use of tag data, which was hard to gather and to interpret.

The models that have been tried in Egypt are:

- Current Fruit Models
- Regression Models
- Survival Models
- Maximum Fruiting Model

These are listed in the order of development and use. Each has its own advantages and disadvantages, which will be discussed in a later section. The current fruiting model is usually the first developed and provides the basic historic data for all of the others.

Forecasting models are more complex than the estimation models because they contain more variables. Forecasters must be able to forecast many months before harvest begins and therefore rely on knowledge of crop growth characteristics and historic data gathered in previous years. The model parameters usually change with the month of the forecasting.

One common forecasting current season model is shown below:

$$\begin{bmatrix}\text{Forecast}\\ \text{Yield per Plot}\end{bmatrix} = \begin{bmatrix}\text{Ave. Number of}\\ \text{Bolls per Plot}\end{bmatrix} \times \begin{bmatrix}\text{Ave. Weight}\\ \text{per Boll}\end{bmatrix} \times \begin{bmatrix}\text{Weight \& Harvest}\\ \text{Adjust. Factors}\end{bmatrix}$$

Average Number of Bolls per Plot (Sample): The number of open bolls are counted, picked and weighed each visit. These are accumulated and the total is used in the average. Sometimes the average number of bolls per plant is computed by multiplying the average number of plants per plot times the average number of bolls per plant.

Average Weight per Boll: This is an average field weight of cotton by dividing the total weight of the cotton in the field by the total number of bolls picked.

The Weight Adjustment Factor: This is computed from the laboratory drying of samples from the plot or historic averages for early season forecasts.

The Harvest Adjustment Factor: This comes from post harvest gleanings or historic averages of past years.

Of course we want the forecast to be on a per feddan basis:

$$\begin{bmatrix}\text{Forecast Yield}\\ \text{Per feddan}\end{bmatrix} = \begin{bmatrix}\text{Forecast Yield}\\ \text{Per Plot}\end{bmatrix} \times \begin{bmatrix}\dfrac{4200\ m^2\ /\ \text{feddan}}{3\ m^2\ /\text{plot} \times 157500\ \text{gms/kentar}}\end{bmatrix}$$

Figure 4 gives a more detailed representation of the forecasting process specifically used in the 1989 forecasting of cotton. The actual numbers will appear as an example of the current fruit model in a later section.

In Figure 4 the components were multiplied together to obtain the average gross (biological yield) seed cotton per sample plot (feddan basis). Since the multiplication included the drying ratio (based on oven-dried cotton), the results are then multiplied by a predetermined factor (such as 1.07 or 1.08), because ginned cotton normally has about 7 or 8 percent moisture. Once the gross seed cotton per sample plot was obtained, the net seed cotton per sample plot was obtained by deducting the average amount of harvest loss per sample plot. These losses were determined by visiting small sample plots after final farmer harvest and picking all cotton remaining on the plants and on the ground. The results from these sample plots were then averaged to get average harvest loss per sample plot.

If forecasts are to be made early in the season (July 1 and August 1), one needs to establish historic averages and relationships for the following components for each specific forecasting time period:

- Average field weight of harvested cotton per boll
- Average drying ratio
- Average harvest loss
- Average boll survival rate

**Figure 4: Cotton Forecasting Computation for Egypt, 1989**

$$\textbf{Feddans}\left(\frac{\textbf{S CF}}{\textbf{S RF}}\right) \;\textbf{X}\; \textbf{1400} \left(\frac{\textbf{S Bolls}}{\textbf{N}}\right) \;\textbf{X}\; \frac{\textbf{S WOB}}{\textbf{S NOB}} \;\textbf{X}\; \frac{\textbf{S WOD}}{\textbf{S WCIB}} \;\textbf{X}\; \textbf{1.07} \;-\; \left(\begin{matrix}\textbf{Harvest}\\ \textbf{Loss}\end{matrix}\right)$$

**Biological (gross) Yield / Feddan**

**Net Yield / Feddan**

**Cotton Production for Governorate**

Feddans = Governorate planted feddans. with cotton

$\left(\frac{\Sigma CF}{\Sigma RF}\right)$ $\frac{\text{Computed Feddans}}{\text{Reported Feddans}}$ = Correction factor based on sample fields.

1400 $= \frac{4200 \text{ meters}^2}{3 \text{ meters}^2}$ = Expansion factor for sample plot to feddan level

$\left(\frac{\Sigma \text{ Bols}}{N}\right)$ = Average bolls per sample (Expected number open bolls at harvest).

$\left(\frac{\Sigma \text{ WOB}}{\Sigma \text{ NOB}}\right)$ = Average Weight per boll in field.

$\left( \frac{\Sigma \text{ WOD}}{\Sigma \text{ WCIB}} \right) = \frac{\text{Weight of dry cotton}}{\text{Weight of cotton (field wt.)}}$ = Drying factor (convert to completely dry).

1.07 = Adjusted to ambient moisture content.

Harvest loss= Cotton left after picking.

1 feddan = 4200 meters$^2$.

Sample plot= 1 x 3 meters = 3 meters$^2$.

### 3.3.2 Intended Forecasting Procedures

While crop cutting estimation procedures have not changed much through the years, forecasting procedures have changed frequently. At the beginning of the forecasting work the AERI and UAES staff worked together implementing the procedures described in the previous section. Later the AERI continued the work reporting their results to their director. They primarily used variations of the current fruit, survival and maximum fruiting models. The CAAE worked mostly with the current fruiting model, as authorization and support were given. In the early 1990s the lack of support greatly hampered their efforts.

### 3.3.3 Assessment of Potential Forecasting Procedures

As was mentioned above, limited resources have generally restricted the ability of MALR staff to carry out crop forecasting work. For this reason, this section will focus on potential forecasting models that could be used in Egypt.

**Components of a Forecasting Model.** Forecasting models have many component parts, each of which must be reasonably correct if an accurate forecast is to be made.

**Weight of cotton per boll or per sample**. These weights are computed from the field data and adjusted to standard market moisture percent through laboratory measurements or coefficients.

**Harvest Loss**. This is the cotton left in the field after farmer picking and is deducted from the biological yield of the crop to obtain the net yield. In Egypt, most cotton is hand picked clean including that on the ground. Economics and price tend to affect the harvest loss, however, it usually tends to be low.

**Biological Yield**. This is the part of the model that requires the most attention. Notice from the formula in Figure 4 that the average number of bolls per sample and average weight per boll is major components of the biological yield. They are very critical in that they contain information about the affects of weather, variety, seed, fertilizer, cultural practices, irrigation and insects. Changes from month to month can alert the researcher to impending damage and estimate the amount of loss. One can obtain these components of the forecasting model by many means.

The coverage in this section will be to discuss the models that could be tried in Egypt, namely:

- Current Fruit Models
- Regression Models
- Survival Models
- Maximum Fruiting Model

These are listed in the order of development and use. Each will be discussed, an example given, and a table shown comparing advantages, disadvantages, and comments concerning their use.

**Current Fruit Models.** The current fruiting model is usually the first developed because some results can be obtained during the current season. As data are gathered over many years, the model can begin forecasting earlier in the season even when only plants have emerged. The data gathered by this model become the basis for development of more sophisticated models using the historic data.

The current fruit model could be used to estimate the yield and production a month before harvest, like the crop-cutting model, by just using sample counts and measurements. However, doing this does not utilize the real potential of the forecasting procedure. One might propose just an August estimate. An August forecast may work well for 60% of the seasons, but this is not good enough, for one needs a forecasting program to provide precise forecasts nearly 100% of the seasons. Three or more visits are needed to catch changes caused by weather, insects, irrigation, and disease. Annual surveys also permit updating the forecasting model parameters through yearly data collected.

As one tries to forecast earlier in the season, procedures change. As plants begin to grow, one can begin to count and measure plant characteristics as they occur. Using research results from the past few years, a forecast of the number of open bolls at harvest can be made from current monthly counts of squares, blooms, small bolls, large bolls, partially open bolls, open bolls, burrs and damaged bolls in the sample plots. The current fruit model is enhanced by combining techniques of survival and regression with current data to forecasting number of open bolls at harvest.

When very early season forecasts are desired, for instance, after plants have finished germination, only plant numbers can be counted. Then one must rely entirely on historic averages of bolls per plant and weight per boll. While doing this might be considered a little risky, it can work if these averages are currently updated and the season coming along will be similar to those that occurred during the years of the average computation. An example of this method is the Maximum Bearing Fruit Model, which will be described later.

To carry out current fruit counts and measurements in the sample plots, field enumerators count and measure many items within the plot. The following lists the data items collected and the objective of these measurements:

Data used to measure the size of each unit:

- The width between two rows
- Plot length ($3m^2$ / width of two rows)
- Dimensions of the four sides of the plot
- Plot Area = $\frac{\text{side (1) + side (2)}}{2} \quad X \quad \frac{\text{length (1) + length (2)}}{2}$

Data used to forecast the number of bolls:

- Number of Hills in each plot
- Number of Plants in each plot
- Number of Squares in each plot
- Number of Small Bolls and Blooms in each plot
- Number of Large Unopened Bolls in each plot
- Number of Opened Bolls in each plot
- Number of Partially Opened Bolls in each plot
- Number of Damaged Bolls in each plot
- Number of Burrs (Bolls with cotton picked) in each plot

Data used to estimate weight per boll:

- Weight of seed cotton 20 bolls harvested by enumerator
- Weight of seed cotton 20 bolls dried to zero moisture
- Weight of seed cotton remaining in sample plot

Date used to estimate harvest loss:

- Area 3$m^2$ of forecasting plot number of large green unopened bolls left in the plot

Current Fruit Model. Figure 4 defines a Current Fruit Model and explains the components.

The following example gives the components and computation of the 1989 Cotton Forecast Table 3-10 shows the computation of the yield per feddan for survey governorates and nationally.

**Table 3-10: CAAE/1989 Cotton Yield Forecasting Data**

| Governorate | Area of Forecast (fed) | Ave. Bolls per sample | Ave. Wt. per Boll | Ave. Drying Factor | Ambient Moisture % | Ave. Wt. of Cotton in Sample | EF Sample to Feddan | EF Grams to Kentars | St. Ave. Kentars per Feddan | Wtd. Ave. Kentars per Feddan | Total Area (fed) | Wtd. by Total Area (fed) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Medium Long Staple** | | | | | | | | | | | | |
| Behira | | | | | | | | | | | | |
| Gharbia | 43,582 | 270.44 | 2.42 | 0.90 | 1.08 | 636.140 | 1400 | 157500 | 5.655 | | 79,184 | |
| Kafr El Sheikh | | | | | | | | | | | | |
| El Dakalia | 94,853 | 174.95 | 2.38 | 0.91 | 1.08 | 409.219 | 1400 | 157500 | 3.638 | | 153,821 | |
| Sharkia | 55,373 | 241.95 | 1.91 | 0.92 | 1.08 | 459.167 | 1400 | 157500 | 4.081 | | 124,727 | |
| Monofia | 29,811 | 296.91 | 2.70 | 0.91 | 1.08 | 787.868 | 1400 | 157500 | 7.003 | | 46,515 | |
| El Fayoum | 21,410 | 176.50 | 1.88 | 0.94 | 1.08 | 336.864 | 1400 | 157500 | 2.994 | | 39,759 | |
| El Minya | 42,385 | 218.62 | 1.86 | 0.92 | 1.08 | 404.031 | 1400 | 157500 | 3.591 | | 79,480 | |
| Assiut | 39,872 | 168.60 | 1.53 | 0.93 | 1.08 | 259.093 | 1400 | 157500 | 2.303 | | 78,037 | |
| Total | 327,286 | 220.38 | 2.17 | 0.92 | 1.08 | 475.164 | 1400 | 157500 | 4.224 | 4.077 | 627,041 | 3.869 |
| **Extra Long Staple** | | | | | | | | | | | | |
| Behira | 64,575 | 364.09 | 2.69 | 0.92 | 1.08 | 973.134 | 1400 | 157500 | 8.650 | | 102,641 | |
| Gharbia | 12,986 | 364.22 | 1.97 | 0.91 | 1.08 | 705.172 | 1400 | 157500 | 6.268 | | 23,373 | |
| Kafr El Sheikh | 61,518 | 304.94 | 2.3 | 0.93 | 1.08 | 704.448 | 1400 | 157500 | 6.262 | | 114,775 | |
| Total | 139,079 | 334.53 | 2.43 | 0.92 | 1.08 | 807.705 | 1400 | 157500 | 7.180 | 7.371 | 240,789 | 7.280 |
| ML& EL | 466,365 | 255.96 | 2.25 | 0.92 | 1.08 | 572.224 | 1400 | 157500 | 5.086 | **5.060** | 867,830 | 4.816 |
| | | | | | | | | | | **5.100** | var.wtd. | **5.044** |

Source: CAAE, Department of Sampling, unpublished data.

Table 3-11 shows the computation of forecast production using the average yield of seed cotton per feddan:

**Table 3-11: CAAE 1989 Cotton Production Forecast**

| CAAE 1989 Cotton Production Forecast | | | | | | |
|---|---|---|---|---|---|---|
| **Feddans at the Egypt level** | | **Estimated Average Yield of seed cotton/feddan** | | **Estimated production of seed cotton at the Egypt level based on: 3/** | | |
| **Uncorrected** | **Corrected 2/** | **Forecast results** | | **Uncorrected Fedans** | | **Corrected Feddans** |
| (feddans) | | (kentars) | | | (000 Kentars) | |
| | | **Medium Long Staple (ML)** | | | | |
| 752,562 | 707,408 | St. | 4.22 | | 3175.812 | 2985.262 |
| 752,562 | 707,408 | Wtd. 1/ | 4.08 | | 3070.453 | 2886.225 |
| | | **Extra Long Staple (EL)** | | | | |
| 252,606 | 237,450 | St. | 7.18 | | 1813.711 | 1704.891 |
| 252,606 | 237,450 | Wtd. 1/ | 7.37 | | 1861.706 | 1750.007 |
| | | **Medium and Extra Long Staple Combined** | | | | |
| 1,005,168 | 944,858 | St. | 5.09 | | 5116.305 | 4809.327 |
| 1,005,168 | 944,858 | Wtd. 1/ | 5.10 | | 5126.357 | 4818.776 |

1/ Weighted average yields per kentar were computed by multiplying the survey objective yields in each of 9 Governorates by the respective number of feddans in each of the 9 Governorates represented by objective yield sample plots and dividing the sum of the extensions by the sum of the weights

2/ The number of feddans in objective yield survey fields reported by farmers compared to measured feddans in the same field indicated that approximately 6% of the feddans assigned to farmers by the Egyptian Government were not planted.

3/ Production is computed by multiplying the estimated average yield of each staple length by the total number of feddans planted to that staple length in all Governorates whether or not the plots feddans were represented by objective yield.

Source: CAAE, Department of Sampling, unpublished data.

**Regression Models.** Regression analysis is a favourite tool of researchers, statisticians and economists. There was some parameter development during the pilot and initial cotton forecasting work in the 1980s. The forecasting work of the 1990s used direct computations at harvest time rather than using regression models to forecast number of bolls and weight of bolls early in the season. The team analyzed current study data and began parameter development. Subsequent years' data can be combined with current data to progressively improve future regression parameters.

To forecast each sample yield per feddan, regression models are developed by maturity category for each survey month. For cotton, the maturity categories are defined by the raw counts obtained in the sample. These categories are:

- No fruit present
- No fruit present, with squares only
- $0 \leq Ratio < 0.5$, with blooms or bolls
- $0.5 \leq Ratio < 2.0$
- $2.0 \leq Ratio$
- Harvested

*Ratio* is the ratio of *large bolls* (burrs, open bolls, partially open bolls and large unopened bolls) to *plants* in the 3m$^2$ plot.

The expected number of large bolls for each sample is forecast using a regression model like:

$$Y = B_0 + B_1 X_1 + B_2 X_2 + B_3 X_3$$

Where:

$Y$ = Forecast number of large bolls
$X_1$ = Observed number of burrs, open bolls, partially open bolls, and large unopened bolls (3m$^2$ equivalent)
$X_2$ = Observed number of small bolls and blooms (3m$^2$ equivalent)
$X_3$ = Observed number of squares (3m$^2$ equivalent).
$B_0$--$B_3$ = Least squares regression coefficients

Small bolls are defined as bolls less than a specified diameter, usually 2.25 cm. Enumerators use a gauge with the specified diameter hole to determine whether a boll is a small or a large unopened boll. (There was a shortage of boll gauges and some indecision as to which size boll should be considered large and which small. This matter needs research to determine which size to use for each variety and area of the country.) A square is an observable fruiting position that has not reached the bloom stage.

Forecasting equations for each model are derived for each maturity category for each month for each governorate and for each variety.

Not all independent variables are used in each model. For instance, for maturity category one, only the intercept coefficient is used. For later maturities and/or months, squares and small bolls are excluded from the models. (Research is needed to determine the independent variables for each category and model). When available, data from the previous 5 years are used to estimate the regression coefficients.

If a unique set of coefficients cannot be determined for a given class (due to insufficient data), the previous month's coefficients are used.

The actual count of large bolls is used for any sample in maturity category six in any month.

The team had to begin estimating the regression coefficients starting from this first year. We used stepwise regression to identify the best equations and regression coefficients. Other suggested models might be:

Regression Models

For July

$$Y_1 = B_0 + B_1 X_{1i} + B_2 X_{2i} + B_3 X_{3i}$$
$$Y_2 = B_0 + B_1' (X_{1i} + X_{2i} + X_{3i})$$

For August

$$Y_3 = B_0 + B_1 X_{1i} + B_2 X_{2i}$$
$$Y_4 = B_0 + B_1 X_{1i} + B_2 X_{2i}' \text{ (small bolls only)}$$
$$Y_5 = B_0 + B_1 (X_{1i} + X_{2i}')$$

For September

$$Y_6 = B_0 + B_1 X_1$$

Where:
$Y_i$ = Forecast number of large bolls in the ith unit
$X_{1i}$ = Observed number of burrs, open bolls, partially open bolls, and large unopened bolls ($3m^2$ equivalent) in the ith unit.
$X_{2i}$ = Observed number of small bolls and blooms ($3m^2$ equivalent) in the ith unit.
$X_{2i}'$ = Observed number of small bolls only ($3m^2$ equivalent) in the ith unit.
$X_{3i}$ = Observed number of squares ($3m^2$ equivalent) in the ith unit.
$B_0$ --$B_3$ = Least squares regression coefficients

Models $Y_1$ to $Y_6$ need to be tested for both hill and plant data in the sample plots, by variety with and without dummy variables. (Use all data for totals (supervised and others in case of insufficient data.).

Section 4.3.5 gives results of the data analysis and regression coefficients from the current study.

**Survival Models.** A survival model tries to forecast how many of a specific type of fruit will survive and produce cotton at harvest. For example, if one knows the number of squares and blooms in July, how many will mature and produce cotton? Of the number of small bolls in August, what percent will actually make cotton?

Logically one might think that each variety of cotton has its own growth characteristics:

- Fruit shape and size may vary
- Time to grow through each stage may vary
  - Squares→bloom→small boll→large boll→open boll→picked cotton
- Number of fruit that appear
- How rapidly they grow
- How many drop off naturally
- How they resist insect and disease
- Many of these factors are affected by moisture, heat, humidity, etc.

A later section of the report (section 4.2) discusses many factors that do affect growth and yield of cotton. Some of the factors mentioned as affecting yield are date of planting, cultural practices, germination, disease and insect attack, weather and plant density. Fortunately, there are also many similarities in the growth of cotton in Egypt. General relationships have been identified which simplify the forecasting process.

An attempt was made to begin cotton forecasting in the mid-1980s. During pilot cotton forecasting work, research plots were laid adjacent to the forecasting sample plots. Fruit were tagged and their progress followed through the season. *In 1999 the study team tried to* tag fruits and identify growth rate, fruit loss rates, and fruit survival. There were many problems obtaining and analysing the data. It was very detailed work keeping track of fruit as it grows and matures. External problems complicated work also, as farmers and their family pulled tags and flagging tape off plants (some even pulled plants).

Using a set of 1990 research data collected for variety Giza 75, there were two visits in August 22nd and September 6th. Of the small bolls on the first visit, 71% survived to totally open bolls. Of those on the second visit, only 64% survived to produce cotton. Generally 68% of small bolls were opened at the end of season.

| Visit Date | Small Bolls | Open Bolls | Open Bolls % |
|---|---|---|---|
| 22-Aug | 356 | 254 | 71 |
| 06-Sep | 218 | 139 | 64 |
| Total | 574 | 393 | 68 |

For Giza 77 three visits were made on July 26th, August 10th, and 26th. The ratios of small bolls to open bolls for the three visits were respectively 82%, 59% and 73%. The overall survival was 72%. The following totals and percents are:

| Visit Date | Small Bolls | Open Bolls | Open Bolls % |
|---|---|---|---|
| 26-Jul | 923 | 755 | 82 |
| 10-Aug | 691 | 406 | 59 |
| 26-Aug | 217 | 159 | 73 |
| Total | 1614 | 1161 | 72 |

An example of relationships we want to identify:

Cotton Plant Growth Events

| Event | Interval | Span |
|---|---|---|
| Planting | | |
| Germination | 6-7 days | |
| | 43-81 days | 90 days |
| Square | | (72-112 days) |
| | 21 days | |
| Flower | | |
| Small Boll | 1-2 days | |
| | 25 days | 52 days |
| Large Boll | | |
| | 25-26 days | |
| Mature Boll | | |
| Open Boll | 2-5 days | |

Table 3-12 gives the maturity categories and survival ratios computed from the current data gathered by the team.

The survival ratios in the table above apply to this year's data. They would be a good starting point for forecasting computations in a future year when the seasonal weather and plant growth are similar. These ratios should be computed every year and data combined to obtain five- to ten-year ratios. When a good database of historic ratios is available, a specific set of years' data could be selected to match the current year situation to provide a better ratio to use for forecasting.

Looking at the maturity categories in the table above, one notes that the July maturity category of Lower Egypt cotton is much smaller, indicating that the cotton is much more immature than in Upper Egypt. This is strong evidence that the two areas need to be treated differently. Upper Egypt forecasting work should begin a month before Lower Egypt surveys.

**Potential Survival Ratio Models (For Totals).** These are recommended for use in future work. Similar models have been used by AERI in the past and by other countries in the past.

July Visit

$$SR_1 = \frac{\text{Total open bolls final}}{X_1 + X_2 + X_3} \times 100$$

August Visit

$$SR_2 = \frac{\text{Total open bolls final}}{X_1 + X_2} \times 100$$

$$SR_2' = \frac{\text{Total open bolls final}}{X_1 + X_2'} \times 100$$

**Table 3-12: Cotton Yield Forecasting, 1999: Survival Ratios and Maturity Categories**

| Governorate | Variety | District | Survival Ratio (%) | | | Maturity Categories | | |
|---|---|---|---|---|---|---|---|---|
| | | | $R_1$ | $R_2$ | $R_3$ | July | August | September |
| **Dakahlia** | G86 (1) | Belkas* (11) | 59.60 | 71.60 | 97.80 | 0.63 | 9.39 | 1st Harvest 8.00 |
| | G85 (2) | Manzala (12) | 67.19 | 88.10 | 98.20 | 2.39 | 7.98 | 1st Harvest 7.11 |
| **Behira** | G89 | Damanhour (21) | 56.02 | 82.90 | 93.60 | 1.67 | 9.80 | 1st Harvest 7.92 |
| | G70 | Abu Homos (22) | 68.00 | 90.80 | 93.50 | 0.70 | 4.80 | 1st Harvest 12.30 |
| | G88 | Rahmania (23) | 73.86 | 79.55 | 95.22 | 2.90 | 13.30 | 1st Harvest 15.80 |
| **Beni Suef** | G80 | Wasta (31)<br>Ahnasia (32) | 73.90 | 89.70 | 96.70 | 3.50 | 7.97 | 1st Harvest 8.29 |
| **Assiut** | G83 | Abu Tig (41)<br>Abnnob (42) | 61.50 | 82.70 | 96.70 | 5.90 | 7.40 | 1st Harvest 7.83 |
| **Average** | | | **65.40** | **83.38** | **95.96** | | | |

Source: Survey data collected by the study team.

* Demelash infected bolls percentage is high (outlayer). Cancelled.

$R_1$ : Final (burrs 9 + OB 9 + POB 9) / all counts of July

R2 : Final (burrs 9 + OB 9 + POB 9) / (burrs 8 + LGB 8 + OB 8+ POB 8 + SGB 8) for (August)

R3 : Final (burrs 9 + OB 9 + POB 9) / (burrs 9 + OB 9+ POB 9 + LGB 9 + SGB 9) for (September)

Maturity Categories :

1) No fruit present
2) No fruit present, squares only.
3) $0 \leq$ ratio $< 0.5$
4) $0.5 \leq$ ratio $< 2$
5) $2.0 \leq$ ratio
6) Harvested

$$\text{Ratio} = \frac{\text{Large bolls number}}{\text{Plants number}}$$

September Visit

$$SR_3 = \frac{\text{Total open bolls final}}{X_1} \times 100$$

The survival models can be used separately or in combination with other forecasting models.

The following three pages contain an example of the use of survival models. These examples were excerpted from a report on AERI forecasting work. The complete report is in the appendix as an excellent reference to forecasting.

The first table(s) on each page gives data necessary for use in the last table on the page. The last table on the page shows the steps in the computation of the survival forecasting for the respective month.

**Table 3-13: Measurements for Forecasting Sample Survey of Cotton, 1998 (July Visit)**

| Governorates | No. Plants /Plot (3m$^2$) | No. Plants /Feddan | No. Bolls /Plot (3m$^2$) | No. Infected Bolls/Plot | Infection (%) |
|---|---|---|---|---|---|
| Gharbia | 35.583 | 49,816 | 470.200 | - | - |
| Kafr El Sheikh | 34.733 | 48,626 | 255.983 | 1.417 | 0.55 |
| Sharkia | 29.883 | 41,836 | 298.567 | 1.500 | 0.50 |
| Menofia | 26.000 | 36,400 | 320.687 | 0.667 | 0.21 |
| Fayoum | 37.367 | 52,314 | 466.300 | 6.167 | 1.32 |
| **Average** | **32.713** | **45,799** | **362.383** | **1.950** | **0.54** |

Source: Agricultural Research Center, Agricultural Economic Research Institute, Results of Cotton Forecasting Survey, 1998, July Visit, unpublished data.

**Table 3-14: Cotton Yield Forecasting Estimates for 1998 Using Survival Ratio**

**(July Visit)**

| Item | Unit | Period | Average |
|---|---|---|---|
| Number of green bolls/plot | No. | July 1998 | 362.383 |
| Survival ratio for July | % | Ave.1994 to 1997 | 97.06 |
| Number of expected open bolls/plot (3m$^2$) | No. | 1998 | 351.729 |
| Average weight of cotton (with seeds)/boll | Gm. | Ave.1994 to 1997 | 2.424 |
| Weight of cotton/plot | Gm. | 1998 | 852.591 |
| Total weight of cotton/feddan (F=24k) | Mk | 1998 | 7.579 |
| Correction factor of area (22k/24k) | Coeff. | 1998 | 0.9167 |
| Total weight of cotton/(22k) | Mk | 1998 | 6.947 |
| Cotton loss/feddan | Mk | Avr.1994 to 1997 | 0.07 |
| Net cotton yield/feddan | Mk | 1998 | 6.877 |
| Transformation coefficient from sample to national level | Coeff. | 1997 | 1.0122 |
| Net yield of cotton | Mk | 1998 | 6.961 |

Source: ARC, AERI, op. cit.

**Table 3-15: Measurements for Forecasting Sample Survey of Cotton for 1998**

**(August Visit)**

| Governorate | No. Plants /Plot (3m$^2$) | No. Plants /Feddan | No. Bolls /Plot (3m$^2$) | No. Infected Bolls/Plot | Infection (%) |
|---|---|---|---|---|---|
| Gharbia | 35.083 | 49.116 | 496.383 | 7.767 | 1.65 |
| Kafr El Sheikh | 34.733 | 48.626 | 255.983 | 1.417 | 1.24 |
| Sharkia | 29.883 | 41.836 | 306.767 | 1.733 | 0.56 |
| Menofia | 25.967 | 36.354 | 429.633 | 7.333 | 1.71 |
| Fayoum | 37.200 | 52.080 | 478.017 | 29.183 | 4.01 |
| **Average** | **32.573** | **45.602** | **403.803** | **10.033** | **2.48** |

Source: AERI, op. cit.

**Table 3-16: Cotton Yield Forecasting for 1998 Using Survival Ratio (August Visit)**

| Item | Unit | Period (Season) | Average |
|---|---|---|---|
| Number of bolls/plot | No. | Aug. 1998 | 403.803 |
| Survival Ratio to August | % | Average* | 86.80 |
| Expected number of open bolls/plot (3m$^2$) | No | 1998 | 350.501 |
| Average weight of cotton/boll | gm. | Average* | 2.424 |
| Cotton weight/plot | Gm. | 1998 | 849.614 |
| Total weight of cotton/feddan (24 k) | mk | 1998 | 7.552 |
| Coefficient of net area (22 k/24k) | Coef. | 1998 | 0.9167 |
| Total weight of cotton(22 k) | mk | 1998 | 6.923 |
| Cotton loss/feddan | mk | Average* | 0.07 |
| Net cotton yield/feddan | mk | 1998 | 6.853 |
| Transformation coefficient sample to national level | Coef. | 1997 | 1.0122 |
| Net yield of cotton | mk | 1998 | 6.937 |

Source: AERI, op. cit.
* Average of years (1994, 1995, 1996, and 1997).
F= Feddan, k= Kirates, MK= metric kentars

**Table 3-17: Measurements of Cotton Forecasting, 1998 (September Visit)**

| Governorate | No. Plants /Plot ($3m^2$) | No. Plants /Feddan | No. Bolls (LGB, POB OB) | No. Infected Bolls/Plot | Infection (%) |
|---|---|---|---|---|---|
| Gharbia | 35.083 | 49116 | 356.333 | 38.583 | 10.83 |
| Kafr El Sheikh | 34.733 | 48626 | 214.967 | 3.950 | 1.84 |
| Sharkia | 29.883 | 41836 | 241.067 | 13.300 | 5.50 |
| Menofia | 25.967 | 36354 | 328.700 | 28.567 | 8.69 |
| Fayoum | 37.200 | 52080 | 324.000 | 26.617 | 8.22 |
| **Average** | **32.573** | **45602** | **293.133** | **22.203** | **7.57** |

Source: AERI, cit.

**Table 3-18: Average Weight of Cotton Per Boll, 1998 (September Visit)**

| Governorate | Average Weight Cotton/Boll (gm.) |
|---|---|
| Gharbia | 2.238 |
| Kafr El Sheikh | 2.233 |
| Sharkia | 2.339 |
| Menofia | 1.908 |
| Fayoum | 1.821 |
| **Ave. Sample** | **2.126** |

Source: AERI, op. cit.

**Table 3-19: Cotton Yield Forecasting for 1998 Using Survival Ratio (September Visit)**

| Item | Unit | Period (Season) | Average |
|---|---|---|---|
| Number of bolls/plot | No. | Sep. 1998 | 293.133 |
| Survival Ratio of September | % | Average* | 100 |
| Expected number of open bolls/plot ($3m^2$) | No. | 1998 | 293.133 |
| Average weight of cotton/boll | gm. | 1998 | 2.161 |
| Weight of cotton/plot | gm. | 1998 | 623.201 |
| Total weight of cotton/(22k) | mk | 1998 | 5.54 |
| Cotton loss/feddan | mk | Average* | 0.07 |
| Net cotton yield | mk | 1998 | 5.47 |
| Transformation coefficient from sample to national level | Coef. | 1997 | 1.0122 |
| Net yield of cotton | mk | 1998 | 5.537 |

Source: AERI, op. cit.
* Average of years (1994, 1995, 1996, and 1997).

**Maximum Bearing Fruit Model.** This model uses only plant counts from the current year and averages for all other factors in the model. It is a favourite for use only when plants are up in the field. It can work well when the current season is going to be the same as those past seasons used in the average computations. This assumption is somewhat risky, as there are usually seasonal differences. The model can work as one part of a comprehensive forecasting program.

Average number of plants per feddan X Average number of open bolls per plant (Final)
Average number of plants per feddan (Current year)
Average number of open bolls final / plant (Average 5 years)

The following example is again from the AERI program. The first table gives the 1998 plant count and average of several years open boll counts. The computations can be followed by going down the rows of the second table.

**Table 3-20: Expected Number of Open Bolls, 1998 by Maximum Bearing Fruit Model (July Visit)**

| Governorate | No. Plants /Feddan (000 plant) | No. Open Bolls /Plant 1997 | Expected No. Open Bolls /Feddan 1998 (000 boll) |
|---|---|---|---|
| **Gharbia** | 49.816 | 8.49 | 422.938 |
| **Kafr El Sheikh** | 48.626 | 11.17 | 543.152 |
| **Sharkia** | 41.836 | 10.01 | 418.778 |
| **Menofia** | 36.400 | 14.13 | 514.332 |
| **Fayoum** | 52.314 | 11.76 | 615.213 |
| **Average Sample** | **45.799** | **11.11** | **508.827** |

Source: ARC, AERI, Sampling Research Section, Results of Cotton Forecasting Activity, 1997 and 1998.

**Comparison of Models and Relationships among Them.** Each of these models has been used to give forecasts of cotton yield. Each has a time of the season when it may be the best model. For example the maximum fruiting model may be very good just after germination of the plants, but has little value if there are any great changes during the season. The other models tend to improve as the season progresses. The regression model is probably the most inflexible, the survival model is more flexible, and the current fruit model is most able to detect subtle changes in plant growth or infection.

Each model could be used exclusively as the only forecasting model, but one seldom likes to rely on only one indication of yield. If more models are computed and they all come out at about the same level then one can more confidently set the forecast at that level. If there are differences in levels of the model indications, then one can review the computations for possible errors or review the data to verify where the large increase or decrease has occurred. This may require verification at the governorate level to confirm an infestation or extremely good crop. By doing so, the decision-maker has more information and confidence in setting the official forecast.

**Table 3-21: Cotton Yield Forecasting Estimates for 1998 By Maximum Bearing Fruit Model (July Visit)**

| Item | Unit | Period (Season) | Average |
|---|---|---|---|
| Number of plants/feddan | (000) | 1998 | 45.799 |
| Average number of open bolls/plant | Boll | 1997 | 11.112 |
| Expected number of open bolls/feddan | (000) boll | 1998 | 508.918 |
| Average weight of cotton/boll | Gm. | Average* | 2.424 |
| Cotton yield/feddan (24 kirats) | Kg. | 1998 | 1233.618 |
| Cotton yield/feddan (24 kirats) | Kentar | 1998 | 7.832 |
| Coefficient of adjust area to (22k/24k) | Coef. | Coef. | 0.9167 |
| Cotton yield/feddan (22 kirats) | Kentar | 1998 | 7.180 |
| Cotton loss/feddan | Kentar | Average* | 0.070 |
| Net yield/feddan | Kentar | 1998 | 7.110 |
| Transformation coefficient from sample to national level | Coef. | 1997 | 1.0122 |
| Net yield of cotton at national level | Kentar | 1998 | 7.197 |

Source: AERI, op. cit.
* Average of years (1994, 1995, 1996, and 1997).

**Table 3-22: Comparison of Different Model Characteristics**

| Models Number of bolls at Harvest | Requirements & Conditions | Advantages | Disadvantages |
|---|---|---|---|
| **Current Fruit Models** | • Accurate counts and measurements from sample plots<br>• As data history increases forecasts can be made earlier in season. | • Can give estimate the first season.<br>• Data gathered monthly.<br>• Can capture changes that occur during the season<br>• Source for data for other models | • Requires good quality control and verification since so much depends on the good data |
| **Regression Models** | • Good database from which to compute regressions parameters.<br>• As years in database increase, precision of regression parameters improves | • Statistically sound procedure.<br>• With computer computing the parameters is relatively easy. | • Takes at least one year to develop parameters. |
| **Survival Models** | • Knowledge of plant growth characteristics.<br>• Measure and record plant growth and survival rates.<br>• Develop models to forecast survival<br>• Improves with database and research. | • Provides understanding of plant growth characteristics.<br>• With series of historic data, current year growth can be compared with past years or similar year subsets. | • Takes time to develop knowledge through research and data analysis |
| **Maximum Fruiting Model** | • Requires a good historic database to begin | • Uses only counts of plants after germination.<br>• It is quick and easy to compute | • It gives only an early season forecasting, with no way to modify based on changes in growing season |

One might wonder if some of the strength of one model could be used to enhance another model. Indeed, this is very possible. For example, in the discussion of the regression model, each sample was classified by its maturity category and regression coefficients were developed for each maturity category. The maturity category was originally developed from the survival model. The survival model attempts to identify relationships between the number of fruit of a certain type at a given time to the number that will survive to be harvested. For example, how many of the small bolls in July will make it to harvest, or how many large bolls in September will be open at harvest. One of the primary ways to define these relationships is to use regression analysis on one or more season's data to derive these coefficients. Both survival and regression relationships can be used to enhance the current fruit model performance.

It was stated earlier that the current fruit model was a source of data for the other models. With only a little planning, all data needed for all models can be gathered during the forecasting fieldwork. The current fruit model data gathered during the first season could be used to estimate yield at harvest time. The next year it could be used to forecast the crop before harvest begins and in subsequent years earlier in the season. One must understand that the forecast for the second season is based only on one year's data, and each subsequent season adds a year's data to estimation of the model parameters. The reliability of the second year's forecast would probably be very low. If the second season were exactly like the first season, the forecast might be good. However, one seldom has seasons just alike. A model's reliability improves as the variation from different seasons is incorporated.

When a strong historic database is developed, specialized parameters can be developed. For example, the US citrus database contains over 40 years of data. When a very unusual situation occurs, such as a severe freeze or insect infestation, one can go back and pick the five or ten most similar years and compute a regression to model this special case.

One cannot begin to develop parameters for the regression or survival models until after the first season is complete. As discussed above, the reliability of the parameters may be questionable at first but should improve as more years are added to the database. The maximum fruiting model needs about five years' data before it can be used with confidence.

### 3.3.4 Findings and Recommendations for Forecasting Models

The team found a great need for model improvement. Fortunately, the ministry staff appeared to be very interested and enthusiastic about potential improvement.

The team developed parameters for most of the models from their survey data. It is recommended that the ministry staff do similar analysis on their larger forecasting database and that these parameters be used to compute forecasting indications for 2000 cotton yield and production. Realizing that these indications are based only on one year of data, they will be used in conjunction with other indications for determining the forecast. The team feels that great improvements can be obtained by using the improved forecasting models.

# 4. ANALYSES OF FIELD DATA AND THEIR IMPLICATIONS FOR SURVEY PROCEDURES AND FORECASTING MODELS

This chapter presents the results of analyses made by the team of the data collected during the field visits. These results have important implications for future survey procedures and for the development of forecasting models. These implications are also given in this chapter. In addition the results of analysis in one area, e.g., forecasting, also have implications in other areas, for example for future sampling procedures. Such recommendations are presented in chapter 5.

## 4.1 Data Analysis and Survey Procedures

### 4.1.1 Plot Size and Measurement

In Table 3.1 and 3.2 the sample plot areas are given with the percentage error and coefficient needed to adjust the sample data. It was noticed that 48% of the plot areas are larger than the desired $3m^2$, and 30% are smaller, with only 22% being equal. Just looking at the area differences it is a little hard to judge if they are significantly different from $3m^2$. A statistical test was run to decide this.

**t -Test** with Null Hypothesis Ho: $\mu = 3$
and Alternate Hypothesis Ha: $\mu \neq 3$

$$t = \frac{\bar{X}_i - m}{s/\sqrt{n}}$$

| **Description** | **Behira-Dakalahia** | **Beni Suef-Assiut** | **All Samples** |
|---|---|---|---|
| **T – values** | 3.6877 | 3.9691 | 2.2942 |
| **Degrees of freedom** | 14 | 11 | 26 |
| **Probability of value** | < 1% | < 1% | < 5% |

The values show that the both the Behira-Dakahlia and the Beni Suef-Assiut plot areas were highly significant. When all data are combined, the sample areas still differ from the $3m^2$ standard by more than can be expected by chance.

The test results confirm that the plots do have enough variation in areas, thus requiring that the exact areas need to be computed for each plot and a correction factor applied to bring the plot data to the standard area for forecasting. This variation is partially due to the irregularities in field row spacing and planting patterns for the crop. Another source of variation is the location, layout of the plots, and measurement procedures.

### 4.1.2 Plot Location, Layout, Shape

The *plot shape* has always been targeted for 1m X 3m. This seems to be working well, but could be investigated to see if it is the optimum shape.

The plot location is more of a problem, and many different ways to determine the plot location have been tried. See Appendix A for specifics. All locations so far have been close to the crop-cutting plot, usually about 1meter from the corner opposite to the SW corner of the plot. The team noticed a lot of damage being done (through stepping or kneeling) to both the crop cutting plot and the forecasting plot as the field crew tried to measure, lay out and count the forecasting plot. Locating the two plots independently would nearly eliminate this damage.

The plot layout procedures could improve the accuracy of plot areas. In the past, plot location was based on exact measurements and could have a boundary right within planted rows or cutting through many rows. Theoretically this is not a problem, but operationally it causes extreme problems in layout. It is a big source of non-sampling errors. This was quickly recognized, and the layout was changed to be parallel to row direction. There were still some problems operationally. The team tried to improve these procedures:

- The plot boundaries (length) should always run down the bottom of the furrows parallel to the direction of planting.

- The plot boundaries (width) should always be from bottom of furrows between hills. If this distance is greater than 70 cm one furrow distance will be used. If the distance is less than 70 cm then two furrow widths will be used.

- The length of the plot should equal $3m^2$ divided by width of plot in meters. This length determination is similar to what has been done in the recent past. The team did see that this computation was difficult for the field workers because they did not have calculators to compute the length. They sometimes did it by hand or in their heads and were not always accurate. The results of the computation often give lengths in decimal amounts that are sometimes hard to measure precisely.

- The team recommends that row width be across two single rows or one M…(flattened wide row with two rows of cotton each along an edge). Once the width is measured, a table similar to this one could be used to determine the length dimension.

An alternative to having to calculate length of plot during the fieldwork might be a table like next table.

The instructions with this table might be the following:

"After determination of forecasting plot-starting point, randomly measure the width of two rows from the middle of furrow bottoms and then, with the help of length table, use the appropriate length. Layout the plot and then measure the fourth side of the plot. Record the five dimensions on the suitable form."

**Table 4-1: The Length of Forecasting Plot (2 Rows, 3m$^2$) for Different Widths**

| Width (m) | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 |
|---|---|---|---|---|---|---|---|---|---|---|
| **1.0** | 3.00 | 2.97 | 2.94 | 2.91 | 2.88 | 2.86 | 2.83 | 2.80 | 2.78 | 2.75 |
| **1.1** | 2.73 | 2.70 | 2.68 | 2.65 | 2.63 | 2.61 | 2.59 | 2.56 | 2.54 | 2.52 |
| **1.2** | 2.50 | 2.48 | 2.46 | 2.44 | 2.42 | 2.40 | 2.38 | 2.36 | 2.34 | 2.33 |
| **1.3** | 2.31 | 2.29 | 2.27 | 2.26 | 2.24 | 2.22 | 2.21 | 2.19 | 2.17 | 2.16 |
| **1.4** | 2.14 | 2.13 | 2.11 | 2.10 | 2.08 | 2.07 | 2.05 | 2.04 | 2.03 | 2.01 |
| **1.5** | 2.00 | 1.99 | 1.97 | 1.96 | 1.95 | 1.94 | 1.92 | 1.91 | 1.90 | 1.89 |
| **1.6** | 1.88 | 1.86 | 1.85 | 1.84 | 1.83 | 1.82 | 1.81 | 1.80 | 1.79 | 1.78 |
| **1.7** | 1.76 | 1.75 | 1.74 | 1.73 | 1.72 | 1.71 | 1.70 | 1.69 | 1.69 | 1.68 |
| **1.8** | 1.67 | 1.66 | 1.65 | 1.64 | 1.63 | 1.62 | 1.61 | 1.60 | 1.60 | 1.59 |
| **1.9** | 1.58 | 1.57 | 1.56 | 1.55 | 1.55 | 1.54 | 1.53 | 1.52 | 1.52 | 1.51 |
| **2.0** | 1.50 | 1.49 | 1.48 | 1.48 | 1.47 | 1.46 | 1.45 | 1.45 | 1.44 | 1.44 |

Source: Developed and calculated by the study team.

The team discussed another procedure to simplify the plot layout and reduce non-sampling error. This would be to set a definite row length and let the plot area vary around the 3m$^2$ target. For example, let plot size be set at two row widths' distance X 2 meter length or one row width by 3 meter length. This simplifies the decision process of the fieldworker and should lead to more precise measurement and layout (reduce non-sampling error). Using this procedure the plot areas would vary. Since the exact plot size has to be computed no matter how the plot is laid out to adjust the data, it would take the calculations out of the field and let all of them be done in the office. The computer would take the exact plot measurements (all four plot dimensions and the diagonal) and compute the adjustment factor to the 3m$^2$ or directly to the feddan basis. The team did not do any testing of this procedure.

The first procedure was that used by the team for their work. These were used on all forecasting plots by the CAAE in 1999.

Of course proper training and supervision are essential to improve the quality of data. The team strongly recommends that fieldwork have quality control measures built into the process.

### 4.1.3 Counts Taken within the Plot

The data were gathered by taking counts on each plant in a hill. The counts were recorded by plant within each hill. There were many reasons for this procedure

- Ease of counting by not having to remember the counts for the whole plot
- Enumerator can recount a plant if he is distracted or forgets his count
- Quality control for rechecks by supervisor
- More detail which can be analyzed to help improve field procedures

### Table 4-2: Identity of Sample Governorates, Districts, Villages, Varieties, Number of Plants and Number of Hills

| Governorate | District | Village | Variety | Number of Plants | | | Number of Hills | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Row 1 | Row 2 | Total | Row 1 | Row 2 | Total |
| Dakahlia (1) | Belkas (11) | Ahmadia (1) | G86 | 14 | 19 | 33 | 8 | 9 | 17 |
| | | Basandila (2) | G86 | 20 | 18 | 38 | 10 | 9 | 19 |
| | | Demellash (3) | G86 | 21 | 16 | 37 | 10 | 8 | 18 |
| | Manzala (12) | Amara (1) | G85 | 14 | 10 | 24 | 9 | 7 | 16 |
| | | Mershak (2) | G85 | 13 | 14 | 27 | 10 | 10 | 20 |
| | | Kafr Gamalia (3) | G85 | 10 | 4 | 14 | 5 | 3 | 8 |
| Behira (2) | Damanhour(21) | Bastara (1) | G89 | 7 | 12 | 19 | 4 | 6 | 10 |
| | | Sanhour (2) | G89 | 24 | 20 | 44 | 10 | 10 | 20 |
| | | Emaria (3) | G89 | 16 | 11 | 27 | 10 | 8 | 18 |
| | Abou Homos (22) | Nakhla Baharia (1) | G70 | 13 | 13 | 26 | 7 | 7 | 14 |
| | | Besentiway (2) | G70 | 7 | 7 | 14 | 5 | 5 | 10 |
| | | Berket Ghatas (3) | G70 | 10 | 12 | 22 | 4 | 6 | 10 |
| | Rahmania (23) | Simakhrat(Nabila)(1) | G88 | 23 | 19 | 42* | 11 | 10 | 21* |
| | | Simakhrat (Al Wakil) (2) | G88 | 11 | 13 | 24 | 6 | 8 | 14 |
| | | Kafr Ghoniem (3) | G88 | 15 | 16 | 31 | 8 | 8 | 16 |
| Beni Suef (3) | Ahansia (31) | Omara (1) | G80 | 33 | | 33 | 18 | | 18 |
| | | Kafr Abu Shohba (2) | G80 | 45 | | 45 | 17 | | 17 |
| | | Kolla (3) | G80 | 47 | | 47 | 19 | | 19 |
| | Wasta (32) | Keman (1) | G80 | 22 | 29 | 51 | 14 | 15 | 29 |
| | | Manshi Abu Sier (2) | G80 | 18 | | 18 | 10 | | 10 |
| | | Abu Sir Al Malak (3) | G80 | 39 | | 39 | 18 | | 18 |
| Assiut (4) | Abu Tig (41) | Abu Tieg (Azab) (1) | G83 | 38 | | 38 | 20 | | 20 |
| | | Abu Tieg (Sarhan)(2) | G83 | 42 | | 42 | 21 | | 21 |
| | | Dwina (3) | G83 | 13 | 16 | 29 | 7 | 10 | 17 |
| | Abnob (42) | Swalem Abnob (Bagdadi) (1) | G83 | 45 | | 45 | 22 | | 22 |
| | | Swalem Abnob (Khalil) (2) | G83 | 43 | | 43 | 18 | | 18 |
| | | Beni Ibrahim (3) | G83 | 32 | | 32 | 17 | | 17 |

Source: Developed and calculated by the study team.

* Plants from third row prorated to row 1 and row 2 to fit into table.

The data should assist us in determining which way is the best to count the fruit on the plants. If one counts each type of fruit for the whole plot at once, then the enumerator has to handle each plant many times. This and increases the chances of damage to the plants and of losing count. It is virtually impossible for enumerator to keep all fruit counts straight in only one pass through the plot. Therefore, we counted and recorded all fruit on each plant by hill. With these data, it was hoped to determine whether counting by plant, by hill or by row worked best. One needs to determine if there is much variation in plant and hill numbers between rows and plots. This knowledge would help in designing plot shape and counting procedures. Table 4.2 gives the sample locations, variety, and number of plants and hills by row for each sample. Looking at the numbers, the row 1 and row 2 numbers do not seem to be too different. Where there is no row 2, the number of total plants seems to be fairly similar to total plants of two row samples.

Table 4.3 gives results of detailed Analysis of Variance (ANOVA) which tests the differences between row means (number of plants or hills in a row of sample plots) to see if they are different from each other. When all of the samples are included, the ANOVA shows that the differences between rows are barely significantly different (For Plants - Prob > F = 0.0382; For Hills - Prob > F = 0.0428).

When samples with only one row of plants (plots with two or more rows are removed from the analysis) the ANOVA, row mean numbers, are likely events (For Plants - Prob > F = 0.9874; For Hills - Prob > F = 0.9245, both clearly non-significant).

When an ANOVA is computed on total plants in plots one finds that there is no significant difference between number of plants and between sample plots (Prob > F 0.7736).

Also when the matched pair t-test was computed for both hills and plants within the two rows, it has been found that there is no significant difference between both.

**Table 4-3a: ANOVA Test to Determine if Number of Plants or Hills Differ Between Rows**

**Plant Numbers for Plots with at least two Rows** - Analysis of Variance

| Source | DF | Sum of Squares | Mean Square | F Ratio |
|---|---|---|---|---|
| Model | 2 | 0.70924 | 0.3546 | 0.0127 |
| Error | 32 | 895.17647 | 27.9743 | Prob>F |
| C Total | 34 | 895.88571 | 26.3496 | 0.9874 |

Means for One way Anova

| Level | Number | Mean | Std Error |
|---|---|---|---|
| 1 | 17 | 14.4118 | 1.2828 |
| 2 | 17 | 14.2353 | 1.2828 |
| 3 | 1 | 15.0000 | 5.2891 |

Std Error uses a pooled estimate of error variance

**Hill Numbers for Plots with at least two Rows** - Analysis of Variance

| Source | DF | Sum of Squares | Mean Square | F Ratio |
|---|---|---|---|---|
| Model | 2 | 1.08660 | 0.54330 | 0.0787 |
| Error | 33 | 227.88562 | 6.90562 | Prob>F |
| C Total | 35 | 228.97222 | 6.54206 | 0.9245 |

Means for One way Anova

| Level | Number | Mean | Std Error |
|---|---|---|---|
| 1 | 18 | 8.05556 | 0.6194 |
| 2 | 17 | 7.94118 | 0.6373 |
| 3 | 1 | 7.00000 | 2.6279 |

**Table 4-3b: Comparison of Sample Means for**

**Paired Observations of Hills and Plants per Row***

| Item | Average Number | | Average of Differences (D) | Standard Error of Differences | Degrees of Freedom | T Calculated | Significant |
|---|---|---|---|---|---|---|---|
| | Row (1) | Row (2) | | | | | |
| Hills | 7.8 | 7.6 | 0.2 | 0.3805 | 14 | 0.526 | Insignif. |
| Plants | 14.53 | 13.60 | 0.93 | 0.9384 | 14 | 0.995 | Insignif |

*The null hypothesis tested is that the mean of the population of differences is zero; the alternatives are that the mean is not zero. The tabulated t .025 for 14 degrees of freedom and a two tailed test with ∝ = .025 is more than 2. Here the observed difference is explained on the basis of random sampling from the population associated with the null hypothesis. The hypothesis for both hills and plants per row is not rejected on the basis of the evidence presented.

**Figure 5: Comparison of Number of Plants in Samples by Variety**

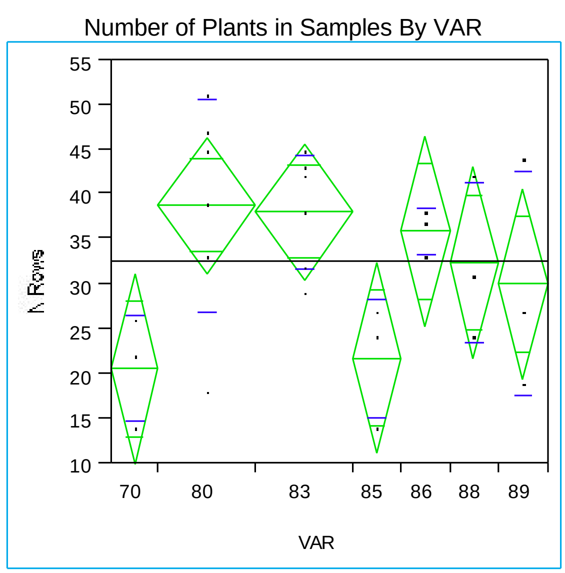


**Table 4-4: ANOVA Test for Comparison of Plants in Samples by Variety**

Analysis of Variance

| Source | DF | Sum of Squares | Mean Square | F Ratio |
|---|---|---|---|---|
| Model | 6 | 1259.5185 | 209.920 | 2.6245 |
| Error | 20 | 1599.6667 | 79.983 | Prob>F |
| C Total | 26 | 2859.1852 | 109.969 | 0.0483 |

Means for One-Way ANOVA

| Level | Number | Mean | Std Error |
|---|---|---|---|
| 70 | 3 | 20.6667 | 5.1634 |
| 80 | 6 | 38.8333 | 3.6511 |
| 83 | 6 | 38.1667 | 3.6511 |
| 85 | 3 | 21.6667 | 5.1634 |
| 86 | 3 | 36.0000 | 5.1634 |
| 88 | 3 | 32.3333 | 5.1634 |
| 89 | 3 | 30.0000 | 5.1634 |

Std Error uses a pooled estimate of error variance

Figure 5 and the ANOVA results show that there are clearly differences in plant numbers by variety. However, the ANOVA test shows that they are just barely significant (probability of greater F value = 0.0483).

### 4.1.4 Findings and Recommendations for Survey Procedures

From the data it is concluded that plant and hill numbers do vary some between one-row and greater-than-one-row samples. However for total plants and hills in a sample plot there is little variation. Plant and hill numbers do vary by varieties. It is unknown why this is true. It could be differences in seeding rate or germination. The implication is that the plots can be one row, but preferably two rows, wide. The most important point is to lay out the plot properly.

## 4.2 Data Analysis and Forecasting Models

This section will concentrate on those characteristics related to forecasting methods. A primary consideration is how the plants grow and mature, differences by variety, factors affecting the development and maturation of cotton.

### 4.2.1 Data Summaries

The data were gathered within the plot in the following way. The team went to over a hundred cotton fields to observe and gather data. Each of the samples was visited at least twice, but usually three times, and fruit were counted. The databases for the fruit counts alone held over 60,000 pieces of data. The following tables summarize the counts by variety, district and governorate.

**Table 4-5: Total Fruit Counts by Variety**

| VAR | 70 | 80 | 83 | 85 | 86 | 88 | 89 | VAR. TOTAL |
|---|---|---|---|---|---|---|---|---|
| **No. Plot** | 3 | 6 | 6 | 3 | 3 | 3 | 3 | |
| **No. Plants** | 62 | 233 | 229 | 65 | 108 | 97 | 90 | 884 |
| **No. Hills** | 34 | 111 | 115 | 44 | 54 | 51 | 48 | 457 |
| BR7 | 0 | 8 | 29 | 0 | 0 | 0 | 0 | 37 |
| DB7 | 3 | 7 | 76 | 3 | 21 | 25 | 13 | 148 |
| OB7 | 0 | 3 | 91 | 0 | 0 | 0 | 0 | 94 |
| POB7 | 0 | 15 | 49 | 0 | 0 | 0 | 0 | 64 |
| LGB7 | 24 | 486 | 824 | 114 | 41 | 122 | 54 | 1665 |
| SGB7 | 205 | 734 | 1152 | 102 | 580 | 304 | 192 | 3269 |
| BL7 | 71 | 89 | 17 | 11 | 76 | 75 | 37 | 376 |
| SQ7 | 555 | 431 | 111 | 68 | 233 | 292 | 132 | 1822 |
| BR8 | 0 | 28 | 117 | 1 | 0 | 0 | 0 | 146 |
| DB8 | 77 | 274 | 312 | 92 | 219 | 139 | 88 | 1201 |
| OB8 | 13 | 939 | 1514 | 53 | 27 | 235 | 121 | 2902 |
| POB8 | 15 | 66 | 95 | 36 | 53 | 59 | 62 | 386 |
| LGB8 | 709 | 786 | 165 | 617 | 953 | 1291 | 600 | 5121 |
| SGB8 | 413 | 400 | 365 | 71 | 247 | 282 | 251 | 2029 |
| BL8 | 2 | 21 | 9 | 1 | 4 | 13 | 7 | 57 |
| SQ8 | 12 | 267 | 92 | 7 | 48 | 57 | 62 | 545 |
| BR9 | 3 | 156 | 170 | 39 | 6 | 0 | 0 | 374 |
| DB9 | 105 | 251 | 277 | 126 | 518 | 206 | 34 | 1517 |
| OB9 | 465 | 1554 | 1794 | 476 | 578 | 1130 | 554 | 6551 |
| POB9 | 83 | 59 | 35 | 55 | 26 | 122 | 136 | 516 |
| LGB9 | 392 | 240 | 25 | 188 | 111 | 280 | 244 | 1480 |
| SGB9 | 51 | 97 | 77 | 18 | 36 | 70 | 64 | 413 |
| BL9 | 11 | 4 | 1 | 1 | 2 | 0 | 0 | 19 |
| SQ9 | 23 | 221 | 3 | 40 | 49 | 40 | 0 | 376 |
| OBPOB | 548 | 1613 | 1829 | 531 | 604 | 1252 | 690 | 7067 |
| OBPOBLGB | 940 | 1853 | 1854 | 719 | 715 | 1532 | 934 | 8547 |

Source: Developed and calculated by the study team.

| | |
|---|---|
| SQi | Squares |
| Bli | Blooms |
| SGBi | Small green bolls |
| LGBi | Large green bolls |
| POBi | Partially open bolls |
| OBi | Open Bolls |
| DBi | Damaged bolls |
| BRi | BR |

Where i = 7 July
8 August
9 September

## Table 4-6: Total Fruit Counts by District

| DIST | 11 | 12 | 21 | 22 | 23 | 31 | 32 | 41 | 42 | DIST TOT. |
|---|---|---|---|---|---|---|---|---|---|---|
| No. Plot | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |
| No. Plants | 108 | 65 | 90 | 62 | 97 | 125 | 108 | 109 | 120 | 884 |
| No. Hills | 54 | 44 | 48 | 34 | 51 | 54 | 57 | 58 | 57 | 457 |
| BR7 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 25 | 4 | 37 |
| DB7 | 21 | 3 | 13 | 3 | 25 | 3 | 4 | 57 | 19 | 148 |
| OB7 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 51 | 40 | 94 |
| POB7 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 17 | 32 | 64 |
| LGB7 | 41 | 114 | 54 | 24 | 122 | 147 | 339 | 206 | 618 | 1665 |
| SGB7 | 580 | 102 | 192 | 205 | 304 | 379 | 355 | 951 | 201 | 3269 |
| BL7 | 76 | 11 | 37 | 71 | 75 | 61 | 28 | 13 | 4 | 376 |
| SQ7 | 233 | 68 | 132 | 555 | 292 | 324 | 107 | 79 | 32 | 1822 |
| BR8 | 0 | 1 | 0 | 0 | 0 | 6 | 22 | 55 | 62 | 146 |
| DB8 | 219 | 92 | 88 | 77 | 139 | 143 | 131 | 167 | 145 | 1201 |
| OB8 | 27 | 53 | 121 | 13 | 235 | 189 | 750 | 728 | 786 | 2902 |
| POB8 | 53 | 36 | 62 | 15 | 59 | 32 | 34 | 60 | 35 | 386 |
| LGB8 | 953 | 617 | 600 | 709 | 1291 | 685 | 101 | 108 | 57 | 5121 |
| SGB8 | 247 | 71 | 251 | 413 | 282 | 255 | 145 | 340 | 25 | 2029 |
| BL8 | 4 | 1 | 7 | 2 | 13 | 19 | 2 | 7 | 2 | 57 |
| SQ8 | 48 | 7 | 62 | 12 | 57 | 95 | 172 | 80 | 12 | 545 |
| BR9 | 6 | 39 | 0 | 3 | 0 | 76 | 80 | 75 | 95 | 374 |
| DB9 | 518 | 126 | 34 | 105 | 206 | 144 | 107 | 197 | 80 | 1517 |
| OB9 | 578 | 476 | 554 | 465 | 1130 | 775 | 779 | 992 | 802 | 6551 |
| POB9 | 26 | 55 | 136 | 83 | 122 | 47 | 12 | 13 | 22 | 516 |
| LGB9 | 111 | 188 | 244 | 392 | 280 | 203 | 37 | 15 | 10 | 1480 |
| SGB9 | 36 | 18 | 64 | 51 | 70 | 59 | 38 | 55 | 22 | 413 |
| BL9 | 2 | 1 | 0 | 11 | 0 | 2 | 2 | 0 | 1 | 19 |
| SQ9 | 49 | 40 | 0 | 23 | 40 | 100 | 121 | 0 | 3 | 376 |

Source: Developed and calculated by the study team.

Fruit Count Coding:

| | |
|---|---|
| SQi | Squares |
| Bli | Blooms |
| SGBi | Small green bolls |
| LGBi | Large green bolls |
| POBi | Partially open bolls |
| OBi | Open Bolls |
| DBi | Damaged bolls |
| BRi | BR |

| Where i = | | |
|---|---|---|
| | 7 | July |
| | 8 | August |
| | 9 | September |

| Governorate | District |
|---|---|
| Dakahlia (1) | Belkas (11) |
| | Manzala (12) |
| Behira (2) | Damanhour(21) |
| | Abou Homos (22) |
| | Rahmania (23) |
| Beni Suef (3) | Ahansia (31) |
| | Wasta (32) |
| Assiut (4) | Abu Tig (41) |
| | Abnob (42) |

**Table 4-7: Total Fruit Counts by Governorate**

| GOV | 1 | 2 | 3 | 4 | GOV TOTAL |
|---|---|---|---|---|---|
| No. Plot | 6 | 9 | 6 | 6 | |
| No. Plants | 173 | 249 | 233 | 229 | 884 |
| No. HILLS | 98 | 133 | 111 | 115 | 457 |
| BR7 | 0 | 0 | 8 | 29 | 37 |
| DB7 | 24 | 41 | 7 | 76 | 148 |
| OB7 | 0 | 0 | 3 | 91 | 94 |
| POB7 | 0 | 0 | 15 | 49 | 64 |
| LGB7 | 155 | 200 | 486 | 824 | 1665 |
| SGB7 | 682 | 701 | 734 | 1152 | 3269 |
| BL7 | 87 | 183 | 89 | 17 | 376 |
| SQ7 | 301 | 979 | 431 | 111 | 1822 |
| BR8 | 1 | 0 | 28 | 117 | 146 |
| DB8 | 311 | 304 | 274 | 312 | 1201 |
| OB8 | 80 | 369 | 939 | 1514 | 2902 |
| POB8 | 89 | 136 | 66 | 95 | 386 |
| LGB8 | 1570 | 2600 | 786 | 165 | 5121 |
| SGB8 | 318 | 946 | 400 | 365 | 2029 |
| BL8 | 5 | 22 | 21 | 9 | 57 |
| SQ8 | 55 | 131 | 267 | 92 | 545 |
| BR9 | 45 | 3 | 156 | 170 | 374 |
| DB9 | 644 | 345 | 251 | 277 | 1517 |
| OB9 | 1054 | 2149 | 1554 | 1794 | 6551 |
| POB9 | 81 | 341 | 59 | 35 | 516 |
| LGB9 | 299 | 916 | 240 | 25 | 1480 |
| SGB9 | 54 | 185 | 97 | 77 | 413 |
| BL9 | 3 | 11 | 4 | 1 | 19 |
| SQ9 | 89 | 63 | 221 | 3 | 376 |

Source: Developed and calculated by the study team.

Fruiting Codes:

| | |
|---|---|
| Sqi | Squares |
| Bli | Blooms |
| SGBi | Small green bolls |
| LGBi | Large green bolls |
| POBi | Partially open bolls |
| Obi | Open Bolls |
| Dbi | Damaged bolls |
| Bri | BR |

| Where i = | | |
|---|---|---|
| | 7 | July |
| | 8 | August |
| | 9 | September |

| Governorate | District |
|---|---|
| Dakahlia (1) | Belkas (11) |
| | Manzala (12) |
| Behira (2) | Damanhour(21) |
| | Abou Homos (22) |
| | Rahmania (23) |
| Beni Suef (3) | Ahansia (31) |
| | Wasta (32) |
| Assiut (4) | Abu Tig (41) |
| | Abnob (42) |

### 4.2.2 Fruit Development by Geographic Area

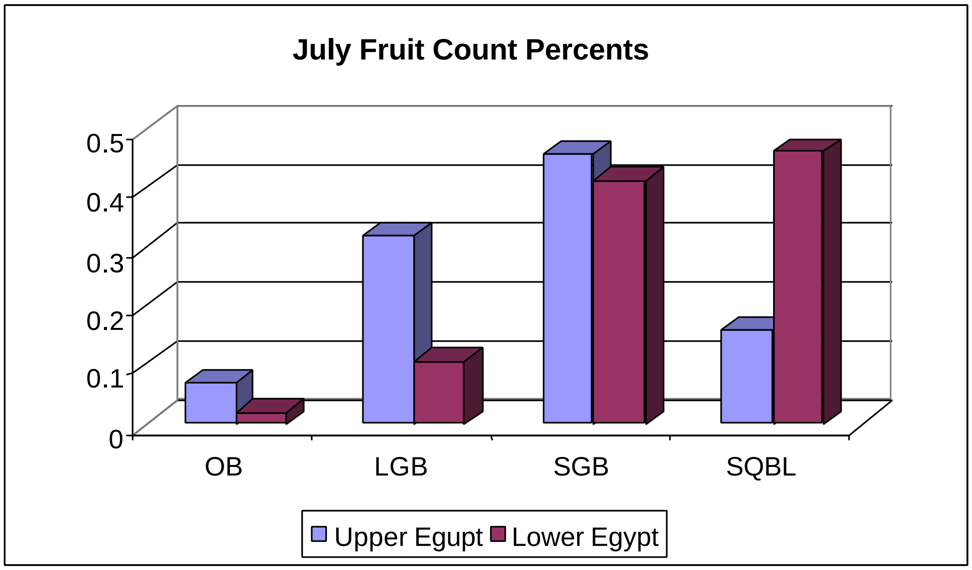
Fruit development is expected to vary across areas because of moisture and heat differentials in the weather, planting time, cultural practices and many other factors. Where these factors become regular enough for a location that the growth and development of the crop can considered consistently early, late or mid-season, then this fact can be used in setting the proper survey dates.

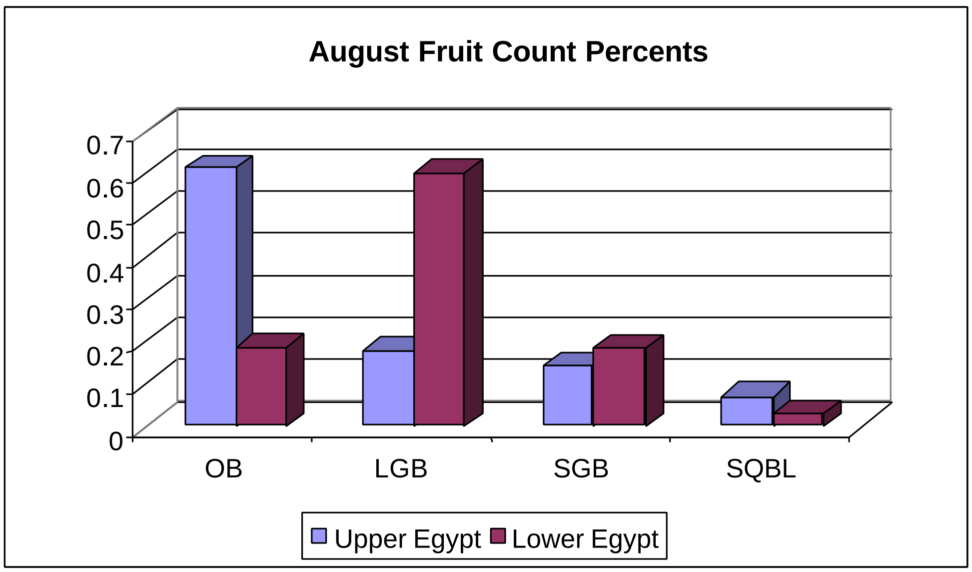
Figure 3 shows the percent of fruit counts falling into different groupings of fruit types. From the chart one can see that Upper Egypt is consistently earlier than Lower Egypt. This is easily explained by weather and planting differences. This lends credence to the recommendation to start the Upper Egypt surveys in late June and leave the Lower Egypt until late July.

### 4.2.3 Fruit Development by Variety and Month

Figure 6 through 13 show fruit counts for each variety by respective months. When one looks at the July, August and September counts for a given variety, the growth and development of the fruit throughout the season can be visualized. When different variety charts are compared side-by-side, one can see how they vary by variety for the season. Note that varieties Giza 80 and 83 seem to be more mature and have more fruit than the other varieties. These varieties are in Upper Egypt and were planted earlier with warmer weather. The charts are labeled by governorate (and by district where more than one variety exists in a governorate). The charts are in an order from the earliest to latest development based on the data. These charts use groupings of similar fruit types for ease of visualization. The team has the individual fruit type totals, which can be studied to further determine growth patterns by variety and survival rates of fruit types.

**Figure 6: Comparison of Lower and Upper Egypt Fruit Development**



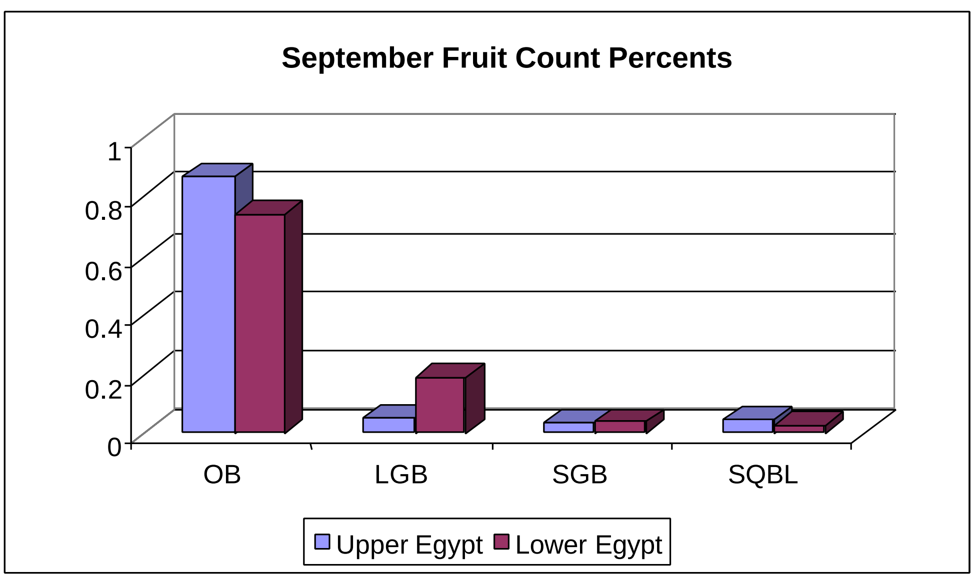
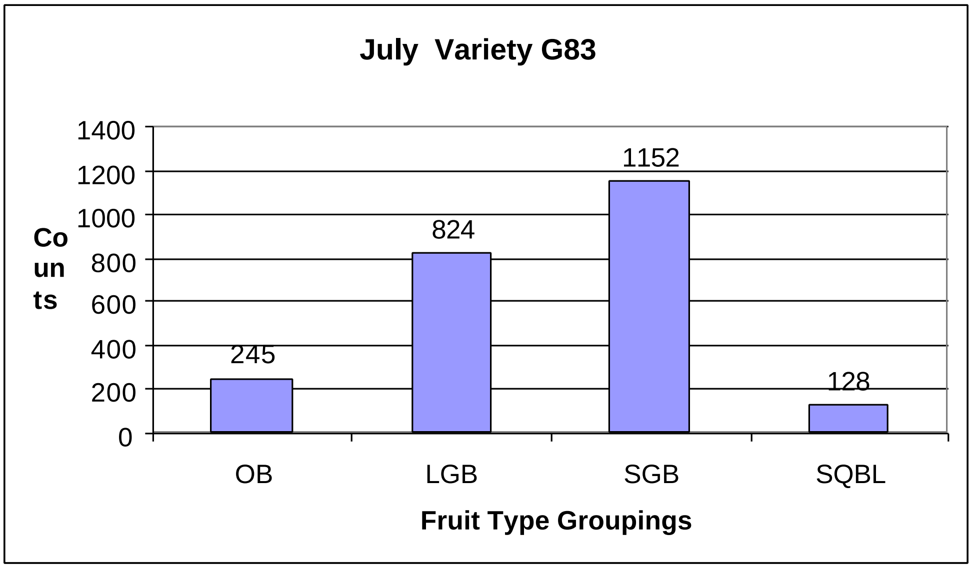
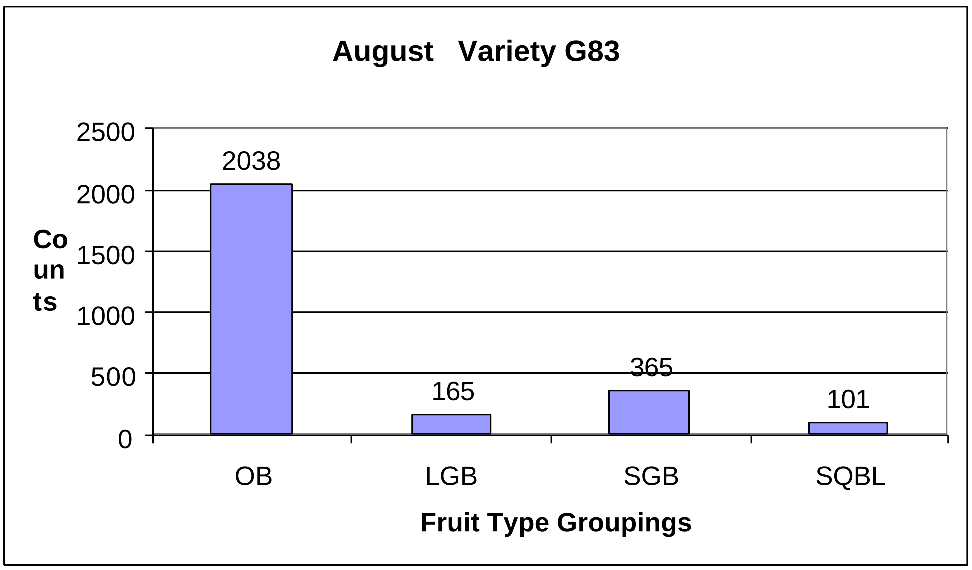



**Figure 7: Monthly Fruit Development, Assiut**



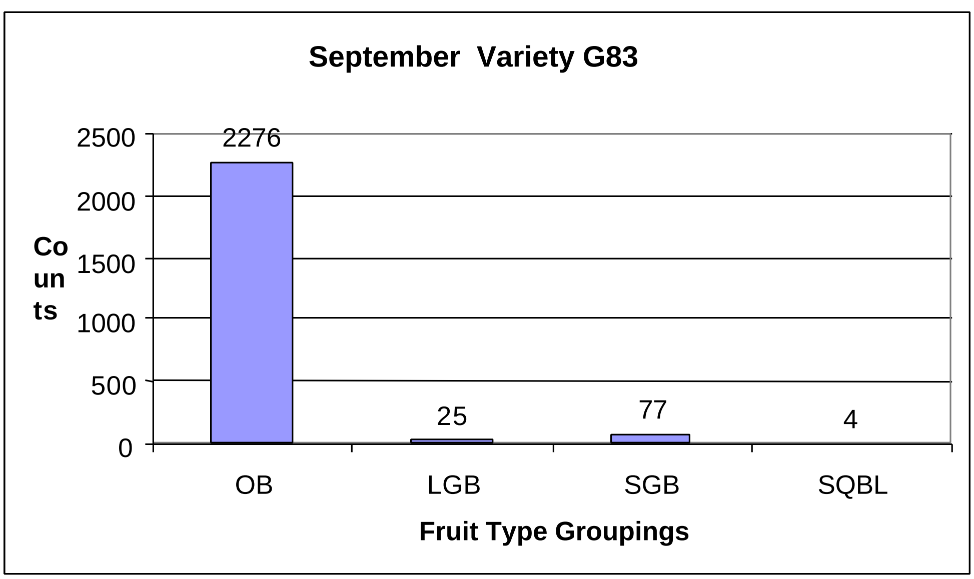
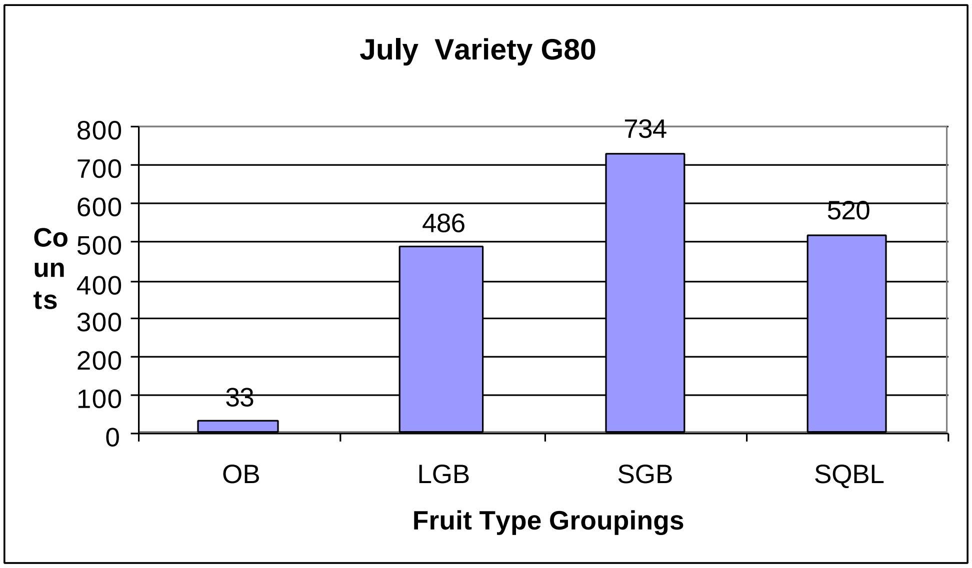
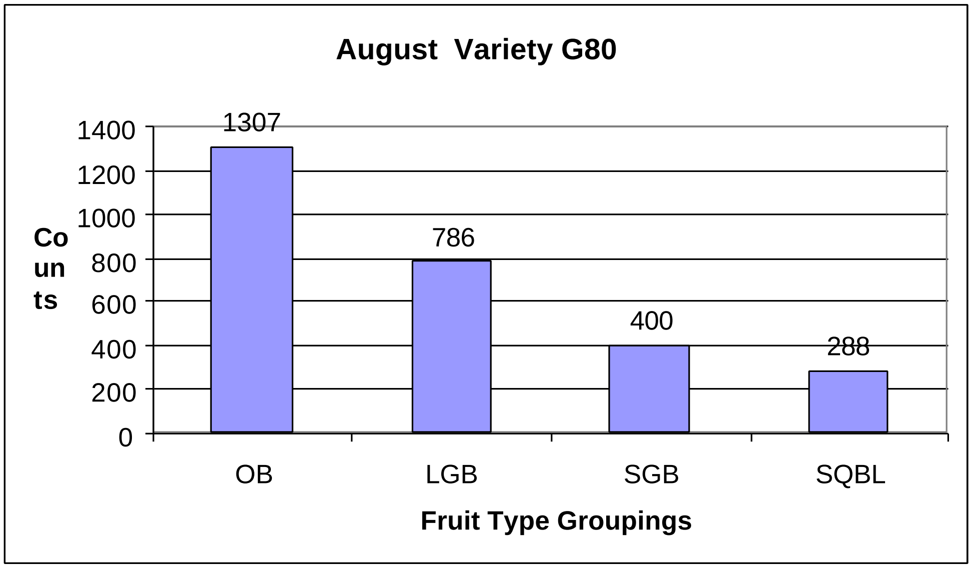



**Figure 8: Monthly Fruit Development, Beni Suef**



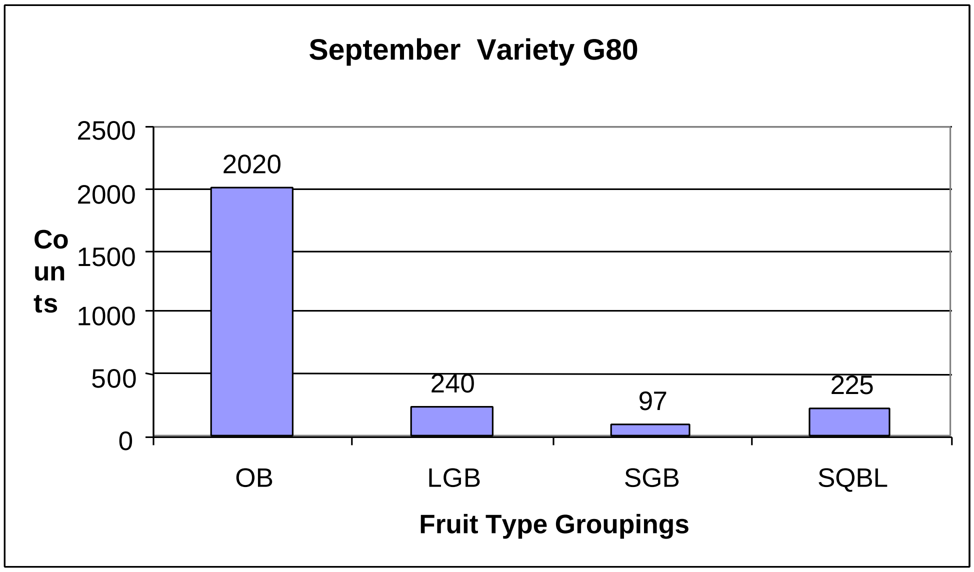
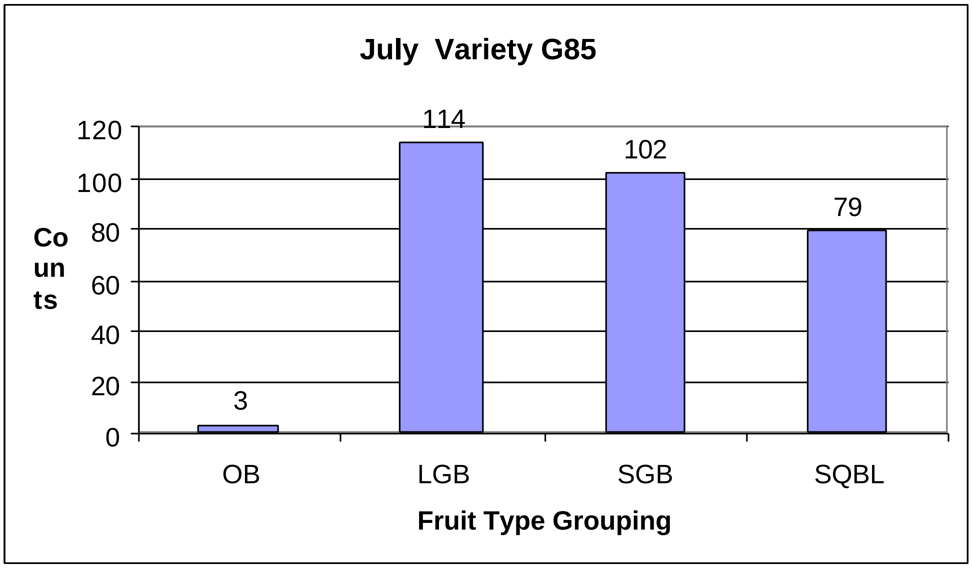
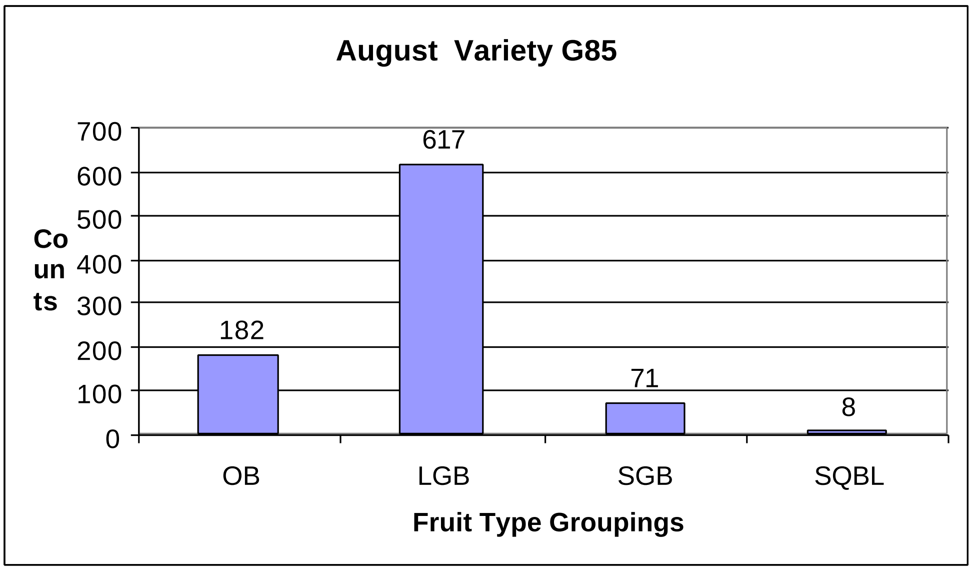



**Figure 9: Monthly Fruit Development, Dakahlia-Manzala**



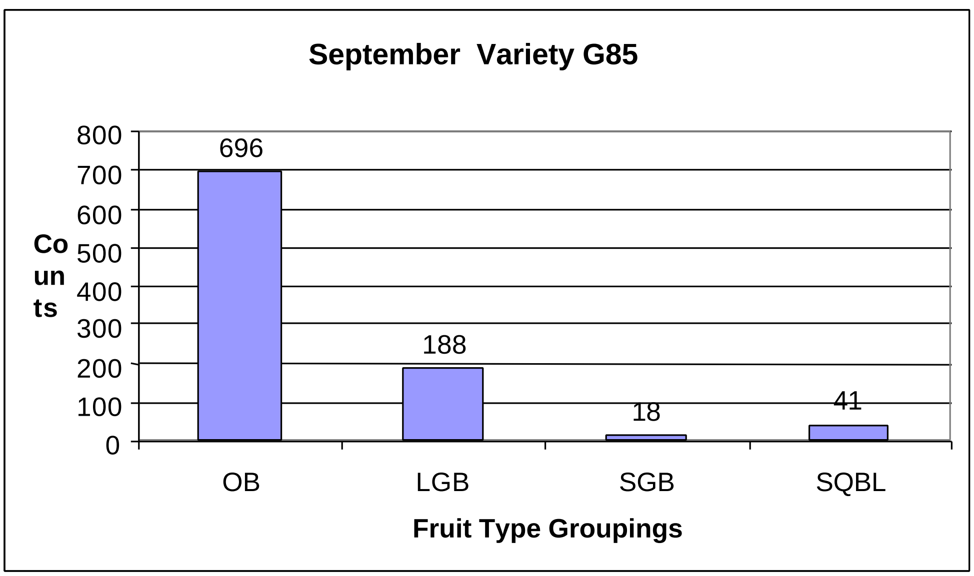
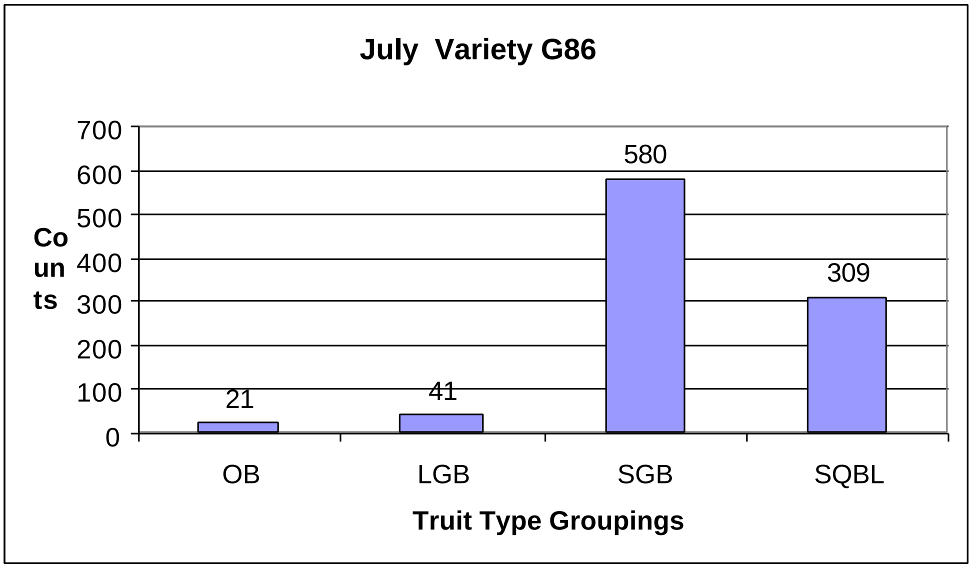
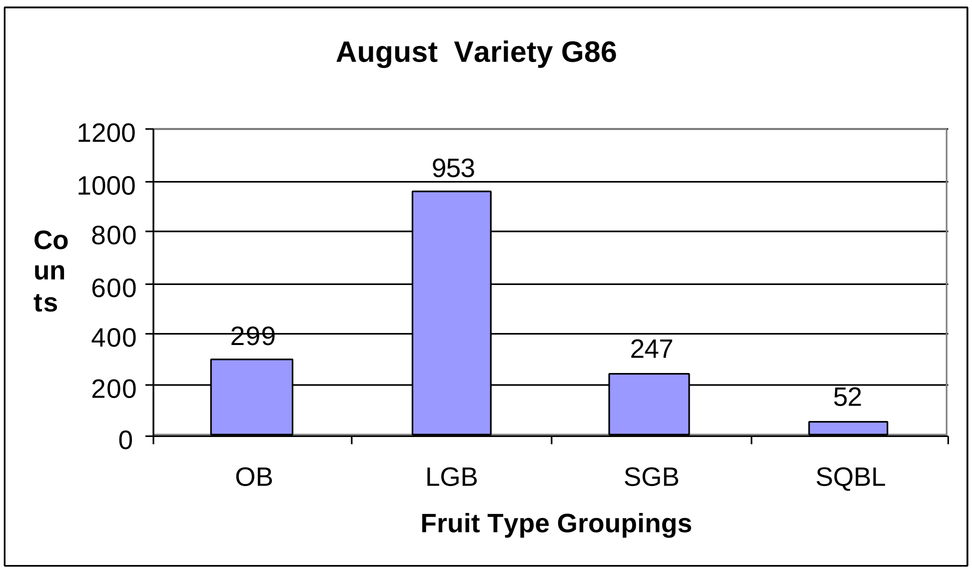



**Figure 10: Monthly Fruit Development, Dakahlia-Belkas**



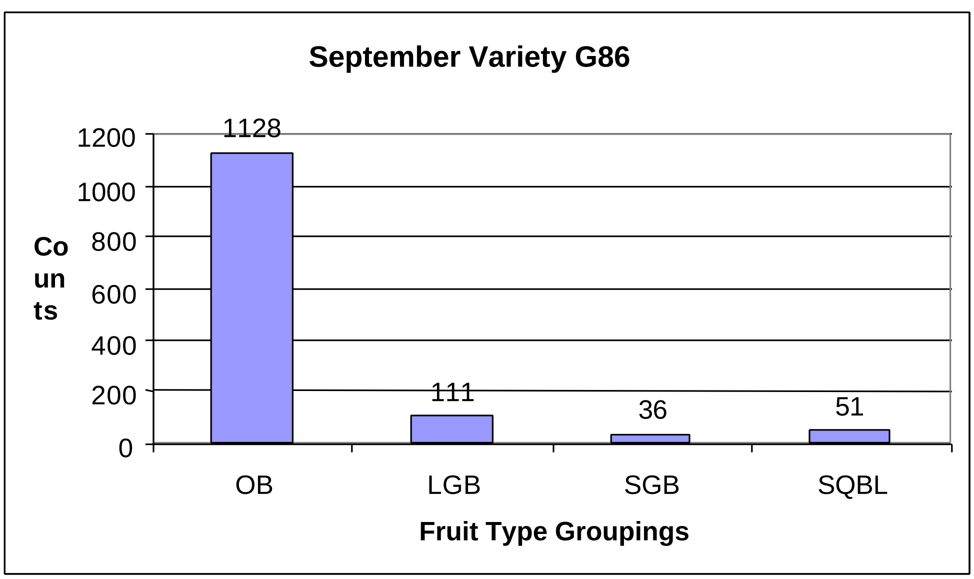
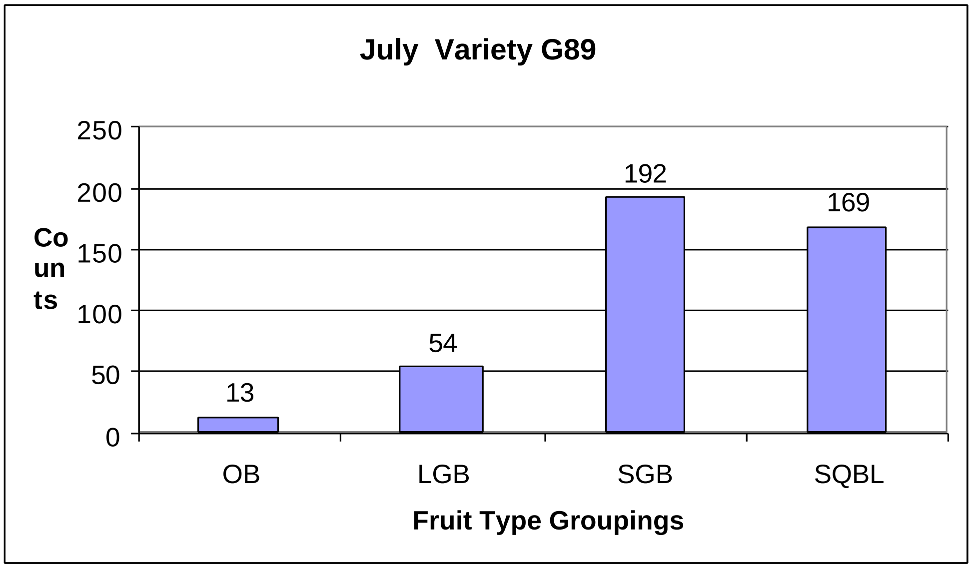
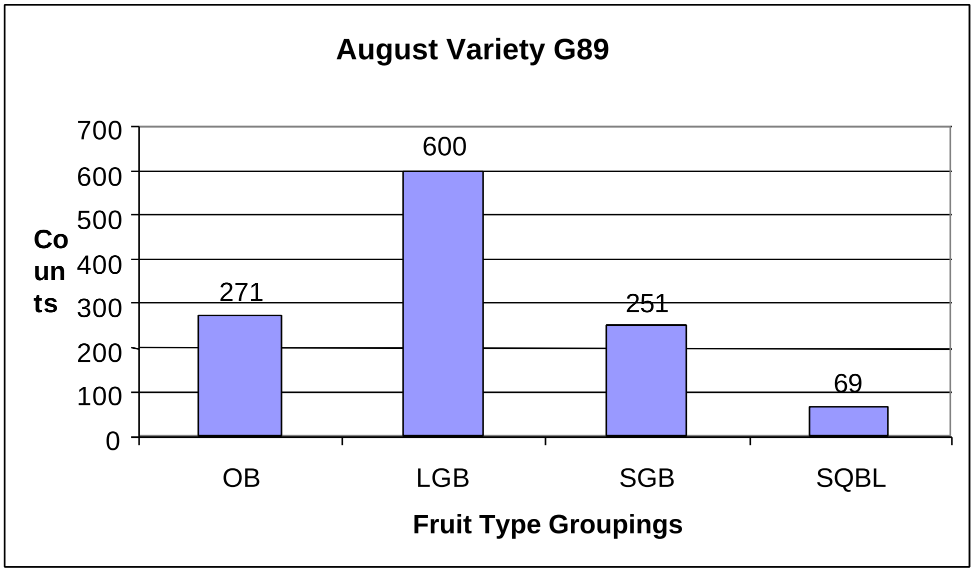



**Figure 11: Monthly Fruit Development, Behira-Damanhour**



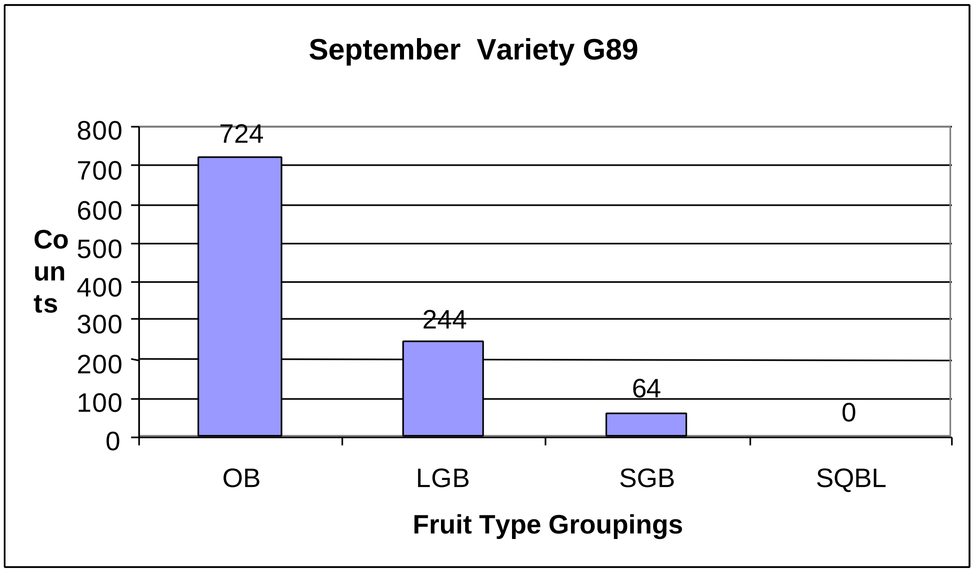
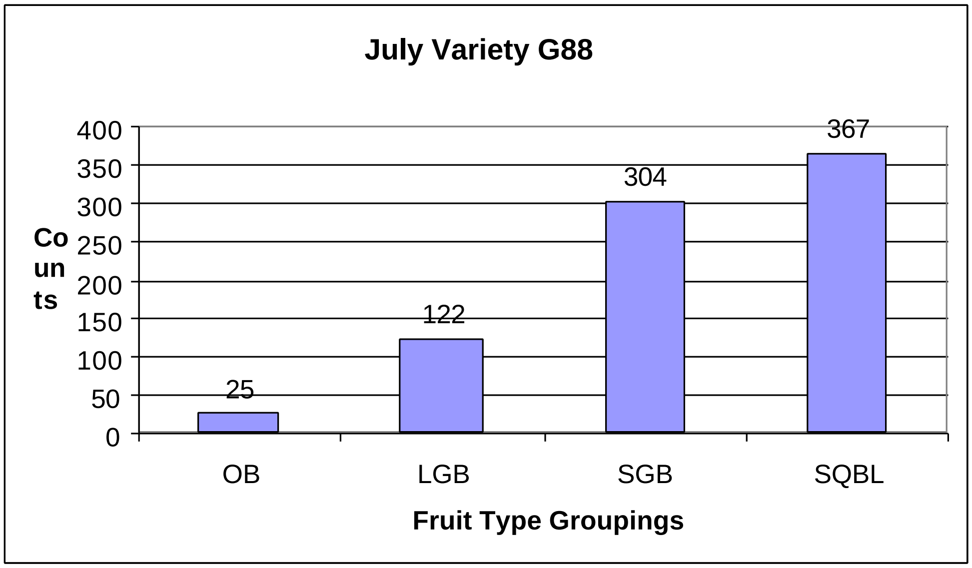
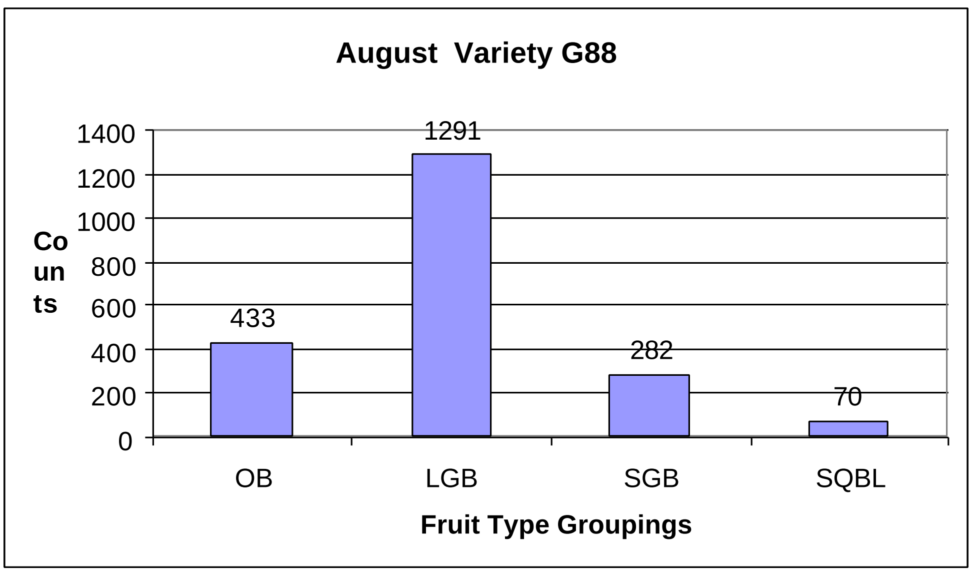



**Figure 12: Monthly Fruit Development, Behira-Rahmania**



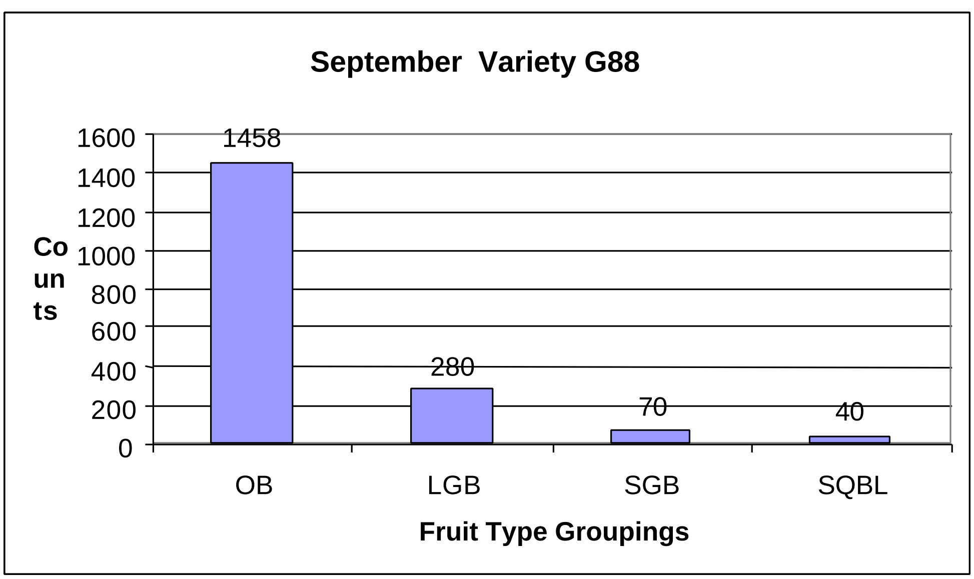
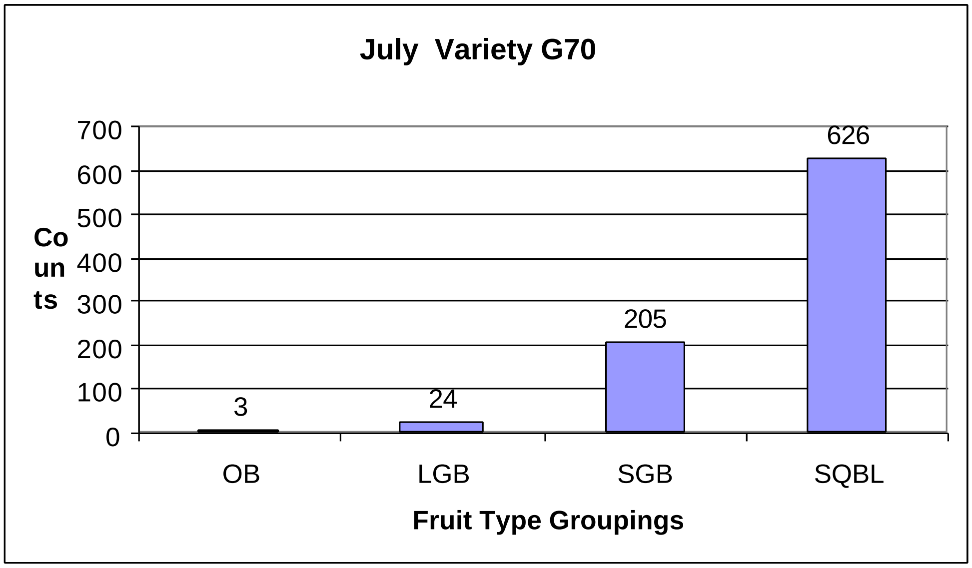
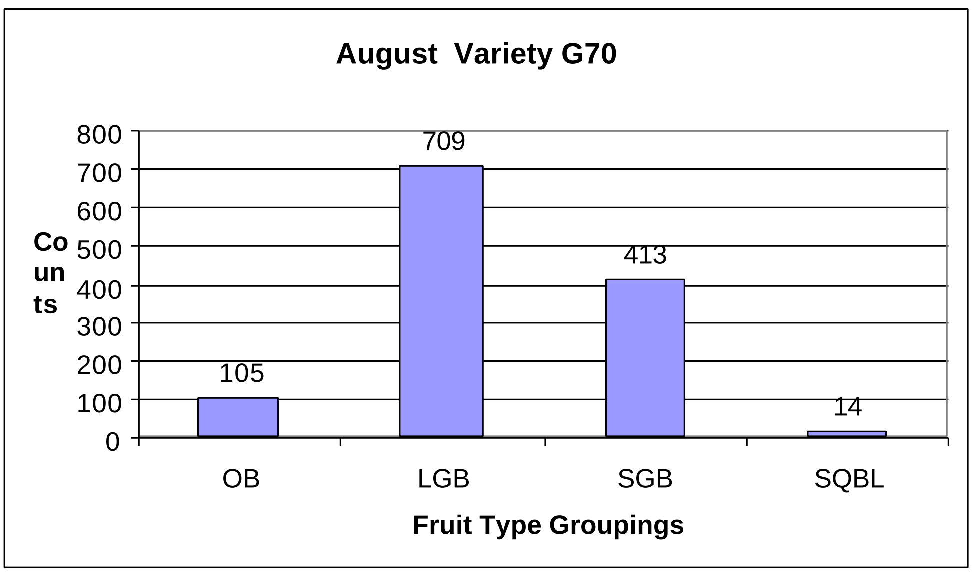



**Figure 13: Monthly Fruit Development, Behira-Abu Homos**



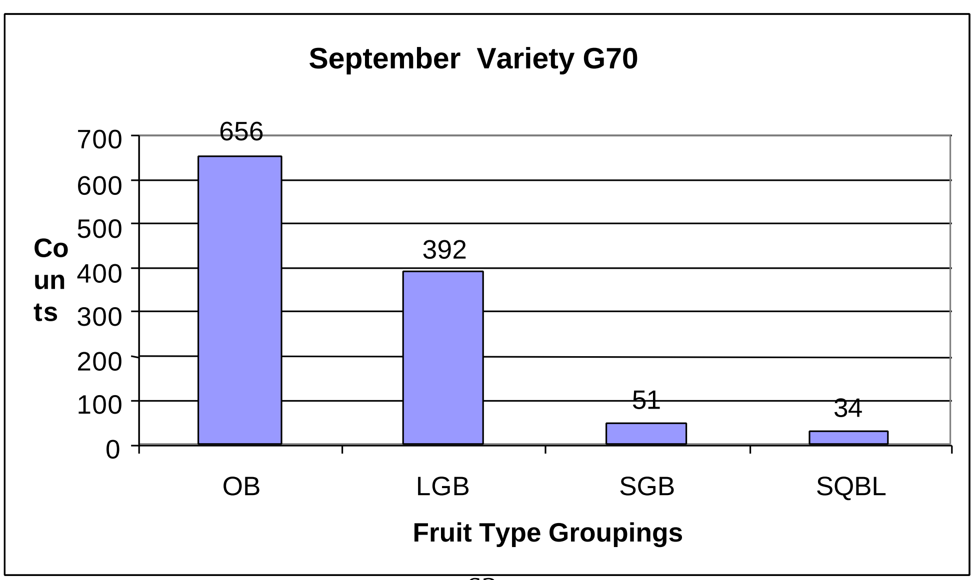



**Table 4-8: Current Fruit Model Forecasts by Variety Using Open Bolls, Partially Open Bolls and Burrs**

| Variety | Sum Plot Areas $m^2$ | Sum No. of Open Bolls | Sum Wt. Open Bolls g. | Ave. Wt. Per boll for Var. g. | Sum Bolls in Variety | Number Bolls per Feddan for Var. | Kentars per Fedan |
|---|---|---|---|---|---|---|---|
| **VAR 70** | 9.5167 | 599 | 1386.5 | 2.3147 | 599 | 264356.34 | 3.9300 |
| **VAR 80** | 18.085 | 1726 | 4300.9 | 2.4918 | 1829 | 424760.85 | 6.7979 |
| **VAR 83** | 17.714 | 2086 | 6354.9 | 3.0465 | 2095 | 496725.75 | 9.7190 |
| **VAR 85** | 9.2042 | 535 | 1108.2 | 2.0714 | 610 | 278351.19 | 3.7031 |
| **VAR 86** | 9.85 | 679 | 1546.1 | 2.2770 | 679 | 289522.84 | 4.2341 |
| **VAR 88** | 9.189 | 1310 | 2513 | 1.9183 | 1310 | 598759.39 | 7.3771 |
| **VAR 89** | 6.1425 | 528 | 1090.5 | 2.0653 | 554 | 378803.42 | 5.0248 |

Source: Developed and calculated by the study team.

Table 4-8 combines variety data from the table above and computes a straight estimate for yield. Once the data are available for plots, straight, or preferably weighted, combinations can be made to arrive at governorate, district or variety estimates.

### 4.2.4 Applying Data to Forecasting Models

**Current Fruit Forecasting Model.** The team took the final data from their work and computed a forecast for each forecasting plot and the corresponding crop-cutting plot. The results of these computations are in the following tables. Table 4-9 computes an estimate using only the September burrs, partially open bolls and open bolls, which might be considered for one harvest field. The second table has the same counts plus the damaged bolls. Damaged bolls need to be given some consideration for there was considerable of damage due to handling the plants that a normal field would not incur. Probably a high percentage of these damaged bolls should be included in the expansion. With better training and more careful handling, future sample plots should not have nearly as much damage. The third table includes burrs, partially open bolls, open bolls and large green bolls. This computation could be a model for fields that were to be harvested twice.

Table 4-12 expanded the regular crop-cutting sample in each of the forecasting fields for comparison purposes. These expansions are similar to the forecasting samples, with some exceptions. It appears as if some of the data could have been recorded on the wrong line, as expansions by forecasting and crop cutting look reversed for a few samples. It would be advisable to check recording of data.

**Regression Analysis of Survey Data.** The team ran thousands of regressions to determine the best parameters for the equations for forecasting work in the future. Earlier in the paper the simple formula

$$Y = B_0 + B_1 X_1 + B_2 X_2 + B_3 X_3$$

was defined. To try and clarify the notation to be used in the regression tables, the following table is given. Table 4-13 identifies the variables initially used in the respective stepwise regressions that were run. The stepwise regression process tests all variables and chooses the best subset of variables to estimate the dependent variable. The tables below give the results of the stepwise regression. There is a table for each dependent variable and each month's independent variables, giving regression coefficients for each variety. The R column gives a relative measure of the precision of the regression in explaining the relationship between the independent and dependent variables.

## Table 4-9: Forecast Plot Estimates Using Burrs, Partially Open Bolls, and Open Bolls Applying Current Fruit Model Forecasting, 1999

| GOV | DIST | VAR | PLOT | AREA | ADJ CF | NO. OB | WT. OB | AVE. WT PER BOLL | AVE. DRYING FACTOR | GINNING MOIS- TURE | BOLLS /SAMPLE | WT. COTTON IN SAMP. | WT. COTTON STND SAMP. | CONV. FACTOR PLOT TO FEDDAN | CONV. FACTOR gm to Kentar | Forecast Kentars per Feddan |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | WT./BOLL | | | FOB | | | | | |
| 1 | 11 | 86 | 1 | 3.210 | 0.9346 | 286 | 585.4 | 2.0469 | | | *286* | 585.4000 | 547.1028 | 1400 | 157500 | 4.8631 |
| 1 | 11 | 86 | 2 | 3.325 | 0.9023 | 301 | 741.0 | 2.4618 | | | *301* | 741.0000 | 668.5714 | 1400 | 157500 | 5.9429 |
| 1 | 11 | 86 | 3 | 3.315 | 0.9050 | 92 | 219.7 | 2.3880 | | | *92* | 219.7000 | 198.8235 | 1400 | 157500 | 1.7673 |
| 1 | 12 | 85 | 1 | 2.926 | 1.0254 | 206 | 316.9 | 1.5383 | | | *206* | 316.9000 | 324.9590 | 1400 | 157500 | 2.8885 |
| 1 | 12 | 85 | 2 | 3.309 | 0.9067 | 217 | 527.6 | 2.4313 | | | *217* | 527.6000 | 478.3897 | 1400 | 157500 | 4.2524 |
| 1 | 12 | 85 | 3 | 2.970 | 1.0101 | 112 | 263.7 | 2.3545 | | | 187 | 440.2848 | 444.7321 | 1400 | 157500 | 3.9532 |
| 2 | 21 | 89 | 1 | 3.068 | 0.9780 | 243 | 561.6 | 2.3111 | | | 269 | 621.6889 | 608.0087 | 1400 | 157500 | 5.4045 |
| 2 | 21 | 89 | 2 | 3.308 | 0.9070 | 163 | 377.8 | 2.3178 | | | *163* | 377.8000 | 342.6757 | 1400 | 157500 | 3.0460 |
| 2 | 21 | 89 | 3 | 3.075 | 0.9756 | 285 | 528.9 | 1.8558 | | | *285* | 528.9000 | 516.0000 | 1400 | 157500 | 4.5867 |
| 2 | 22 | 70 | 1 | 3.067 | 0.9783 | 144 | 253.9 | 1.7632 | | | *144* | 253.9000 | 248.3777 | 1400 | 157500 | 2.2078 |
| 2 | 22 | 70 | 2 | 3.450 | 0.8696 | 154 | 395.4 | 2.5675 | | | *154* | 395.4000 | 343.8261 | 1400 | 157500 | 3.0562 |
| 2 | 22 | 70 | 3 | 3.000 | 1.0000 | 301 | 737.2 | 2.4492 | | | *301* | 737.2000 | 737.2000 | 1400 | 157500 | 6.5529 |
| 2 | 23 | 88 | 1 | 3.002 | 0.9995 | 545 | *1090.0* | *2.0000* | | | 545 | 1090.0000 | 1089.4553 | 1400 | 157500 | 9.6840 |
| 2 | 23 | 88 | 2 | 3.188 | 0.9412 | 373 | 817.6 | 2.1920 | | | *373* | 817.6000 | 769.5059 | 1400 | 157500 | 6.8401 |
| 2 | 23 | 88 | 3 | 3.000 | 1.0000 | 392 | 605.4 | 1.5444 | | | *392* | 605.4000 | 605.4000 | 1400 | 157500 | 5.3813 |
| 3 | 31 | 80 | 1 | 2.965 | 1.0118 | 264 | 673.4 | 2.5508 | | | *264* | 673.4000 | 681.3491 | 1400 | 157500 | 6.0564 |
| 3 | 31 | 80 | 2 | 3.060 | 0.9804 | 339 | 708.2 | 2.0891 | | | 353 | 737.4472 | 722.9874 | 1400 | 157500 | 6.4266 |
| 3 | 31 | 80 | 3 | 3.000 | 1.0000 | 304 | 726.7 | 2.3905 | | | *304* | 726.7000 | 726.7000 | 1400 | 157500 | 6.4596 |
| 3 | 32 | 80 | 1 | 3.000 | 1.0000 | 315 | 383.4 | 1.2171 | | | 350 | 426.0000 | 426.0000 | 1400 | 157500 | 3.7867 |
| 3 | 32 | 80 | 2 | 2.840 | 1.0563 | 234 | 894.0 | 3.8205 | | | *234* | 894.0000 | 944.3662 | 1400 | 157500 | 8.3944 |
| 3 | 32 | 80 | 3 | 3.220 | 0.9317 | 270 | 915.2 | 3.3896 | | | *324* | 1098.2400 | 1023.2050 | 1400 | 157500 | 9.0952 |
| 4 | 41 | 83 | 1 | 2.856 | 1.0504 | 488 | 1217.0 | 2.4939 | | | *488* | 1217.0000 | 1278.3613 | 1400 | 157500 | 11.3632 |
| 4 | 41 | 83 | 2 | 2.940 | 1.0204 | 363 | 1103.6 | 3.0402 | | | *363* | 1103.6000 | 1126.1224 | 1400 | 157500 | 10.0100 |
| 4 | 41 | 83 | 3 | 2.990 | 1.0033 | 288 | 461.6 | 1.6028 | | | *288* | 461.6000 | 463.1438 | 1400 | 157500 | 4.1168 |
| 4 | 42 | 83 | 1 | 3.164 | 0.9482 | 448 | 1416.3 | 3.1614 | | | *448* | 1416.3000 | 1342.8887 | 1400 | 157500 | 11.9368 |
| 4 | 42 | 83 | 2 | 2.900 | 1.0345 | 285 | 1297.3 | 4.5519 | | | 294 | 1338.2674 | 1384.4145 | 1400 | 157500 | 12.3059 |
| 4 | 42 | 83 | 3 | 2.864 | 1.0475 | 214 | 859.1 | 4.0145 | | | *214* | 859.1000 | 899.8953 | 1400 | 157500 | 7.9991 |

Source: Developed and calculated by the study team.

**Table 4-10: Forecast Plot Estimates Using Burrs, Partially Open Bolls, Open Bolls, and Damaged Bolls Applying Current Fruit Model Forecasting, 1999**

| GOV | DIST | VAR | PLOT | AREA | ADJ CF | NO. OB | WT. OB | AVE. WT PER BOLL | AVE. DRYING FACTOR | GINNING MOIS-TURE | BOLLS /SAMPLE | WT. COTTON IN SAMP. | WT. COTTON STND SAMP. | CONV. FACTOR PLOT TO FEDDAN | CONV. FACTOR gm to Kentar | Forecast Kentars per Feddan |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | WT./BOLL | | | FOBLB | | | | | |
| 1 | 11 | 86 | 1 | 3.210 | 0.9346 | 286 | 585.4 | 2.0469 | | | *286* | 585.4000 | 547.1028 | 1400 | 157500 | 4.8631 |
| 1 | 11 | 86 | 2 | 3.325 | 0.9023 | 301 | 741.0 | 2.4618 | | | 320 | 787.7741 | 710.7736 | 1400 | 157500 | 6.3180 |
| 1 | 11 | 86 | 3 | 3.315 | 0.9050 | 92 | 219.7 | 2.3880 | | | 140 | 334.3261 | 302.5575 | 1400 | 157500 | 2.6894 |
| 1 | 12 | 85 | 1 | 2.926 | 1.0254 | 206 | 316.9 | 1.5383 | | | 226 | 347.6670 | 356.5084 | 1400 | 157500 | 3.1690 |
| 1 | 12 | 85 | 2 | 3.309 | 0.9067 | 217 | 527.6 | 2.4313 | | | 330 | 802.3410 | 727.5050 | 1400 | 157500 | 6.4667 |
| 1 | 12 | 85 | 3 | 2.970 | 1.0101 | 112 | 263.7 | 2.3545 | | | 202 | 475.6018 | 480.4058 | 1400 | 157500 | 4.2703 |
| 2 | 21 | 89 | 1 | 3.068 | 0.9780 | 243 | 561.6 | 2.3111 | | | 312 | 721.0667 | 705.1997 | 1400 | 157500 | 6.2684 |
| 2 | 21 | 89 | 2 | 3.308 | 0.9070 | 163 | 377.8 | 2.3178 | | | 180 | 417.2025 | 378.4149 | 1400 | 157500 | 3.3637 |
| 2 | 21 | 89 | 3 | 3.075 | 0.9756 | 285 | 528.9 | 1.8558 | | | 442 | 820.2589 | 800.2526 | 1400 | 157500 | 7.1134 |
| 2 | 22 | 70 | 1 | 3.067 | 0.9783 | 144 | 253.9 | 1.7632 | | | 205 | 361.4549 | 353.5933 | 1400 | 157500 | 3.1431 |
| 2 | 22 | 70 | 2 | 3.450 | 0.8696 | 154 | 395.4 | 2.5675 | | | 321 | 824.1779 | 716.6765 | 1400 | 157500 | 6.3705 |
| 2 | 22 | 70 | 3 | 3.000 | 1.0000 | 301 | 737.2 | 2.4492 | | | 417 | 1021.3037 | 1021.3037 | 1400 | 157500 | 9.0783 |
| 2 | 23 | 88 | 1 | 3.002 | 0.9995 | 545 | | *2.0000* | | | 600 | 1200.0000 | 1199.4003 | 1400 | 157500 | 10.6613 |
| 2 | 23 | 88 | 2 | 3.188 | 0.9412 | 373 | 817.6 | 2.1920 | | | 504 | 1104.7464 | 1039.7613 | 1400 | 157500 | 9.2423 |
| 2 | 23 | 88 | 3 | 3.000 | 1.0000 | 392 | 605.4 | 1.5444 | | | 428 | 660.9980 | 660.9980 | 1400 | 157500 | 5.8755 |
| 3 | 31 | 80 | 1 | 2.965 | 1.0118 | 264 | 673.4 | 2.5508 | | | 318 | 811.1409 | 820.7159 | 1400 | 157500 | 7.2953 |
| 3 | 31 | 80 | 2 | 3.060 | 0.9804 | 339 | 708.2 | 2.0891 | | | 364 | 760.4271 | 745.5168 | 1400 | 157500 | 6.6268 |
| 3 | 31 | 80 | 3 | 3.000 | 1.0000 | 304 | 726.7 | 2.3905 | | | 419 | 1001.6030 | 1001.6030 | 1400 | 157500 | 8.9031 |
| 3 | 32 | 80 | 1 | 3.000 | 1.0000 | 315 | 383.4 | 1.2171 | | | 378 | 460.0800 | 460.0800 | 1400 | 157500 | 4.0896 |
| 3 | 32 | 80 | 2 | 2.840 | 1.0563 | 234 | 894.0 | 3.8205 | | | *234* | 894.0000 | 944.3662 | 1400 | 157500 | 8.3944 |
| 3 | 32 | 80 | 3 | 3.220 | 0.9317 | 270 | 915.2 | 3.3896 | | | 331 | 1121.9674 | 1045.3112 | 1400 | 157500 | 9.2917 |
| 4 | 41 | 83 | 1 | 2.856 | 1.0504 | 488 | 1217.0 | 2.4939 | | | 452 | 1127.2213 | 1184.0560 | 1400 | 157500 | 10.5249 |
| 4 | 41 | 83 | 2 | 2.940 | 1.0204 | 363 | 1103.6 | 3.0402 | | | 371 | 1127.9218 | 1150.9406 | 1400 | 157500 | 10.2306 |
| 4 | 41 | 83 | 3 | 2.990 | 1.0033 | 288 | 461.6 | 1.6028 | | | *288* | 461.6000 | 463.1438 | 1400 | 157500 | 4.1168 |
| 4 | 42 | 83 | 1 | 3.164 | 0.9482 | 448 | 1416.3 | 3.1614 | | | *448* | 1416.3000 | 1342.8887 | 1400 | 157500 | 11.9368 |
| 4 | 42 | 83 | 2 | 2.900 | 1.0345 | 285 | 1297.3 | 4.5519 | | | 303 | 1379.2347 | 1426.7946 | 1400 | 157500 | 12.6826 |
| 4 | 42 | 83 | 3 | 2.864 | 1.0475 | 214 | 859.1 | 4.0145 | | | *214* | 859.1000 | 899.8953 | 1400 | 157500 | 7.9991 |

Source: Developed and calculated by the study team.

**Table 4-11: Forecast Plot Estimates Using Burrs, Partially Open Bolls, Open Bolls and Large Green Bolls Applying Current Fruit Model Forecasting, 1999**

| GOV | DIST | VAR | PLOT | AREA | ADJ CF | NO. OB | WT. OB | AVE. WT PER BOLL | AVE. DRYING FACTOR | GINNING MOIS-TURE | BOLLS /SAMPLE | WT. COTTON IN SAMP. | WT. COTTON STND SAMP. | CONV. FACTOR PLOT TO FEDDAN | CONV. FACTOR gm to Kentar | Forecast Kentars per Feddan |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | WT./BOLL | | | FOBLBDB | | | | | |
| 1 | 11 | 86 | 1 | 3.210 | 0.9346 | 286 | 585.4 | 2.0469 | | | 348 | 712.3049 | 665.7055 | 1400 | 157500 | 5.9174 |
| 1 | 11 | 86 | 2 | 3.325 | 0.9023 | 301 | 741.0 | 2.4618 | | | 372 | 915.7874 | 826.2743 | 1400 | 157500 | 7.3447 |
| 1 | 11 | 86 | 3 | 3.315 | 0.9050 | 92 | 219.7 | 2.3880 | | | 408 | 974.3217 | 881.7391 | 1400 | 157500 | 7.8377 |
| 1 | 12 | 85 | 1 | 2.926 | 1.0254 | 206 | 316.9 | 1.5383 | | | 208 | 319.9767 | 328.1139 | 1400 | 157500 | 2.9166 |
| 1 | 12 | 85 | 2 | 3.309 | 0.9067 | 217 | 527.6 | 2.4313 | | | 229 | 556.7760 | 504.8444 | 1400 | 157500 | 4.4875 |
| 1 | 12 | 85 | 3 | 2.970 | 1.0101 | 112 | 263.7 | 2.3545 | | | 259 | 609.8063 | 615.9659 | 1400 | 157500 | 5.4753 |
| 2 | 21 | 89 | 1 | 3.068 | 0.9780 | 243 | 561.6 | 2.3111 | | | 283 | 654.0444 | 639.6523 | 1400 | 157500 | 5.6858 |
| 2 | 21 | 89 | 2 | 3.308 | 0.9070 | 163 | 377.8 | 2.3178 | | | 170 | 394.0245 | 357.3919 | 1400 | 157500 | 3.1768 |
| 2 | 21 | 89 | 3 | 3.075 | 0.9756 | 285 | 528.9 | 1.8558 | | | *285* | 528.9000 | 516.0000 | 1400 | 157500 | 4.5867 |
| 2 | 22 | 70 | 1 | 3.067 | 0.9783 | 144 | 253.9 | 1.7632 | | | 159 | 280.3479 | 274.2504 | 1400 | 157500 | 2.4378 |
| 2 | 22 | 70 | 2 | 3.450 | 0.8696 | 154 | 395.4 | 2.5675 | | | *154* | 395.4000 | 343.8261 | 1400 | 157500 | 3.0562 |
| 2 | 22 | 70 | 3 | 3.000 | 1.0000 | 301 | 737.2 | 2.4492 | | | 352 | 862.1076 | 862.1076 | 1400 | 157500 | 7.6632 |
| 2 | 23 | 88 | 1 | 3.002 | 0.9995 | 545 | | *2.0000* | | | 652 | 1304.0000 | 1303.3483 | 1400 | 157500 | 11.5853 |
| 2 | 23 | 88 | 2 | 3.188 | 0.9412 | 373 | 817.6 | 2.1920 | | | 377 | 826.3678 | 777.7580 | 1400 | 157500 | 6.9134 |
| 2 | 23 | 88 | 3 | 3.000 | 1.0000 | 392 | 605.4 | 1.5444 | | | 429 | 662.5423 | 662.5423 | 1400 | 157500 | 5.8893 |
| 3 | 31 | 80 | 1 | 2.965 | 1.0118 | 264 | 673.4 | 2.5508 | | | 271 | 691.2553 | 699.4151 | 1400 | 157500 | 6.2170 |
| 3 | 31 | 80 | 2 | 3.060 | 0.9804 | 339 | 708.2 | 2.0891 | | | 444 | 927.5540 | 909.3666 | 1400 | 157500 | 8.0833 |
| 3 | 31 | 80 | 3 | 3.000 | 1.0000 | 304 | 726.7 | 2.3905 | | | 327 | 781.6806 | 781.6806 | 1400 | 157500 | 6.9483 |
| 3 | 32 | 80 | 1 | 3.000 | 1.0000 | 315 | 383.4 | 1.2171 | | | 380 | 462.5143 | 462.5143 | 1400 | 157500 | 4.1112 |
| 3 | 32 | 80 | 2 | 2.840 | 1.0563 | 234 | 894.0 | 3.8205 | | | 236 | 901.6410 | 952.4377 | 1400 | 157500 | 8.4661 |
| 3 | 32 | 80 | 3 | 3.220 | 0.9317 | 270 | 915.2 | 3.3896 | | | 362 | 1227.0459 | 1143.2105 | 1400 | 157500 | 10.1619 |
| 4 | 41 | 83 | 1 | 2.856 | 1.0504 | 488 | 1217.0 | 2.4939 | | | *488* | 1217.0000 | 1278.3613 | 1400 | 157500 | 11.3632 |
| 4 | 41 | 83 | 2 | 2.940 | 1.0204 | 363 | 1103.6 | 3.0402 | | | 414 | 1258.6512 | 1284.3380 | 1400 | 157500 | 11.4163 |
| 4 | 41 | 83 | 3 | 2.990 | 1.0033 | 288 | 461.6 | 1.6028 | | | 377 | 604.2472 | 606.2681 | 1400 | 157500 | 5.3890 |
| 4 | 42 | 83 | 1 | 3.164 | 0.9482 | 448 | 1416.3 | 3.1614 | | | *448* | 1416.3000 | 1342.8887 | 1400 | 157500 | 11.9368 |
| 4 | 42 | 83 | 2 | 2.900 | 1.0345 | 285 | 1297.3 | 4.5519 | | | 353 | 1606.8312 | 1662.2392 | 1400 | 157500 | 14.7755 |
| 4 | 42 | 83 | 3 | 2.864 | 1.0475 | 214 | 859.1 | 4.0145 | | | 216 | 867.1290 | 908.3055 | 1400 | 157500 | 8.0738 |

Source: Developed and calculated by the study team.

**Table 4-12: Crop Cutting Plot Estimates from MVE Sample Fields, 1999**

| GOV | DIST | VAR | PLOT | AREA | ADJ CF | WT. COTTON PER PLOT | WT. COTTON STND PLOT | CONV.TO WT. PER FEDDAN | CONV. KENTAR PER FEDDAN |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | WT. KG. | | *400 | /155.7 |
| 1 | 11 | 86 | 1 | 10.800 | 0.9722 | 1.980 | 1.9250 | 770.0000 | 4.9454 |
| 1 | 11 | 86 | 2 | 10.980 | 0.9563 | 3.050 | 2.9167 | 1166.6667 | 7.4930 |
| 1 | 11 | 86 | 3 | 9.750 | 1.0769 | 1.240 | 1.3354 | 534.1538 | 3.4307 |
| 1 | 12 | 85 | 1 | 10.650 | 0.9859 | 2.050 | 2.0211 | 808.4507 | 5.1924 |
| 1 | 12 | 85 | 2 | 14.437 | 0.7273 | *2.000* | 1.4546 | 581.8383 | 3.7369 |
| 1 | 12 | 85 | 3 | 10.500 | 1.0000 | 2.550 | 2.5500 | 1020.0000 | 6.5511 |
| 2 | 21 | 89 | 1 | 10.875 | 0.9655 | 1.650 | 1.5931 | 637.2414 | 4.0928 |
| 2 | 21 | 89 | 2 | 10.725 | 0.9790 | 2.100 | 2.0559 | 822.3776 | 5.2818 |
| 2 | 21 | 89 | 3 | 10.546 | 0.9956 | 2.050 | 2.0410 | 816.4001 | 5.2434 |
| 2 | 22 | 70 | 1 | 10.575 | 0.9929 | 1.340 | 1.3305 | 532.1986 | 3.4181 |
| 2 | 22 | 70 | 2 | 10.859 | 0.9670 | 2.450 | 2.3690 | 947.6185 | 6.0862 |
| 2 | 22 | 70 | 3 | 10.500 | 1.0000 | 3.000 | 3.0000 | 1200.0000 | 7.7071 |
| 2 | 23 | 88 | 1 | 10.500 | 1.0000 | 3.300 | 3.3000 | 1320.0000 | 8.4778 |
| 2 | 23 | 88 | 2 | 10.115 | 1.0381 | 3.810 | 3.9550 | 1582.0069 | 10.1606 |
| 2 | 23 | 88 | 3 | 11.625 | 0.9032 | 3.690 | 3.3329 | 1333.1613 | 8.5624 |
| 3 | 31 | 80 | 1 | 9.825 | 1.0687 | 1.350 | 1.4427 | 577.0992 | 3.7065 |
| 3 | 31 | 80 | 2 | 10.500 | 1.0000 | 2.100 | 2.1000 | 840.0000 | 5.3950 |
| 3 | 31 | 80 | 3 | 10.500 | 1.0000 | 1.350 | 1.3500 | 540.0000 | 3.4682 |
| 3 | 32 | 80 | 1 | 11.760 | 0.8929 | 3.570 | 3.1875 | 1275.0000 | 8.1888 |
| 3 | 32 | 80 | 2 | 11.100 | 0.9459 | 2.670 | 2.5257 | 1010.2703 | 6.4886 |
| 3 | 32 | 80 | 3 | 10.600 | 0.9906 | 3.520 | 3.4868 | 1394.7170 | 8.9577 |
| 4 | 41 | 83 | 1 | 10.350 | 1.0145 | 4.430 | 4.4942 | 1797.6812 | 11.5458 |
| 4 | 41 | 83 | 2 | 10.350 | 1.0145 | 4.215 | 4.2761 | 1710.4348 | 10.9855 |
| 4 | 41 | 83 | 3 | 10.500 | 1.0000 | 1.820 | 1.8200 | 728.0000 | 4.6757 |
| 4 | 42 | 83 | 1 | 10.920 | 0.9615 | 4.670 | 4.4904 | 1796.1538 | 11.5360 |
| 4 | 42 | 83 | 2 | 9.825 | 1.0687 | 4.670 | 4.9908 | 1996.3359 | 12.8217 |
| 4 | 42 | 83 | 3 | 10.840 | 0.9686 | 4.340 | 4.2039 | 1681.5498 | 10.7999 |

Source: Developed and calculated by the study team.

**Table 4-13: Regression Variables and Model Notation**

| Dependent Variables | Independent Variables Xi's | | | |
|---|---|---|---|---|
| *Y's* | July survey Data | August Survey Data | July & August Data | July, August & Variety Dummy |
| OB9 | BR7 | | BR7 | BR7 |
| | DB7 | | DB7 | DB7 |
| | OB7 | | OB7 | OB7 |
| | POB7 | | POB7 | POB7 |
| | LGB7 | | LGB7 | LGB7 |
| | SGB7 | | SGB7 | SGB7 |
| | BL7 | | BL7 | BL7 |
| | SQ7 | | SQ7 | SQ7 |
| OBPOB9 | | BR8 | BR8 | BR8 |
| | | DB8 | DB8 | DB8 |
| | | OB8 | OB8 | OB8 |
| | | POB8 | POB8 | POB8 |
| | | LGB8 | LGB8 | LGB8 |
| | | SGB8 | SGB8 | SGB8 |
| | | BL8 | BL8 | BL8 |
| | | SQ8 | SQ8 | SQ8 |
| OBPOBLGB9 | | | | D70 |
| | | | | D80 |
| | | | | D83 |
| | | | | D85 |
| | | | | D86 |
| | | | | D88 |
| | | | | D89 |

Source: Based on the study team's visit.

SQi Squares
Bli Blooms
SGBi Small green bolls
LGBi Large green bolls
POBi Partially open bolls
OBi Open Bolls
DBi Damaged bolls
BRi BR

Where i = 7 July
8 August
9 September

$D_k$ Dummy Variable Where $D_k = 1$ if variety = k
$D_k = 0$ if variety not = k

**Table 4-14: Regression Coefficients, July: Y=OB**

| Variety Regression based on July visit by hill | | | | | | |
|---|---|---|---|---|---|---|
| Dependent variable ( Open bolls) | | | | | | |
| **Variety** | **Constant** | **Large Green Bolls** | **Small Green Bolls** | **Blooms** | **Squares** | **R** |
| | | LGB7 | SGB7 | BL7 | SQ7 | |
| G70 | 2.006 | | 0.877 | | | 0.830 |
| G80 | 3.979 | 0.365 | 0.414 | | 0.519 | 0.634 |
| G83 | 6.643 | 0.490 | 0.428 | 3.335 | -1.065 | 0.778 |
| G85 | 1.682 | 0.758 | 0.646 | | | 0.708 |
| G86 | 3.775 | | 0.434 | | 0.487 | 0.855 |
| G89 | -3.239 | | 1.122 | | | 0.876 |

Source: Based on the data collected by the study team.

**Table 4-15: Regression Coefficients, July: Y=OB+POB**

| Variety Regression based on July visit by hill | | | | | | |
|---|---|---|---|---|---|---|
| Dependent variable ( Open & Partially Open bolls) | | | | | | |
| **Variety** | **Constant** | **Large Green Bolls** | **Small Green Bolls** | **Blooms** | **Squares** | **R** |
| | | LGB7 | SGB7 | BL7 | SQ7 | |
| G70 | 1.972 | | 1.062 | | | 0.829 |
| G80 | 4.177 | 0.352 | 0.427 | | 0.541 | 0.642 |
| G83 | 6.585 | 0.529 | 0.429 | 3.199 | -1.016 | 0.785 |
| G85 | 1.789 | 0.758 | 0.795 | | | 0.712 |
| G86 | 4.173 | | 0.442 | | 0.488 | 0.843 |
| G88 | -0.309 | | 0.153 | | | 0.525 |
| G89 | -2.961 | | 1.206 | | | 0.870 |

Source: Based on the data collected by the study team.

**Table 4-16: Regression Coefficients, July: Y=OB+POB+LGB**

| Variety Regression based on July visit by hill | | | | | | | |
|---|---|---|---|---|---|---|---|
| Dependent variables ( Open & Partially Open & Large green bolls) | | | | | | | |
| **Variety** | **Constant** | **Large Green Bolls** | **Small Green Bolls** | **Damaged bolls** | **Blooms** | **Squares** | **R** |
| | | LGB7 | SGB7 | DB7 | BL7 | SQ7 | |
| G70 | 8.252 | 2.480 | 1.147 | 8.457 | | | 0.841 |
| G80 | 6.230 | | 0.561 | | | 0.624 | 0.655 |
| G83 | 6.520 | 0.539 | 0.441 | | 3.235 | -0.963 | 0.794 |
| G85 | 8.860 | | 1.048 | | | | 0.531 |
| G86 | 6.735 | 1.891 | | | 1.547 | 0.617 | 0.825 |
| G88 | 11.262 | | 1.269 | | | | 0.591 |
| G89 | 2.762 | | 0.886 | | | 0.313 | 0.950 |

Source: Based on the data collected by the study team.

**Table 4-17: Regression Coefficients, August: Y=OB**

| Variety Regression based on August visit by hill | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Dependent variables ( Open bolls) | | | | | | | | | |
| **Variety** | **Constant** | **Open Bolls** | **Partially Open Bolls** | **Large Green Bolls** | **Small Green Bolls** | **Damage d Bolls** | **Blooms** | **Squares** | **R** |
| | | OB8 | POB8 | LGB8 | SGB8 | DB8 | BL8 | SQ8 | |
| G70 | 2.844 | 0.661 | | | 0.751 | | -6.636 | | 0.848 |
| G80 | 4.847 | 0.385 | | 0.407 | 0.405 | 0.622 | | | 0.585 |
| G83 | 3.162 | 0.739 | 2.029 | | 0.352 | | | | 0.790 |
| G85 | 0.001 | | 2.428 | 0.478 | | | | | 0.863 |
| G86 | 2.716 | | | 0.496 | | | -10.369 | | 0.576 |
| G88 | -0.837 | | | | 0.137 | | | | 0.652 |
| G89 | 2.247 | 1.180 | 1.493 | 0.374 | | | | -1.243 | 0.858 |

Source: Based on the data collected by the study team.

**Table 4-18: Regression Coefficients, August: Y=OB+POB**

| Variety Regression based on August visit by hill | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Dependent variables ( Open & Partially open bolls) | | | | | | | | | |
| **Variety** | **Constant** | **Open Bolls** | **Partially Open Bolls** | **Large Green Bolls** | **Small Green Bolls** | **Damaged Bolls** | **Blooms** | **Squares** | **R** |
| | | OB8 | POB8 | LGB8 | SGB8 | DB8 | BL8 | SQ8 | |
| G70 | 3.246 | 0.810 | | | 0.861 | | -8.233 | | 0.858 |
| G80 | 5.276 | 0.366 | | 0.433 | 0.398 | 0.666 | | | 0.577 |
| G83 | 3.224 | 0.740 | 2.111 | | 0.357 | | | | 0.791 |
| G85 | 0.081 | | 2.454 | 0.548 | | | | | 0.857 |
| G86 | 2.366 | | | 0.544 | | | -10.456 | | 0.603 |
| G88 | -0.503 | | | | 0.156 | | | | 0.681 |
| G89 | 3.745 | 1.221 | 1.640 | 0.408 | | | | -1.120 | 0.856 |

Source: Based on the data collected by the study team.

**Table 4-19: Regression Coefficients, August: Y=OB+POB+LGB**

| Variety Regression based on August visit by hill | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Dependent variables ( Open, Partially Open and Large Green bolls) | | | | | | | | | |
| **Variety** | **Constant** | **Open Bolls** | **Partially Open Bolls** | **Large Green Bolls** | **Small Green Bolls** | **Damaged Bolls** | **Blooms** | **Squares** | **R** |
| | | OB8 | POB8 | LGB8 | SGB8 | DB8 | BL8 | SQ8 | |
| G70 | 0.107 | 0.948 | | 1.112 | 0.431 | | | | 0.980 |
| G80 | 7.845 | 0.341 | | 0.624 | 0.415 | | | | 0.477 |
| G83 | 3.185 | 0.749 | 2.177 | | 0.366 | | | | 0.791 |
| G85 | 1.785 | | | 0.800 | | 0.666 | | | 0.822 |
| G86 | 0.045 | | 1.633 | 0.842 | | -0.669 | -7.329 | | 0.756 |
| G88 | 2.498 | | | 1.463 | | | | 1.253 | 0.729 |
| G89 | 3.275 | 0.938 | 1.349 | 0.841 | | | | | 0.918 |

Source: Based on the data collected by the study team.

**Table 4-20: Regression Coefficients, July & August: Y=OB**

| Variety Regression based on July & August visit by hill | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Dependent variables ( Open bolls) | | | | | | | | | | |
| Variety | Cons-tant | Open Bolls | Partially Open Bolls | Large Green Bolls | Small Green Bolls | Dam-aged Bolls | Large Green Bolls | Small Green Bolls | Squ-ares | R |
| | | OB8 | POB8 | LGB8 | SGB8 | DB8 | LGB7 | SGB7 | SQ7 | |
| G70 | 2.006 | | | | | | | 0.877 | | 0.830 |
| G80 | 4.628 | | | | | 0.750 | | 0.486 | 0.411 | 0.635 |
| G83 | 5.253 | 0.714 | 1.922 | | | | | | | 0.767 |
| G85 | -1.282 | | 2.258 | 0.331 | | | 0.370 | 0.370 | | 0.924 |
| G86 | 0.206 | | | 0.379 | | -0.584 | | 0.565 | | 0.901 |
| G88 | -0.837 | | | | 0.137 | | | | | 0.652 |
| G89 | 1.531 | 0.980 | | | | -1.629 | | 0.927 | | 0.977 |

Source: Based on the data collected by the study team.

**Table 4-21: Regression Coefficients, July & August: Y=OB+POB**

| Variety Regression based on July & August visit by hill | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dependent variables ( Open & Partially open bolls) | | | | | | | | | | | |
| Var-iety | Cons-tant | Open Bolls | Partially Open Bolls | Large Green Bolls | Small Green Bolls | Dam-aged Bolls | Blooms | Large Green Bolls | Small Green Bolls | Squ-ares | R |
| | | OB8 | POB8 | LGB8 | SGB8 | DB8 | BL8 | LGB7 | SGB7 | SQ7 | |
| G70 | 1.972 | | | | | | | | 1.062 | | 0.829 |
| G80 | 4.733 | | | | | 0.779 | | | 0.494 | 0.429 | 0.649 |
| G83 | 5.387 | 0.712 | 2.010 | | | | | | | | 0.764 |
| G85 | -1.598 | | 2.399 | 0.342 | | | 6.662 | 0.382 | 0.504 | | 0.924 |
| G86 | -0.144 | | | 0.422 | | -0.564 | | | 0.565 | | 0.901 |
| G88 | -0.503 | | | | 0.156 | | | | | | 0.681 |
| G89 | 1.901 | 1.172 | | | 0.460 | -1.859 | | | 0.859 | | 0.988 |

Source: Based on the data collected by the study team.

**Table 4-22: Regression Coefficients, July & August: Y=OB+POB+LGB**

| Variety Regression based on July & August visit by hill | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dependent variables ( Open & Partially Open & Large green bolls) | | | | | | | | | | | | |
| **Var-iety** | **Cons-tant** | **Open Bolls** | **Partially Open Bolls** | **Large Green Bolls** | **Small Green Bolls** | **Dam-aged Bolls** | **Squares** | **Large Green Bolls** | **Small Green Bolls** | **Blooms** | **Squares** | **R** |
| | | OB8 | POB8 | LGB8 | SGB8 | DB8 | SQ8 | LGB7 | SGB7 | BL7 | SQ7 | |
| G70 | -0.031 | 0.893 | | 1.157 | 0.401 | | | | | | | 0.970 |
| G80 | 6.584 | | | | | | | | 0.539 | | 0.627 | 0.655 |
| G83 | 7.271 | 0.614 | | | 1.516 | | | | | 4.307 | -2.042 | 0.831 |
| G85 | -1.718 | | 1.698 | 0.550 | | | | 0.507 | | | 0.462 | 0.890 |
| G86 | -1.059 | | 0.975 | 0.600 | | -0.636 | | | 0.327 | | 0.395 | 0.920 |
| G88 | 2.498 | | | 1.463 | | | 1.253 | | | | | 0.729 |
| G89 | 2.762 | | | | | | | | 0.886 | | 0.313 | 0.886 |

Source: Based on the data collected by the study team.

The following regression coefficients are derived by using combinations of monthly variables as the independent variables and the same set of dependent variables.

Y = Number of Large bolls at harvest (OB or OBPOBLGB month 9)
X1 = Number of Burrs, Open Bolls, Partially Open Bolls, Large Green Bolls
X2 = Number of Small Bolls and Blooms
X3 = Number of Squares

**Table 4-23: Regression Coefficients, July: X= Combinations; Y=OB**

| Variety Regression based on July visit by hill | | | | | |
|---|---|---|---|---|---|
| Dependent variable ( Open Bolls) | | | | | |
| **Variety** | **Constant** | **Expected Open Bolls** | **Small Bolls & Blooms** | **Squares** | **R** |
| | | X1 | X2 | X3 | |
| G70 | 2.069 | | 0.653 | | 0.808 |
| G80 | 4.059 | 0.367 | 0.374 | 0.477 | 0.629 |
| G83 | 5.510 | 0.489 | 0.445 | -0.578 | 0.771 |
| G85 | 1.537 | 0.737 | 0.654 | | 0.718 |
| G86 | 3.707 | | 0.407 | 0.441 | 0.861 |
| G89 | -4.552 | | 0.998 | | 0.925 |

Source: Based on the data collected by the study team.

**Table 4-24: Regression Coefficients, July: X= Combinations; Y=OB+POB+LGB**

| Variety Regression based on July visit by hill | | | | | |
|---|---|---|---|---|---|
| Dependent variables ( OB & POB & LGB) | | | | | |
| Variety | Constant | Expected Open Bolls | Small Bolls & Blooms | Squares | R |
| | | X1 | X2 | X3 | |
| G70 | 6.480 | 4.089 | | 0.531 | 0.832 |
| G80 | 6.311 | | 0.540 | 0.541 | 0.647 |
| G83 | 4.940 | 0.535 | 0.439 | | 0.777 |
| G85 | 0.837 | 1.041 | 0.535 | 0.529 | 0.749 |
| G86 | 6.423 | | 0.314 | 0.659 | 0.793 |
| G89 | 2.595 | | 0.734 | 0.341 | 0.941 |

Source: Based on the data collected by the study team.

**Table 4-25: Regression Coefficients, July: X= Combinations; Y=OB**

| Variety Regression based on July visit by hill | | | |
|---|---|---|---|
| Dependent variables ( Open Bolls) | | | |
| Variety | Constant | All Fruit | R |
| | | X123 | |
| G70 | 1.853 | 0.221 | 0.766 |
| G80 | 3.919 | 0.406 | 0.626 |
| G83 | 5.705 | 0.405 | 0.719 |
| G85 | 3.224 | 0.272 | 0.451 |
| G86 | 3.764 | 0.393 | 0.861 |
| G89 | -4.007 | 0.538 | 0.793 |

Source: Based on the data collected by the study team.

**Table 4-26: Regression Coefficients, July: X= Combinations; Y=OB+POB**

| Variety Regression based on July visit by hill | | | |
|---|---|---|---|
| **Dependent variables ( Open Bolls & Partially Open Bolls)** | | | |
| **Variety** | **Constant** | **All Fruit** | **R** |
| | | X123 | |
| G70 | 1.694 | 0.274 | 0.784 |
| G80 | 4.110 | 0.414 | 0.631 |
| G83 | 5.892 | 0.413 | 0.726 |
| G85 | 2.641 | 0.343 | 0.517 |
| G86 | 4.148 | 0.399 | 0.850 |
| G89 | -4.820 | 0.603 | 0.821 |

Source: Based on the data collected by the study team.

### 4.2.5 Findings and Recommendations for Forecasting Models

While forecasting models were used in the 1980s, during recent years only direct expansion of survey data was used to estimate yield and production by CAAE. AERI has continued using some forecasting models. Both organizations have come under severe budgetary constraints, which have forced reduction of their work.

This section has reviewed many models and forecasting procedures. The team has helped initiate many improvements in the forecasting methods. The data gathered and analyzed by the team should form an excellent base from which to begin cotton forecasting in the next season. The addition of subsequent years' data will help improve future forecasts.

Detailed findings and recommendations will be given in chapter 5 with those of other sections of the report.

# 5. MAIN FINDINGS AND RECOMMENDATIONS

## 5.1 Crop Cutting and Forecasting Surveys

### 5.1.1 Findings

The use of crop cutting plots for cotton estimating at the time of harvest is a proven method and gives a reliable indication of production *when properly applied*. However, this method does not provide any indication of crop size prior to harvest.

The forecasting method has been proven to be very precise in other countries and has that potential in Egypt, *when properly applied*. Forecasting methods have the advantage of being able to forecast the yield and production many months before harvest. They can also identify insect, disease and cultural problems with the crop as they occur. Monthly surveys on an established set of sample plots give the Government a quick way to assess the affects of a major infestation or calamity. Technical coefficients can be updated through add-on work. Reimbursable surveys can be undertaken with the staff.

### 5.1.2 Recommendations

Both crop forecasting and crop cutting surveys should be continued with greatly improved survey methods. After a series of years when the forecasting methods have proven themselves, the reduction of cotton crop cutting samples can be considered.

## 5.2 Sampling Procedures

### 5.2.1 Findings

It is very clear that the number of forecasting samples is too small and does not give a good representation of the cotton crop by variety or by governorate. The selection of one sample per stratum or district is not representative of the cotton in that area. Current sample selection is not random and often is the first name in the first selected cluster in the stratum.

The selection of crop cutting samples is done in a more statistically acceptable manner, but analysis of data and optimum allocation have not been done recently to verify the sample distribution. Convenience factors (transportation, time, and costs) sometimes take precedence over statistical representativeness.

### 5.2.2 Recommendations

- The sample selection process should be reviewed and optimum allocations should be computed for both the forecasting and crop cutting surveys. Optimum sample size should be based on estimates of precision and costs. Samples should be drawn with probability proportional to the area of each variety in each district.

- Resources should be provided to bring the forecasting work up to an operational level.
- Stratification efficiency should measured regularly.

## 5.3 Survey Timing

### 5.3.1 Findings

The team observed that in late July the cotton in Upper Egypt was well advanced (maturity category greater than 3). Clearly, the forecasting work needs to begin in late June. In Lower Egypt, the cotton was not as far advanced (maturity category 1 & 2); late July may be a proper time to begin current forecasting work in Lower Egypt. However, it was noted that in a few geographic areas in Lower Egypt, the cotton was more advanced than in other areas. Timing for surveys should be given consideration. One must remember that forecasting depends on consistency in data over years to develop models. One can not frequently change survey times because in one year the crop in that area was early or late. Research is recommended to identify proper timing for the surveys.

Another consideration is that cotton in both areas was well along in maturity. A maturity category was computed for each variety in the governorates and found that many samples were already up to category 3. As the desire to forecast earlier in the season comes along, data and models will need to be developed to give the capability to forecast cotton earlier before the plants are very mature.

### 5.3.2 Recommendations

Next year, the forecasting survey should begin in Upper Egypt during the last 10 days of June, and in Lower Egypt during the last 10 days of July. Research should be done to determine if there are other areas that are consistently early and where forecasting could begin earlier. Inquiries should be made of the government and other potential users to determine if forecasts earlier in the season are worthwhile and, if so, begin the process of developing them.

## 5.4 Survey Procedures

### 5.4.1 Findings

The observation of fieldwork procedures and counting methods was very beneficial. Many possible improvements were observed and, after demonstration and discussion with the enumerators, better methods were immediately initiated. Some topics covered were how to lay out the plot properly, how to handle and count plants so as to not damage them, and staying out of the sample plot as one works. Few enumerators had any training or written instructions before the work began so the team provided forms to record the data and wrote instructions for the enumerator’s reference. Virtually all of the errors observed could be corrected with proper training and better equipment. Another consideration the unit of count within the plot. Data analyses show that there is no significant difference between total plants and total hills in a sample. However, plant and hill numbers do vary by varieties.

### 5.4.2 Recommendations

- Survey procedures should be clearly defined with a manual of written instructions for enumerator use.
- A set of sample recording forms should be designed, for example:

  | | |
  |---|---|
  | Form (1-A) | Field diagram and plot dimensions. |
  | Form (1-B) | Plot Map to locate every hill and plant within plot. |
  | Form (2-A) | Counting of first visit |
  | Form (2-B) | Counting of second visit. |
  | Form (2-C) | Counting of third visit. |
  | Form (3) | Weight results. |

- Add coding on each form to facilitate data entry.
- Add pre-coding of identification data on forms, i.e. governorate, district, variety, plot number, month.
- Lay out plot earlier to better identify the plots.
- The plot size can be two rows wide.

## 5.5 Training

### 5.5.1 Findings

The lack of knowledge about the purpose and use of survey data was clearly evident. Enumerators were having trouble doing the job well. After the team gave them some explanation and instructions, the enumerators did a much better job. The enumerators were generally interested and eager to do a good job, but just did not know how.

### 5.5.2 Recommendations

- Proper training of enumeration staff to eliminate errors due to layout, counts, measurements, plant damage and human biases.

- Supervision of fieldwork to cover the whole forecasting period, all sample forms and verification of a representative sub-sample of all forecasting plots. This can be done by selecting at random 10–25% of the total number of clusters and supervising and verifying the work.

A training program should be designed and implemented to assist the enumerators to do their job well. A section of the appendix has the old forms and instructions and the new improved instructions and recording forms for reference. These would make a good starting point for development of the program for future years. A strong supervision and quality assurance portion should be included in the program.

For the success of the sample survey system, it is essential that non-sampling errors be minimized. This can be achieved by:

- Intensive training of field staff by conducting training classes and field training.
- Providing adequate supervision of fieldwork so as to ensure uniformity of procedure followed by the field staff.
- Careful checking of returns during the fieldwork.
- Training the statistical analysis group in the proper statistical analysis of the results.
- Training for data entry into formatted programs at the governorate level and a database at the national level. Programs will need to be developed for these.

## 5.6 Supplies and Equipment

### 5.6.1 Findings

There was a shortage of string and stakes for use in laying out the plots. These were supposed to be placed in the field and left throughout the season. The enumerators used them for the survey and then pulled them up or replaced them with palm fronds. Measuring tapes and boll gauges were also in short supply, even though they are relatively inexpensive. Scales for weighing the cotton in the field were old and often not very precise. They are the balance type for measuring the larger crop cutting samples.

### 5.6.2 Recommendations

Adequate supplies should be obtained and given to the enumerators so they can do their job well. Most of the items mentioned are relatively inexpensive. The scales should be replaced with more modern ones, but they must be durable to withstand the rigors of the field conditions.

## 5.7 Vehicles

### 5.7.1 Findings

There is a critical lack of vehicles for enumerators to do their job. This is a common problem shared by all of the sampling office staff. They have tried to manage by sharing use of vehicles. The vehicles are very old also.

### 5.7.2 Recommendation

Motorcycles are much more practical for the field staff to use, as many of the fields are hard to get to with bigger vehicles. Rental of cars during the peak workload times is a logical solution, provided there is sufficient budget to cover the costs. In other countries, paying per kilometre rate for use of personal vehicles has been successful. Other countries have provided an enumerator with a motorcycle with the condition that if he maintains it and uses it for work for a certain time period it becomes his personally. They found that the motorcycles were better maintained this way.

## 5.8 Incentives

### 5.8.1 Findings

The forecasting and crop cutting work is sometimes done under less than ideal conditions. It can be hot, sunny and dusty with flies around. If a person working under these conditions is making the same pay as someone sitting back in the office in more pleasant conditions, he may lack enthusiasm for the work. Fortunately, the enumerators have seemed to be very interested in this improved, more scientific approach to forecasting yields. To keep up the interest and quality of work, some incentive system will need to be devised. Money is the quickest and most appreciated incentive; but there are other things that can sustain interest.

### 5.8.2 Recommendations

The Government should devise a reasonable incentive system that will reward effort and high quality work. The CAAE has started to provide some incentives for those doing excellent work on the forecasting project.

## 5.9 Office Structure

### 5.9.1 Findings

The majority of the staff are at higher pay grades and are senior personnel. Most of the staff trained in the 1980s have retired, and the few remaining are about to retire. The fieldwork for both crop cutting and forecasting is best done by younger or more physically active staff. The competitive market makes hiring young qualified staff difficult.

### 5.9.2 Recommendations

- The government should find some creative way to attract younger staff to work in sampling offices.
- Some have suggested that an independent section be established, perhaps a sample forecasting branch within the General Administration of Sampling.

## 5.10 Laboratory Procedures

### 5.10.1 Findings

The set up and maintenance of a laboratory to dry and weigh cotton and other forecasting crops has long been a problem. The team experimented with sun drying cotton and testing to determine the moisture content. Preliminary indications are that the sun dried cotton moisture content was the same as the requirements for ginning operations. If further research verifies this, then the drying and weighing procedure for forecasting could be greatly simplified. Each governorate office could handle its own samples. Good scales to weigh the samples of 20 bolls from each sample need to be supplied to each governorate office to complete the work.

### 5.10.2 Recommendations

Research should be done to verify the sun drying procedures. Scales should be provided to each office to do the work.

## 5.11 Forecasting Models

### 5.11.1 Findings

The team researched models used in other countries and in this country in the past. The data gathered during this team effort was subjected to extensive analysis, as discussed in the report. The results give sets of parameters for use in the survival, regression and maximum fruit model.

These parameters are based only on one year's data and will be valid if next year is similar to this year. As more yearly information is added to the database, the reliability of forecasts should improve. In the future when an unusual crop year occurs, one can identify similar past years and develop a unique set of parameters, which should provide precise forecasts. It is good to collect a complete set of data each year to help understand the development of the crop. Then, in unusual years this auxiliary data is invaluable.

### 5.11.2 Recommendation

- Make cotton forecasts yearly using these forecasting models. Incorporate yearly data into the forecasting database so that improved parameters can be developed for future years. Add ancillary data (temperature, humidity, previous crop, etc.) and update each year to enhance forecasting model development.
- Continue to develop improved models to forecast cotton production
- Develop a computer program to handle all aspects of data processing and analysis using software like Excel or Access.
- Investigate early forecasts using a model like the Maximum Bearing Fruit Model.

## 5.12 Other Components for Forecasting

### 5.12.1 Findings

Forecasting models are used to forecast the number of open bolls that will be present at harvest time, and the laboratory work is used to forecast the weight of the cotton in the field. There are other components that go into the forecasting that must be remembered. Adjustments may need to be made to forecasting plot area, like harvest loss or economic adjustments. These need to be verified before they are made.

### 5.12.2 Recommendations

One must be alert to other influences that may be affecting the forecasts and eliminate or compensate for these aberrations.

## 5.13 Topics Needing Research in the Future

### 5.13.1 Sample Size and Allocation

It is clear that the forecasting *sample size and allocation* process is not at all representative of the cotton population. Immediate research is needed to determine the proper sample size and allocation process. This year's data from the study and the regular forecasting data are being computerized and should make a good start on optimum allocation computations.

### 5.13.2 Laboratory or Sun Drying

In the past, cotton samples of up to 20 bolls were picked and weighed in the field and then sent to a laboratory to be dried. The (dry weight)/(field weight) ratio was used to adjust the total weight of field cotton to a dry weight. Then this dry weight is readjusted to 7% or 8%, which is the ginning moisture content. The process takes equipment, time, and manpower to accomplish. Frankly, the work was not being done well due to equipment and personnel problems. Consequently, the team did some tests using sun drying. Preliminary results show that sun drying may be a good alternative, which could be done in each office at a very moderate cost. Research to confirm the adequacy of sun drying needs to be done, or to devise an alternative procedure. Some additional laboratory work, which would be helpful to derive a current conversion coefficient from seed, cotton to lint cotton.

### 5.13.3 Location of Forecasting Plot

Locating the forecasting plot one meter from the crop cutting plot was originally done as research to compare the results of the two procedures. Being so close would eliminate some sources of error due to different fertility and cultural practices on the yield. The team's observation is that having the plots almost on top of each other is causing damage to both plots. Field workers are standing in one while working on the other. Because the crop-cutting plot has to be laid out in order to lay out the forecasting plot, the plants in the crop cutting plot are disturbed three months before they are needed. These disturbances, like opening to more sun, breaking limbs or trampling down plants, have to alter the crop cutting yields. Research into alternative sample plot location would be beneficial. Perhaps independent selection of the crop cutting and forecasting sample plots in the same field would reduce these errors. It would separate the plots most of the time and eliminate so much damage, while still permitting comparison of results. It would eliminate the necessity to layout the crop cutting plot so early before needed. Some have suggested making the forecasting plot part of the crop-cutting plot. It is not evident how one could do this and not disturb the results of the crop cutting experiment.

### 5.13.4 Survey Start Dates

It quickly became obvious that cotton matures at different times and rates in Upper Egypt and Lower Egypt. The upper and lower areas definitely need to have different starting times for forecasting. There were also pockets in the Delta where cotton seemed to be maturing a little faster. Any other suggested changes in survey schedules need to be thoroughly researched to assure that observed differences are not just due to current weather, planting times, or other temporary factors. The use of maturity codes developed and used in the forecasting process might help in identifying plant development and maturation characteristics and determination of the proper timing for forecasting as well as parameters to apply to the sample.

### 5.13.5 Other Research Topics

- Fruit development patterns, timing, and survival rates: this detailed research probably would best be done at experiment stations.

- Proper boll gauge size to distinguish determines large boll status from small boll for each variety.

- Factors affecting growth and yield of cotton and effective ways to capture them in surveys for use in forecasting modeling.

  Some knowledge of the effects of date of planting, temperature, humidity, and other factors on growth and yield are currently available. The data gathered during this study could be matched with these weather and environmental data to begin to form a database. Within a few years enough data will be accumulated that some research could begin to quantitatively link these factors to yield.

- Effects of previous crop and inter-planted crops on yield.

- Determining the optimum plot size and the plot shape for various cotton varieties and locations with respect to the required plot precision, costs and sample size.

# ANNEX A: CROP CUTTING SURVEY PROCEDURES AND ESTIMATES

## Crop Cutting Survey Procedures and Estimates

Egypt has a long history of gathering statistical data, but the quality has been quite variable. Prior to 1955, only subjective methods were used to estimate crop yields, like talking to farmers and government field officers to obtain their personal judgements. Experience has shown that these estimation procedures are usually unreliable, when subjected to a wide range of agricultural and economic conditions.

In 1955, Egypt began improving their estimates of crop production by moving towards more objective methods.  Mr. Koshal, FAO consultant, initiated crop-cutting experiments in Dakahlia for cotton and paddy on a pilot basis.  In 1956, crop cutting was expanded nationwide for cotton, wheat and paddy.  Crop cutting has continued through the years for cotton and some other crops with some success.

**Overview of the Procedures:**

Estimates - Cotton crop cutting is a process that involves over 3,000 plots randomly located throughout the cotton producing area. When the crop is mature and ready for harvest, all cotton is harvested from these sample plots by hand and weighed. These weights from the sample plots are expanded to per feddan level to give weight of cotton per feddan.

**Crop Cutting yield per feddan:**

$$\left[\begin{array}{l}\text{Weight of cotton}\\ \text{in crop cutting plot}\end{array}\right] \mathbf{X} \left[\frac{4200\ m^2\ /\ \text{feddan}}{10.5\ m^2\ /\ \text{plot}}\right] = \left[\begin{array}{c}\text{Weight of cotton}\\ \text{per Feddan}\end{array}\right]$$

**Sampling Procedures for Crop Cutting Survey**

A sampling frame was constructed identifying crop production areas in a geographic location, by the type of cropping pattern and drainage system. There was a belief that production was different between tube (or tile) drainage and gravity flood drainage.

A stratified multi-stage sampling procedure is usually used to estimate yield and production for all crop cutting work. For each district, strata are constructed of contiguous areas of the same cropping pattern and drainage system.  Each stratum is a specific combination of these factors. Within each stratum, clusters are formed of adjacent hodes containing about 200 feddans of cultivated area, these become Primary Sampling Units (PSU).  Within the cluster, two parcels are selected which contain many crop fields (second stage of sampling). From each parcel, a field of the desired crop is selected at random, in this case cotton, (third stage of sampling). The selected field is measured and a crop-cutting plot is randomly located within the field based on the field dimensions (fourth stage of sampling). A selected PSU is used for all crops during a given year for crop cutting experiments, for efficiency reasons.

The number of crop-cutting samples in a stratum is based on total number of feddans in the stratum and allocation constraints. The original sample size and allocation was representative of the major governorates.  When the application of forecasting technique coverage was expanded to all cotton producing governorates in the nation, the sample size was not increased. Leaving some doubt about the sample being fully representative of all national cotton.

The sampling procedures have not changed much over the years, and the sample size has not increased with the survey coverage area. Table (1) shows that the cotton sample size has fluctuated from about 3200 to 3800 during the years 1990 to 1998.

**Table A-1: Crop Cutting and Forecasting Sample Sizes 1990-1998**

| Governorate | Crop Cutting Sample Size | | | | | | | | | Forecasting Sample Size |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1990-1998** |
| **Beheira** | 380 | 350 | 350 | | 430 | 430 | 430 | 430 | 430 | 90 |
| **Gharbia** | 374 | 350 | 336 | | 274 | 330 | 314 | 314 | 314 | 40 |
| **Kafr El Sheikh** | 392 | 395 | 385 | | 400 | 400 | 356 | 360 | 360 | 50 |
| **Dakahlia** | 456 | 410 | 394 | | 318 | 334 | 382 | 366 | 366 | 66 |
| **Damietta** | 88 | 80 | 80 | | 70 | 270 | 78 | 102 | 102 | 20 |
| **Sharkia** | 426 | 416 | 386 | | 344 | 356 | 360 | 334 | 328 | 75 |
| **Menofia** | 266 | 254 | 250 | | 206 | 214 | 230 | 250 | 250 | 40 |
| **Qalubia** | 168 | 160 | 158 | | 120 | 160 | 170 | 140 | 140 | 30 |
| **Beni Suef** | 210 | 200 | 200 | | 198 | 220 | 250 | 246 | 246 | 35 |
| **Fayoum** | 180 | 176 | 164 | | 188 | 190 | 190 | 138 | 138 | 25 |
| **Menya** | 330 | 320 | 332 | | 316 | 324 | 320 | 280 | 280 | 53 |
| **Assuit** | 286 | 262 | 258 | | 216 | 238 | 250 | 220 | 220 | 55 |
| **Sohag** | 232 | 224 | 232 | | 112 | 140 | 154 | 124 | 124 | 49 |
| **Total Egypt** | **3788** | **3597** | **3525** | **3698** | **3192** | **3606** | **3484** | **3304** | **3298** | **628** |

**Assessment of sampling procedures**

The current crop cutting procedures are much the same as described in a previous section. The sample is somewhat representative of the cotton population in that it is distributed based according to the cotton population. However, there should be an analysis of survey data to obtain variances. Cost of doing the survey should be obtained. An optimum allocation of samples using these variables should be made to determine the best allocation of samples to district and varieties.

**Plot Size**

When the crop cutting began in 1955, the size of plots was large and the farmer assisted the enumerator in harvesting cotton within the plots. The original cotton plot size was 7 x 12 meters. In1970 they started decreasing the plot size to 6 x 7 meters. To simplify exact plot location, the enumerator was instructed to locate the starting point of the plot in middle (between rows). The measurement would continue down the middle for a specified distance. The other measurement would then be made across rows to the middle that was nearest the desired distance measurement. Therefore, the crop-cutting plot was not an exact 6 x 7 meters and the area not exactly 42 square meters. The true area then had to be computed for each plot using the dimensions and diagonal measurements. Then an adjustment or correction factor was computed to adjust all data to the exact plot size.

After some research with different plot sizes in 1984, it was determined that the plot size could be reduced by at least 75%. Starting in 1985, the size of the crop cutting plots was changed to 3 x 3.5 meters (10.5 square meters). This gave an estimated 40 percent reduction in survey cost. Since these plots are still measured from row middle to row middle across rows, and not always 3.5 meters wide, individual plot adjustment factors must still be computed and applied to the data.

**Plot location for crop cutting and forecast plots**

The length and width of the selected sample field is measured. Random numbers between 0 and the length and width measurements of the field are drawn. The crop cutting unit is located in the field by measuring the designated distance (random number distance) along the edge and into the field. Measurement usually begins at the southwest corner of the field. The crop-cutting plot is nearly 3 X 3.5 meters. In the direction of the planted rows, the length is exactly 3 meters. The perpendicular boundaries are as near to 3.5 meters as possible, being located in the bottom of the furrows. The corners of the crop-cutting plot are marked with wooden stakes and then string stretched between the tops.

Diagram (1-A) for 1984, shows the cotton crop cutting and forecast plot sizes and positions relative to each other. Forecast plot size is $3m^2$. Dimensions are 3m perpendicular to rows and 1 m parallel to rows. The forecast plot is located exactly 1 meter from the far corner of the crop-cutting plot. The forecast plot is exactly 1 X 3 meters and begins at the 1 meter mark regardless where it falls. It could be anywhere from the bottom to top of the furrow, even splitting the planted rows. Wooden sticks are placed at the four corners of the plot and string runs between the stakes. The beginning and ending plants in each row of the forecast plot are marked with colored tags that wrap around the plant stalks.

Beyond the forecast plot two rows are identified and marked. A calculation (research) row on which the same counts as the forecast plot is taken. A tag row where fruit are tagged based on when they appear on the plant and their stage of development. In July large bolls are tagged with red tags and small bolls and blooms are tagged with yellow tags. White tags are placed on new fruit that appear in August and orange tags in September. Each month the maturity or disposition of the fruit is recorded. This information can be used to determine the survival ratios of the fruit.

Advantages: The plot size is exactly $3m^{2.}$ Procedure includes a tag row.
Disadvantage: Border bias problem of plant separation as plot boundary cuts through the planted rows. It is critical to determine whether a plant lies inside or outside the plot since each plant represents 1400 in a feddan.

The above theoretical procedure was found to be very difficult to accomplish. The tag work was difficult to do and of marginal value due to problems noted later. Thus the forecast lay out was modified. Diagram 1-B gives the 1985-1986 plot configuration.

**Diagram (1-A)**
**1984**

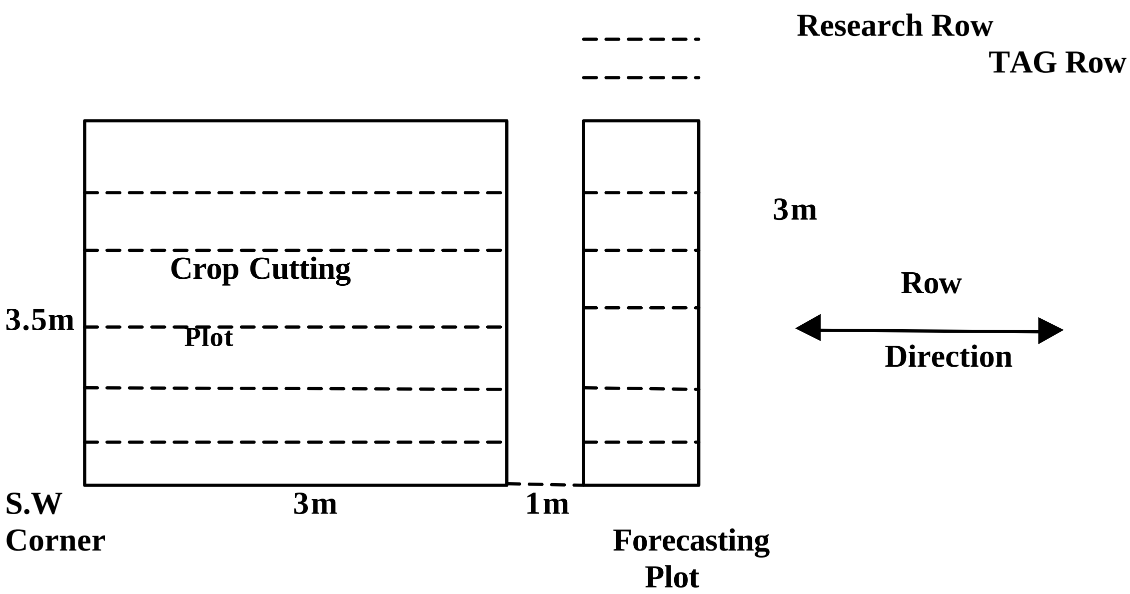



**Diagram (1-B)**
**1985 – 1986**

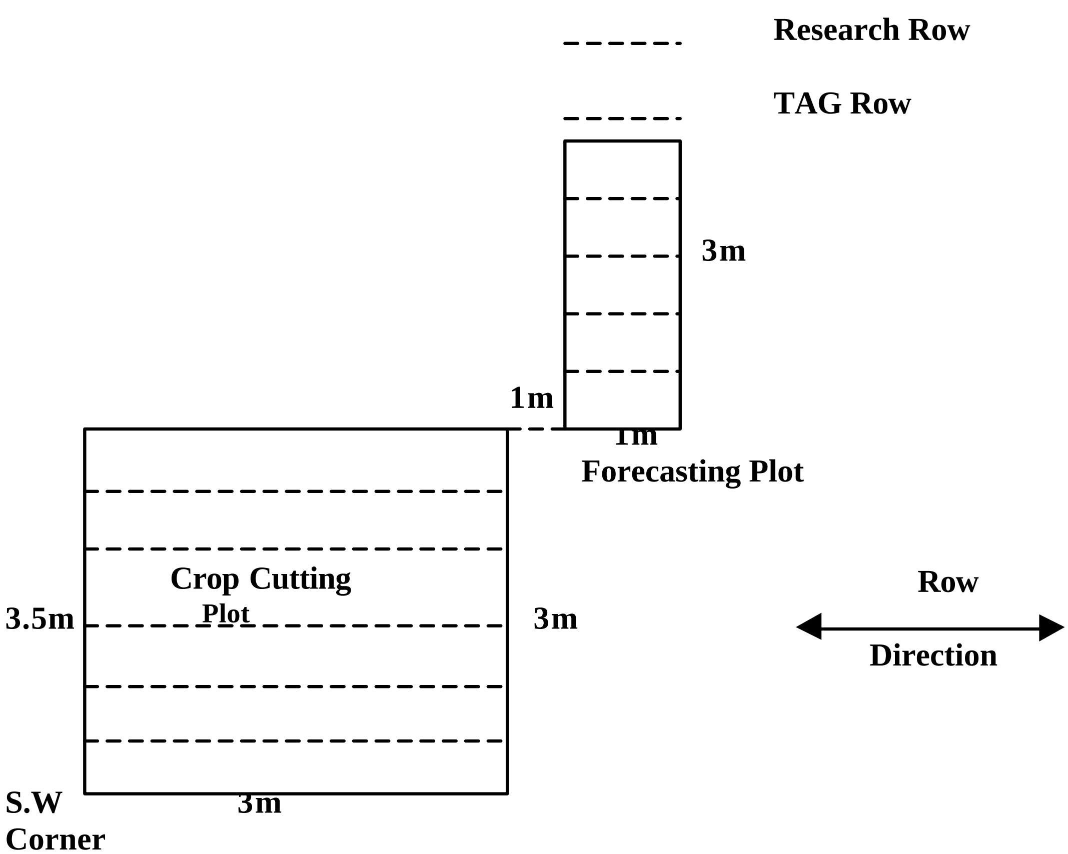


**Diagram (2)**
**1990**

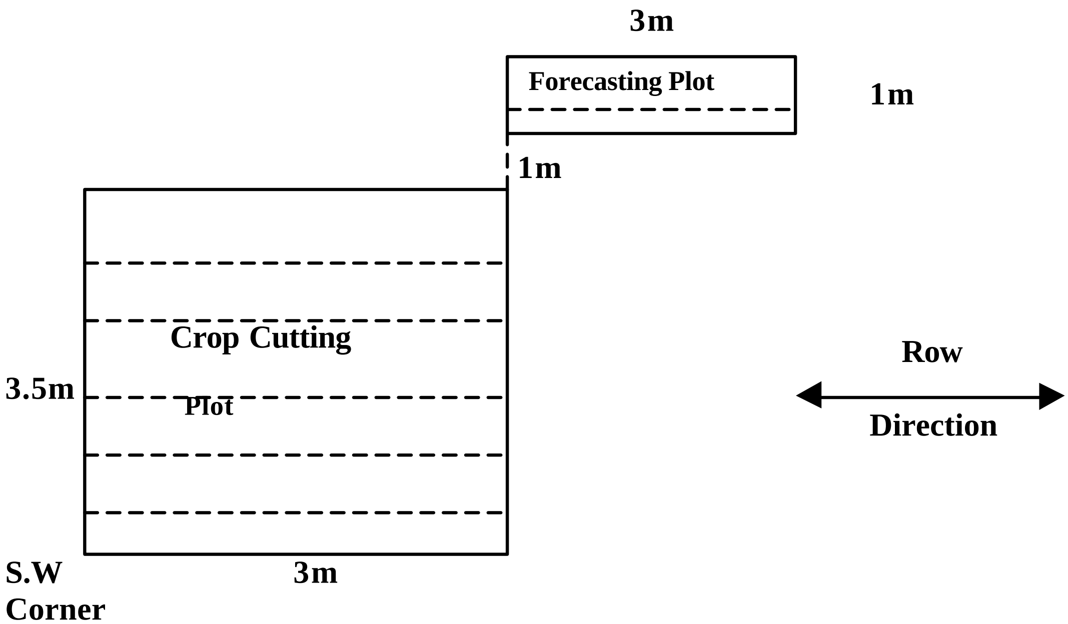



Diagram (2) shows that the forecast plot was one meter beyond the opposite corner of the crop-cutting plot. However, the dimensions were 3m parallel to the rows and 1m perpendicular to rows.

Advantages: Greatly reduces the border bias
Disadvantage: Plot area bias due to number of rows included within the one meter plot width.

**Diagram (3)**
**1991 – 1999**

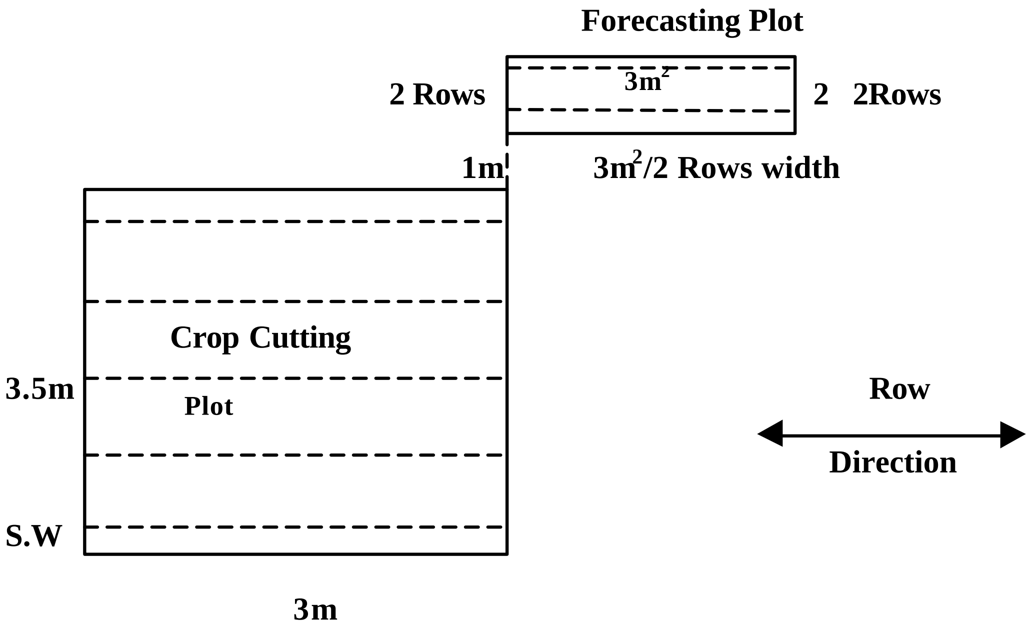



Diagram (3) The forecast plot has the same position relative to the crop cutting plot as in diagram (2) but the plot shape will change. The dimensions vary due to row width The plot width is the width of one furrow if greater than 70 cm, or two furrows if less than 70 cms. The length is computed by ($3m^2$/ one or 2 rows width).

Advantage: Greatly reduced border bias.
Disadvantage: Difficult to make the plot exactly $3m^2$
One has to measure the four sides of the plot and diagonal distance to compute the adjustment factor

**Survey Procedures for Crop Cutting**

Crop cutting plots are randomly located based on field dimensions. A random pair of measurements is chosen based on the field dimensions. The chosen measurements are taken along the edge and into the field. Plots are laid out according to specific instructions, which have changed throughout the years as seen in the above section.

Within the plots, all cotton is picked from plants and off the ground. The total weight of cotton is recorded. The work within the plot has remained the same throughout the years.

**Crop Cutting Estimation Model**

The crop cutting estimation model is very simple. Take the weight of the cotton in the sample plot and expand it to a per feddan basis:

$$\left[\begin{array}{c}\textbf{Estimated}\\ \textbf{Yield per feddan}\end{array}\right] = \left[\begin{array}{c}\textbf{Weight of cotton}\\ \textbf{in sample plot}\end{array}\right] \quad \textbf{X} \quad \left[\begin{array}{c}\textbf{Expansion Factor to}\\ \textbf{convert to feddan basis}\end{array}\right]$$

For example:

$$\textbf{Yield per feddan Estimate} = \frac{\textbf{kg. wt. of cotton in CC plot}}{\textbf{157.5 kg/kentar}} \quad \textbf{X} \quad \frac{\textbf{4200 m}^2\textbf{ / feddan}}{\textbf{3 X 3.5 m}^2}$$

To estimate production of cotton one just multiplies the estimated yield per feddan by the corresponding production area of cotton:

**Production = Number of feddans in Governorate X Yield per feddan**

The estimates of yield and production can be made at any level but are usually made at the governorate or variety levels and then added to the national level.

**Findings and Recommendations**

The crop cutting survey was not the main focus of the Team's work, but the forecast plots are so closely tied to crop cutting that we could observe and assess the process also. The allocation and sample selection process should be updated to assure that they do represent the true cotton population in Egypt. Training of the field staff would be very beneficial and would improve the precision of the data and estimates.

# ANNEX B: EVALUATION OF PAST COTTON FORECASTS AND ESTIMATES

**Evaluation of Past Cotton Forecasts and Estimates**

A current evaluation of the accuracy of the crop forecasts appears useful since farmers, agribusiness firms and government agencies make decisions involving millions of pounds annually on the basis of forecasts. Deficiencies in forecasts may cause undesired effects on plans and resource allocation. The results of an evaluation may also provide data procedures with information useful in deciding what changes, if any, are needed in forecasting procedures to meet user requirements.

To evaluate methods of forecasting in Egypt, we have to examine its accuracy and efficiency, these measures constitute quality checking of data or evaluation (quality appraisal) and it was divided into two broad categories, post-hoc techniques used after the survey is completed and applied to results of past surveys. The second is the use of sampling methods at a time not too far from the reference period of the main survey. The comparison was made between the actual yield of cotton (calculated from cotton ginning returns) and forecasting estimates of Ministry of Agriculture (MALR).

**1) The accuracy of cotton yield forecasts (1992 –1998).**

AAPE – Size of Average Absolute Percentage Error

$$AAPE = \frac{\sum_{i=1}^{n} \left| \frac{(Fi - Ai)}{Fi} x100 \right|}{n}$$

where

Fi Forecast estimate of yield for year i

Ai Final estimate of yield for year i

i i=, …..,n designated year

***a) National Level***

Studying size of average absolute percentage error (AAPE) between cotton forecasts and the final yield during the period 1992 – 1998. Table (1) showed that this measure was for the national level about 9.7% for August visit forecast of (CAAE) general administrative sampling and about 10.16% for crop cutting. For the AERI forecasts during this period the AAPE was about 14.15%, 12.30%, 3.86% and 5.10% for July visit, August visit, September visit and picking visit respectively.

***b) Governorate Level***

For the governorate level of the four governorates of the study, the AAPE measure of accuracy showed in Table (2) period 1993 – 1998, 13.45% for Beheira, about 20.89% for Dakahlia, about 13.04% for Beni Suef, and about 10.10% for Assuit.

No governorate level forecasts estimates of AERI.

**The efficiency of cotton yield forecasts accuracy.**

**Theil's Inequality Statistic $U_2$. Formula**

$$U_2 = \frac{\left[\dfrac{\sum_{i=1}^{n}(Fit - Ait)^2}{n}\right]^{\frac{1}{2}}}{\left[\dfrac{\sum_{i=1}^{n}(Ai(t-1) - Ait)^2}{n}\right]^{\frac{1}{2}}} = \frac{RMSE}{RMSE_{rw}}$$

Where:
Fi  Forecast esitmate of yield for year i
Ai  Final estimate of yield for year I
i  Years (from i to n)
t  Time period in sequence

Using Theil's inequality statistic $U_2$ we measured cotton yield forecasts efficiency during the period 1992 – 1998 for both CAAE & AERI.

Meaning and interpretation of Theil's $U_2$ statistic:
When $U_2 < 1$ it means that the current forecast is efficient.
As $U_2$ tends towards 0 it means increasing efficiency of the forecasts.
When $U_2 > 1$ it means the forecast is inefficient.

***a) National Level***

From CAAE $U_2$ were 0.694 for forecasts of August visit and 0.688 for crop cutting (national level).
From AERI $U_2$ were 0.903 for July visit, 0.777 for August visit forecasts and 0.598 for September forecasts visit.
This is for national level.

***b) Governorate Level***

For the governorate level, from CAAE forecasts estimates $U_2$ was 0.86 for Beheira, 0.93 for Dakahlia, 0.90 for Beni Suef, and 0.92 for Assuit.

This means the efficiency of forecasts on the governorate level is low, medium on national level, and no forecasts on cotton varieties level had been made inspite of its importance on cotton export transactions.

**Table B-1 : Accuracy Evaluation Using AAPE & Theil's $U_2$ Inequality**
**Comparison : Cotton Yield Forecasting - Crop Cutting & Final Yield**
**1992 - 1998**

| Year | July Visit* | | August Visit* | | September Visit* | | Picking* | | Crop Cutting*** | | Final | August Visit** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | K/F | % | K/F | % | K/F | % | K/F | % | K/F | % | | K/F | % |
| **1992** | 6.04 | -15.52 | 6.32 | -11.61 | 0.00 | 0.00 | 6.40 | -6.04 | 7.11 | -0.56 | 7.15 | 0.00 | 0.00 |
| **1993** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 7.85 | 0.90 | 7.78 | 7.77 | -0.01 |
| **1994** | 7.37 | 22.80 | 6.77 | 12.80 | 0.00 | 0.00 | 6.16 | 2.70 | 7.14 | 19.00 | 6.00 | 7.10 | 18.30 |
| **1995** | 5.48 | -4.20 | 5.45 | -4.70 | 5.76 | -0.50 | 5.38 | -5.90 | 6.97 | 21.80 | 5.72 | 6.09 | 6.50 |
| **1996** | 6.55 | -4.63 | 6.68 | -6.71 | 6.56 | 4.79 | 6.38 | 1.92 | 7.29 | 16.45 | 6.26 | 6.51 | 4.00 |
| **1997** | 6.80 | 0.00 | 6.84 | -0.59 | 6.77 | -0.44 | 0.00 | 0.00 | 7.01 | 3.09 | 6.80 | 6.75 | -0.70 |
| **1998** | 6.96 | 37.80 | 6.94 | 37.40 | 5.54 | 9.70 | 5.73 | 13.50 | 5.52 | 5.05 | 5.05 | 6.50 | 28.70 |
| **AAPE** | **14.15** | | **12.30** | | **3.86** | | **5.01** | | **10.16** | | **0.00** | **9.70** | |

* AERI Forecasts

** CAAE Forecast

*** CAAE Crop Cutting

AAPE  size of average absolute percentage error.

**Table B-2 : Evaluation of the Accuracy of Forecasting Result [1] of Cotton Four Governorates Using Absolute Average Percentage Error & Theil's $U_2$ Inequality**

**1993 - 1998**

| Year | Beheira | | | | Dakahlia | | | | Beni Suef | | | | Assuit | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Forecast | Final | Def (K/F) | % | Forecast | Final | Def (K/F) | % | Forecast | Final | Def (K/F) | % | Forecast | Final | Def (K/F) | % |
| **1993** | 8.75 | 8.40 | 0.35 | 4.17 | 7.35 | 7.31 | 0.04 | 0.54 | 7.39 | 7.70 | 0.31 | 4.03 | 5.67 | 7.03 | 1.36 | 19.35 |
| **1994** | 7.37 | 6.63 | 0.74 | 11.16 | 7.30 | 5.30 | 2.00 | 37.74 | 8.60 | 6.76 | 1.84 | 27.22 | 6.50 | 8.13 | 1.63 | 20.05 |
| **1995** | 7.32 | 6.46 | 0.86 | 11.74 | 5.44 | 4.89 | 0.55 | 11.25 | 6.85 | 5.62 | 1.23 | 21.89 | 8.04 | 7.94 | 0.10 | 1.26 |
| **1996** | 6.79 | 6.52 | 0.27 | 4.14 | 6.03 | 5.33 | 0.70 | 13.13 | 6.48 | 7.25 | 0.77 | 10.62 | 8.28 | 9.44 | -1.16 | -12.29 |
| **1997** | 6.80 | 7.62 | 0.82 | 10.76 | 6.53 | 6.18 | 0.35 | 5.66 | 6.53 | 6.73 | 0.20 | 2.97 | 8.67 | 8.54 | 0.13 | 1.52 |
| **1998** | 7.63 | 5.50 | 2.13 | 38.73 | 5.93 | 3.77 | 2.15 | 57.03 | 4.46 | 5.04 | 0.58 | 11.51 | 8.17 | 7.70 | 0.47 | 6.10 |
| **AAPE** | | | | **13.45** | | | | **20.89** | | | | **13.04** | | | | **10.10** |
| **Theil'S $U_2$ Inequality** | | | | **0.86** | | | | **0.93** | | | | **0.90** | | | | **0.92** |

[1] Forecasts of CAAE, General Administrative Sampling, Period 1993 - 1998

**Table B-3 : Accuracy Evaluation of Cotton Yield Forecasting Using Theil's $U_2$ Inequality**

| Year | | $A_{i(t-1)}$ $A_{it}$ | AERI | | | CAAE | |
|---|---|---|---|---|---|---|---|
| | | | (1) $F_{it}$ - $A_{it}$ July visit | (2) $F_{it}$ - $A_{it}$ August visit | (3) $F_{it}$ - $A_{it}$ September visit | (4) $F_{it}$ - $A_{it}$ August visit | (5) Crop Cutting |
| **1992** | | -1.25 | -1.11 | -0.83 | | | -0.04 |
| **1993** | | -0.63 | | | | -0.01 | 0.07 |
| **1994** | | 1.78 | 1.37 | 0.77 | | 1.10 | 1.14 |
| **1995** | | 0.28 | -0.24 | -0.27 | 0.04 | 0.37 | 1.25 |
| **1996** | | -0.54 | 0.29 | 0.42 | 0.30 | 0.25 | 1.03 |
| **1997** | | -0.54 | 0.00 | 0.04 | 0.03 | -0.05 | 0.21 |
| **1998** | | 1.75 | 1.91 | 1.89 | 0.49 | 1.45 | 0.47 |
| **RMSE** | **(5)** | 1.1245 | 1.07229 | 0.92239 | 0.57671 | 0.76534 | 0.7741 |
| | **(1,2)** | 1.1871 | | | | | |
| | **(3)** | 0.9649 | | | | | |
| | **(4)** | 1.1022 | | | | | |
| **Theil's $U_2$** | | | 0.9033 | 0.7770 | 0.5977 | 0.6944 | 0.6884 |

Theil's inequality statistic $U_2$

**$A_{it}$** Final estimate for the current year $_t$

**$Ai_{(t-1)}$** Final estimate for the previous year $_{(t-1)}$

**$F_{it}$** Forecast estimate number $_i$ for the year $_t$

**$U_2$** Measures the efficiency of estimates :

when $U_2 < 1$ it means that the current forecast has a value.

when $U_2$ tends towards 0 it means increasing efficiency of the forecasts.

when $U_2 > 1$ it means inefficient forecast.

# ANNEX C: INSTRUCTIONS FOR IMPLEMENTING COTTON YIELD FORECASTING TECHNIQUES

**Instructions of Implementing Cotton Yield Forecasting Techniques [•]**
**(Traditional Instructions)**

***First: Sample Selection***

- In the case of less than 5 strata within district, we should select 5 parcels/variety/district, proportional allocation for strata due to relative area of cotton crop.

- In the case of strata more than 5, take one trial for every stratum.

***Second: Fieldwork***

- Take one or two rows, in which the measured area is exactly $3m^2$. Use two rows if ridge width is less than or equal to 70 cm, or one row if it is more than 70 cm. The plot length is determined by dividing $3m^2$ by the width of the one or two ridges.

- The forecast plot is located within field by the same procedure of locating sampling plot, beyond one meter of it.

***Third: Weight***

- Collect 20 open bolls or less (no defects or infection). Put cotton inside a plastic bag.

- Send the sample to central office after writing the identification data.

- Tabulate boll numbers only on the form of the questionnaire.

[•] Old form

**Questionnaire Form[•]**
**Cotton Yield Forecasting (1999)**
**Traditional Questionnaire**

| Governorate | District | Village | Hode |
|---|---|---|---|
| | | | |

| Variety | Cultivator Name | Serial |
|---|---|---|
| | | |

**Counting Data of Plot ($3m^2$)**

| | |
|---|---|
| 1- Number of plants | |
| 2- Number of rows | |
| 3- Number of bolls | |
| a) Infected | |
| b) Totally opened | |
| c) Partially opened | |
| d) Green large | |
| e) Green small | |
| 4- Number of squares and blooms | |

**Data Weight Per Plot ($3m^2$)**

| Number of Bolls | Weight Grams |
|---|---|
| | |

| Signature | Name of Staff | Date of Visit |
|---|---|---|
| | | |

• Old form

**2nd Visit**

**Cotton Yield Forecasting**
**Instructions of August Visit (21-31 August, 1999)**

1) We have to visit the same forecasting fields of July visit at the same date with only 1 – 2 day exceptions.

2) Take with you all data of selected field collected from the first visit.

3) Be sure that you visit the same field of the first visit. No permission to select another one.

4) If the selected field is irrigated and you can not conduct data collection of the forecasting plot, postpone the visit to the second day.

5) Make a revision for the field dimensions

6) With the help of field dimensions random selection, find the starting point of the forecast plot.

7) Measure the forecast plot dimensions again; the four sides and the diagonal. Measure from furrow bottom to furrow bottom of the two rows. Write the dimensions on the suitable form.

8) Count the data of hills, plants, squares, blooms, small green bolls, large green bolls, partially opened bolls, opened bolls, infected bolls, damaged bolls, and burrs for each plant within each row of the plot. Use form number (2). Be sure that you collect the data of the same hill and plants of the first visit.

9) Start the counting from the south west of the first row and the inverse with the second row.

10) Pick 20 open bolls or less from the bottom of the first plant to top and from the top of the second plant to bottom. Put the cotton in plastic case with identification data. Send it to lab. Take out picked open bolls.

11) The cultivator is to be asked that he has to give notice three days before harvesting to enable counting bolls and weighing plot yield. In case of late harvest, the third visit will be at the same day in September.

***Remarks***

One) Large bolls can not go through 2.25 cm gauge measurement. You should test the size of the gauge.
Two) Open bolls are bolls totally opened and boll cover is dry.
Three) Partially opened bolls are bolls not opened completely and cover is green.
Four) Burrs are bolls lost its cotton by mechanic factors.
Five) Infected bolls are the ones infected by insects or diseases, and expected unopened bolls or cotton.

**3rd visit**

## Instructions of the Third Visit (21-30 September) or First Pick

It is better to visit the same selected fields of July and second visit in the same date in September except there are cotton harvesting. You have to conduct the field sample in the day of harvest that determined by the cultivator, with the following instructions:

**First: Forecasting Experiments**

1) Use the random dimensions to find the forecasting plot. Be sure that there are four wooden stakes at the four corners of the plot and string runs between the stakes.
2) Check the four dimensions of the plot. Be sure that they are the same measurement as the previous visits.
3) Use form (2) to count bolls number as in the previous visits, hill by hill and plant by plant. Count small green bolls, large green bolls, partially opened bolls, opened bolls, infected and damaged bolls, burrs, and the dropped open bolls.
4) Pick 20 opened bolls from the second row from bottom to top of the first plant and from top to bottom in the second plant. Send it to lab.
5) Pick the open bolls within the plot. Do not pick cotton before 10 o'clock in he morning.
6) Weigh the picked cotton of forecast plot with accurate balance. Write the weigh in form (3).
7) In case of expecting second pick, write the expected date and the expected cotton yield.

**Second: Crop Cutting Experiment**

Use the instructions of crop cutting experiments for layout the plot, picking and weighing the plot cotton.

**The Main Points of Supervisor Field Visits for Cotton Yield Forecasting**

**The supervisor has to follow up the enumerators' fieldwork. The main points of the report are:**

1) The purpose of visit, includes visit nature (where, when, number of fields to be visited … etc.).

2) Means of transportation (accompanies members).

3) Description of achievements during the visit for every forecasting experiment includes:

   - Governorate, district, village, cultivator name, hode, cotton variety, area, rows, pattern, planting date, pervious crop, interplanting crops, crop condition (infection, plant health, …etc.) weather condition.

- Supervision of plot location layout, dimension, revised field selection, field dimensions, random selection of length and width of the field, plot location, measuring the four sides of the plot and the diagonal.

- Number of hills, plants within plot and bolls within every plant.

- Selection of 20 open bolls or less for oven dry.

- Mistakes of enumerators' application and deviations from instructions received.

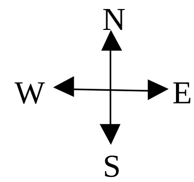
- During picking visit, revise cotton weight of the forecasting plot, test the steel yard scale used, revise crop cutting cotton weight, measure the dimensions of crop cutting plot, and record both data of enumerator and yours.

- Write any additional remarks and opinions (general condition of cotton crop in the village, opinion of cultivator and expectation on yield …etc.

**Form (1): Cotton Plot Location**

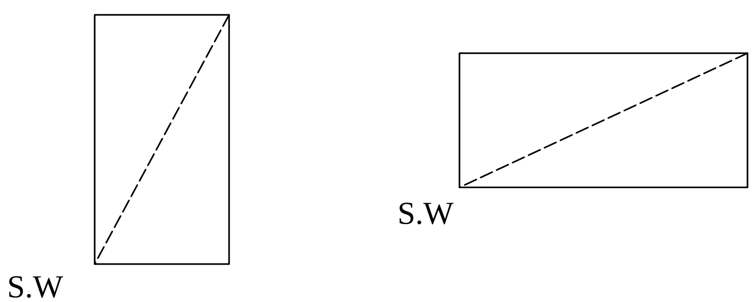
| | | |
|---|---|---|
| Governorate: | District: | Village: |
| Cluster: | Parcel: | Cultivator: |
| Hode: | Area: ___(F) ____(K) | Number of fields: |
| Date: | Variety: | |

Field Diagram




| Number of Fields:<br>Selected Field: | Field Dimension (m)<br><br>(1) Parallel to Rows: | Random Dimensions (m)<br><br>(1) |
|---|---|---|
| | (2) Perpendicular to Rows: | (2) |

Forecasting Plot Dimensions: Measure the 4 sides and the diagonal




| | | |
|---|---|---|
| Row Direction: | Row Pattern (Ridges, Beds, ..etc.): | Number: |
| Hill Number: | Plant Number: | |
| Date of Plantation: | Inter Planting Crop: | |
| Previous Crop: | | |
| Expected Harvesting date: | | |

# Form (2)

**Governorate -** **District -** **Village -** **Date -**
**Variety -** **Farmers Name -**
**Cluster -** **Parcel -** **Random numbers -**

| **Row No.** | **Hill No.** | **Plant No.** | **C o u n t s o f F r u I t T y p e s** | | | | | | | | **Com-ments** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Burrs | Damaged Bolls | Open Bolls | Partially Open Bolls | Large Green Bolls | Small Bolls | Blooms | Squares | |
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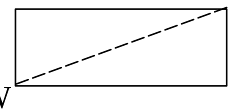
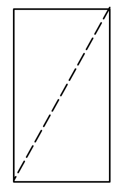
**Form (3): Cotton Yield Forecasting**
**Cotton Plot Dimensions, Cotton Sample Weights – Field and Laboratory**

| | | |
|---|---|---|
| Governorate: | District: | Village: |
| Crop: | Variety: | Stratum: |
| Cluster No.: | Parcel No.: | Field No.: |
| Cultivator Name: | Hode: | Area: ___(F) ___(K) |

---

**<u>Forecasting Plot</u>**

Plot Area:
Adjustment Coefficient:

S.W  

S.W corner

**Cotton Weight Grams**

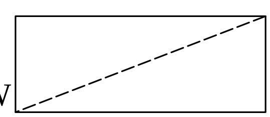
| | | Open Bolls | | | Infected Open Bolls | | | |
|---|---|---|---|---|---|---|---|---|
| **Item** | **Date of visit** | **No. Boll** | **Total Weight** | **Avg. Wt** | **No. Boll** | **Total Weight** | **Avg. Wt** | **Remarks** |
| **Dry sample (1)** | | | | | | | | |
| **Dry sample (2)** | | | | | | | | |
| **Dry sample (3)** | | | | | | | | |
| **First pick** | | | | | | | | |
| **Second pick** | | | | | | | | |
| **Total weight** | | | | | | | | |
| **Adjusted total weight** | | | | | | | | |

Number of opened bolls left in the plot:

---

**<u>Crop cutting Plot</u>**

Plot Area:
Adjustment Coefficient:
Cotton Weight (kg.)

S.W 

| **Pick No.** | **Date** | **Cotton Weight/Plot (kg.)** | **Expected Second Pick (kg.)** |
|---|---|---|---|
| **First** | | | |
| **Second** | | | |
| **Total** | | | |

Enumerator Name: Signature: Date:
Supervisor:

# ANNEX D: ADDITIONAL INFORMATION ABOUT COTTON GROWTH

# Additional Information about Cotton Growth

## 1. General Discussion of Factors Affecting Cotton Growth and Yield

Many factors have been suggested as affecting cotton growth and yield. We first list many of them with a few comments and discuss some in more detail later.

### Previous Crop Planted in Field

If only one or two cuttings are made on temporary breseem it may not affect cotton too badly. Broadbeans (foul) may or may not affect cotton depending on the nitrogen fixation effect. Wheat usually reduces cotton yield due to forcing late planting and reduced nutrients left in the soil. Potatoes can cause the following cotton crop to have very rank growth and low yield because of the fertilizer remaining in the field. The rank growth can be limited by reducing the fertilizer applied to the cotton.

### Interplanting Other Crops in the Cotton Field

One often sees tomatoes, cucumbers, melons, onions garlic and sometimes sugar beets planted among the cotton. The reason given is that these mature and can be harvested before the cotton gets too mature. It provides commodities for the family needs and gives additional income. The effect on cotton yield is not considered to be too great or the farmer is willing to accept reduced cotton yield in exchange for the production of other commodities.

Interplanting of other crops within the cotton will affect yield and insect infestation

### Date of Planting

This is felt to be very important to cotton production. Planting goes from February through April. Harvest begins in September. This will be discussed in greater detail later.

Time Planted Vs Yield– Earlier planted cotton tends to yield better than late planted.

### Variety of Cotton

The length of time for maturation is similar for most varieties. G85 does mature about 10 days earlier.

**Cotton Plant Growth Events**

| Stage | Interval | Total |
|---|---|---|
| Planting | 6-7 days | 90 days (72-112 days) |
| Germination | 43-81 days | |
| Square | 21 days | |
| Flower | 1-2 days | 52 days |
| Small Boll | 25 days | |
| Large Boll | 25-26 days | |
| Mature Boll | 2-5 days | |
| Open Boll | | |

Flowering begins in June and early July no matter when cotton is planted.
Plants shed excess squares and small bolls (within about 5 days) under certain conditions.

**Varieties Location and Characteristics**

The farmer has the choice whether to grow cotton or not, but the choice of variety is determined by the government based on geographical area. The upland cotton grown in Upper Egypt has 30-50% higher yield but quality is lower and price is lower. The Egyptian cotton of the Delta is of higher quality than that of UE, but does have somewhat lower yield.

(1) Upper Egypt-long-staple: Giza 80 and Giza 83. The newly developed Giza 90 is of somewhat better yield.
Delta (Lower Egypt) – Long staple: Giza 85, Giza 86 and Giza 89. Giza 85 and Giza 89 are of higher yield, while Giza 86 is of somewhat higher quality. About 80% of the Delta cotton are long staple.

(2) Extra-long-staple : Giza 45(its cultivation is limited this year in government farms), the highest cotton quality, Giza 70 of high quality and yield and the newly developed Giza 88 similar to Giza 70 in quality but of somewhat better yield. Giza 45 is the lowest yielder of Egyptian varieties has smaller boll weight but higher number of bolls. Giza 87 is being developed to replace Giza 45, but it will be a while before ready.

Each variety has a typical shape. The color of the boll can be used to help determine maturity

**Method of Cultivation**

Many things need to be considered like: is planting on mastaba or regular rows; row spacing; and plant or hill distances within the rows all affect plant population, growth and production.

Number of plants per hill – two or three plants per hill does not make a statistical difference in yield. However, if there are more than three plants per hill the production per plant seems to be reduced due to competition for nutrients and sun, and the total yield will be reduced as well.

Plant population – Plants per feddan- Assuming the number of plants is evenly distributed over the field 40,000 - 70,000 plants per feddan yield about the same. More than 17 plants per square meter or less than 9 plants tend to reduce yield

Some experimentation has been done to see if cotton could be transplanted to the field. Starting plants in pots or over plastic sheets and then transplanting after 21-25 days has been tried. In theory, this would permit the farmer to have the use of his field for almost an additional month. Preliminary experiment results indicate that yields are about the same, but the process is expensive. A comparison of March sown fields vs transplanted showed yield slightly less.

**Seed Type and Planting Rate**

Soil Fertility - Medium fertility soil is best for cotton. Low fertility soil needs to have more plants per feddan to give best yields. High fertility soil tends to give more vegetative growth. Therefore, need to have fewer plants so sun can get to them and stimulate boll production.

**Temperature during the Growing Season**

A cold spell (5 days with 5 degree drop) in March or April will actually force plants to deepen their root system which will help growth later. Net effect is usually better yield.
Hot spells will tend to wilt plants and to reduce yields

Very hot weather in June will cause more shedding of squares and small bolls.

High temperature in September will cause more bolls to open and can give 10% increase in yield. There have been no studies of temperature vs. yield

**Humidity during the Growing Season**

Plants are affected by humidity only if it is very high and continues for a long time without relief. The plants can not transpire and the stress may then cause flowers and squares to shed.

## Amount of Sunlight during the Season

Obviously this affects the photosynthesis and directly affects growth. Fortunately Egypt usually has adequate sunshine.

## Irrigation Practices

Type of irrigation and drainage, frequency of irrigation, quantity of water during the irrigation, time between irrigations all have impact on growth and yield. This will be discussed more later.

## Salinity and Water Table

Water table: High water table will reduce yield by killing roots. . High water table from closed irrigation systems or nearby rice can raise the water table, which will affect cotton plants. (This is one reason for consolidation of crop growing areas

Salinity: Cotton has some tolerance to salinity. Proper irrigation can reduce the effects if enough water is put on to keep the salinity from the roots

## Insect Infestation

Early season after germination, check to see if thrips have attacked plant roots. July to September pest control is important.

## Disease Attacks

Bacteria and fungi attacks Leaves red, yellow, or black instead of green – wilting or unhealthy plants.

## Government Intervention

Effects of decisions related to seed and insecticide usage and information given to or withheld from farmers can have major influence on production.

## Factors Affecting Weight of Fruit

Weight differences between varieties is not too large. Early set fruit and late set fruit tend to be a little lighter than mid-season fruit.

Fruit setting patterns affect fruit weight. Flowering and fruit set takes place during 6 weeks around June. Fruit set goes from bottom to top and from inner to outer plant.

## Cotton Moisture Content

Cotton moisture content in the field is affected by the relative humidity. For trade purposes, moisture content (seed cotton) of 8.5% is standard. If moisture is lower, farmer is not paid more; if higher, then the price paid can be discounted.

The specialist's estimate is that cotton in Upper Egypt has about 7% moisture, while the delta cotton is 8%. If one were to sun dry the cotton he thinks the moisture content would be 7 – 7.5% in Upper Egypt and 8 – 8.5% in the Delta.

**Harvest Loss**

In the past it was thought to be about 10%, but now that price is better it should be very low.

Ginning Out Turn: A kentar of seed cotton (cotton with seeds) weighs 157.5 kg , a kentar of lint is 50 kg This makes cotton lint out turn 31.5 % of the total weight of seed cotton. Cotton varieties vary in ginning out turn, Giza 45 about 31-33%, Giza 83 has a higher out turn of about 39%

**Considerations Affecting Harvest**

If 2 pickings are planned – First is usually done when 50% of bolls are open, because these have a higher quality and higher price. Second picking when most of remaining bolls open.
If one picking is planned – Farmer waits until greater than 90% of bolls open.

## 2. More Detailed Information on Cotton Growth Factors

Information necessary for building a background for yield forecasting and explaining the factors causing increase or decrease in yield. The crop season could be divided into four stages:

**I First Stage (1$^{st}$ Feb. – 31$^{st}$ May)**

First order of importance: Date of sowing
Second order of importance:

1) Land preparation & soil fertility & preceding crop.
2) Germination.
3) Disease and insect attack (mainly soreshin & thrips & gryllotalpa.
4) Weather (max. and min. temp.) (cold spells & hot spells & khamasein).
5) Agricultural practices thinning & time of thinning, irrigation, fertilization, weeding

**II Second Stage (1$^{st}$ June – 31$^{st}$ July)**

The flowers that open during this stage constitute the bulk of the crop.

1) Flowering & bolling & shedding.
2) Agricultural practices: Irrigation & fertilization & weed and rank growth control.
3) Insect control.
4) Weather: Temperature & Humidity.

**III Third Stage (August)**

The flowers that open during August constitute a sizeable proportion of the yield.

1) Insect control.
2) Weather: temp. & relative humidity.
3) Irrigation (and Redding).
4) Rank growth.

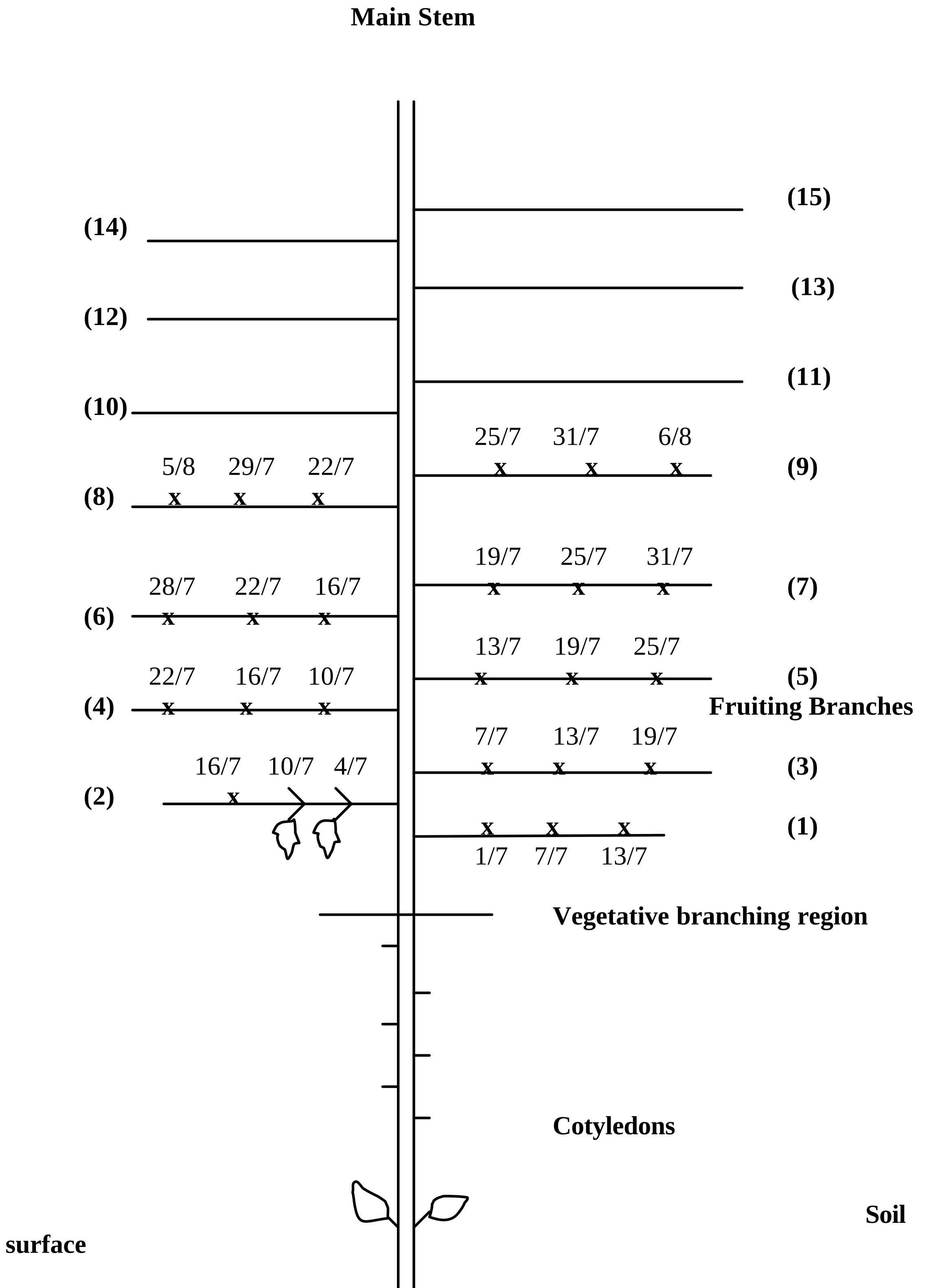
**IV Fourth Stage (September)**

The maturation period of the latest component of the crop which is composed of the late flowers that opened up to 15th August.

1) Insect attack (boll worms & red spider & white fly).
2) Redding (excessive irrigation)

During the first half of October, in north Delta, temperature. & insect attack will affect a very small proportion of the crop.

**Cotton Flowering Diagram (Cotton Plant)**




Note: In Egypt Cotton, the 1st fruiting branch is at the 6 – 7 node

***Notes:***

1) The vegetative branches develop in succession from the cotyledons upward to the node of the first fruiting branch (NFB). The vegetative branch behaves essentially like the main stem

2) The fruiting branches develop in succession from the NFB upwards but become shorter giving the plant its typical pyramid shape.

3) The position at which the first fruiting branch appears (NFB), is an important characteristic as it affects earliness of the crop. The NFB in Egyptian cotton varieties is 6 or 7, and is influenced by planting date & plant density.

- The subtending leaves are the main sources of assimilation for cotton bolls throughout their maturation period.

- The number of flowers on each sympodium (fruiting branch) depends on plant density, date of sowing and the position of the branch on the main stem.

- The horizontal flowering interval, i.e. the period from the date of opening of a flower on a fruiting branch and the opening of the next flower on the same branch is approximately six days, while the vertical flowering interval between the same node of the successive fruiting branches on the same main stem is three days approximately, the ratio between the horizontal and vertical being (2).

- The date of the appearance of the first flower (the beginning of the flowering period) depends to a large extent on environmental factors, especially date of sowing and plant density. The variety also affects length of the period from sowing to first flower.

**Table D-1: Flowering and Bolling as Affected by Date of Sowing**

| | **Date of Sowing** | | |
|---|---|---|---|
| | **5th March** | **25th March** | **25th April** |
| Date of 1st flower | 25th June | 27th June | 6th July |
| Days from sowing to 1st flower | 112 | 94 | 72 |
| Date of first boll opening | 17th August | 20th August | 31st August |
| Days from flowering to 1st boll opening | 53 | 54 | 56 |
| Flowers/plant | 10.8 | 14.4 | 15.2 |
| Open bolls/plant | 7.6 | 9.8 | 6.4 |
| Shedding (%) | 29.5 | 31.1 | 56.2 |

*El-Akkad, M. H. et al. (1980). Agric Res. Rev., 58 (9): 149-168.*

- After the opening of the first flower, flower opening proceeds through a period that may extend for two months, with an increasing number at first until reaching a maximum followed by a decrease to a low level. Another maximum may appear under certain conditions, making one or more maxima. A plot of fruiting rate is known as the "flowering curve," usually takes on a sigmoidal shape.

- The boll consists of 3 and sometimes 4 locks, each containing 7-9 seeds.

Sigmoidal Chart Here

- Boll growth follows a sigmoidal curve, with the most rapid increase taking place during the period 7 –18 days past antithesis, and the boll reaches its mature size after about 25-26 days, with the seeds reaching full size and the fibers reaching full length. Another period is needed for maturation of the seeds and fibers which usually extends for another 25-26 days, the boll opens after approximately 50 –52 days from the opening of the flower.

- The shape of the unopened boll varies among varieties, while the size varies to some extend among varieties and to a large extent according to environmental conditions and the position of the boll on the same fruiting branch. On the same fruiting branch boll weight decreases for bolls further from the main stem. Bolls on the same node on successive fruiting branches are usually of the same size except for those on the uppermost fruiting branches which are usually smaller.

- Not all opened flowers develop into bolls that mature and open. A sizable proportion of young bolls usually fails to continue growth and shed.

**Table D-2: Effect of Soil Water-table and Irrigation Interval on Seed Cotton Yield (gm/plot)**

| **Irrigation Interval (days)** | **Soil Water-table (cm)** | | | | | |
|---|---|---|---|---|---|---|
| | **40** | **70** | **100** | **130** | **160** | **Mean** |
| 18 | 265 | 503 | 605 | 690 | 722 | 557 |
| 24 | 312 | 606 | 687 | 696 | 732 | 607 |
| 30 | 332 | 556 | 686 | 660 | 686 | 582 |
| **Mean** | 303 | 555 | 659 | 682 | 713 | |

Mohamed, M. E., et al. (1997). Egypt. Soil Science, 37 (2): 251-266

**Table D-3: Effect of Planting Date on Seed Cotton Yield**

| **Variety & Yield** | **Date of Sowing** | | | | | |
|---|---|---|---|---|---|---|
| | **1st March** | **16th March** | **1st April** | **16th April** | **1st May** | **15th May** |
| G83 (Mallawy) | | | | | | |
| Yield (kentar/f) | 6.1 | 6.1 | 5.0 | 4.7 | 3.0 | 3.0 |
| % | 100 | 100 | 82 | 77 | 57 | 49 |
| G80 (Sids) | | | | | | |
| Yield (k/f) | 13.4 | 11.8 | 11.5 | 10.3 | 5.7 | |
| % | 100 | 88 | 86 | 77 | 43 | |
| G75 (Gemmeiza) | | | | | | |
| Yield (k/f) | | 11.5 | 10.2 | 8.1 | 5.1 | |
| % | | 100 | 89 | 70 | 44 | |
| G81 (Sakha) | | | | | | |
| Yield (k/f) | | 8.3 | 7.5 | 5.0 | 3.5 | |
| % | | 100 | 90 | 60 | 42 | |

El-Saadany, Rashad, et al. (1994). " Short Season Cotton Study", Principal Bank for Development and Agric. Credit.

**Table D-4: Effect of Irrigation Interval on Seed Cotton Yield and Water Consumption of Cotton Grown in Three Regions**

| Location and Irrigation Interval | Date of Sowing, Yield, and Water Consumption | | | | | |
|---|---|---|---|---|---|---|
| | Yield (K/F) | Water Cons. ($M^3$/F) | Yield (K/F) | Water Cons. ($M^3$/F) | Yield (K/F) | Water Cons. ($M^3$/F) |
| **Sakha** | **1953** | **(16 March)** | **1954** | **(17 April)** | **1955** | **(16 Feb.)** |
| 12 days | 6.31 | 2321 | 6.03 | 2308 | 8.30 | 2338 |
| 15 days | 6.45 | 2311 | 6.24 | 2295 | 8.21 | 2315 |
| 18 days | 5.54 | 2320 | 4.76 | 2377 | 7.24 | 2300 |
| 21 days | 5.04 | 2341 | 4.40 | 2376 | 6.83 | 2289 |
| L.S.D (1%) | 0.64 | | 0.48 | | 0.41 | |
| **Gemmeiza** | **1954** | **8 March** | **1955** | **9 March** | **1956** | **8 March** |
| 12 days | 4.63 | 2664 | 8.30 | 2674 | 5.38 | 2725 |
| 15 days | 5.21 | 2674 | 9.10 | 2704 | 5.86 | 2754 |
| 18 days | 4.04 | 2645 | 7.89 | 2661 | 4.70 | 2732 |
| 21 days | 3.49 | 2717 | 7.13 | 2658 | 3.92 | 2655 |
| L.S.D (1%) | 0.46 | | 0.56 | | 0.96 | |
| **Sids** | **1956** | **23 Feb.** | | | | |
| 12 days | 8.70 | 3347 | | | | |
| 15 days | 8.57 | 3450 | | | | |
| 18 days | 6.56 | 3440 | | | | |
| 21 days | 6.67 | 3441 | | | | |
| L.S.D (1%) | 1.16 | | | | | |

Khalil, M. B., et al. (1962). Cotton 3rd. Conference, 17-22 March, Cairo.

**Table D-5: Cotton Plants Response to NPK Fertilization Seed Cotton Yield (K/F)**

| NPK Rates (Kg./F) | | | General Average (138 Experiments) | | Soil Productivity | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Low (20 Exp.) | | High (20 Exp.) | |
| | | | Yield (K/F) | Increase (%) | Yield (K/F) | Increase (%) | Yield (K/F) | Increase (%) |
| - | - | - | 6.13 | - | 4.89 | - | 9.45 | - |
| 15 | - | - | 6.95 | 13.2 | 5.82 | 19.0 | 10.26 | 8.6 |
| 30 | - | - | 7.40 | 23.3 | 6.44 | 31.7 | 10.57 | 11.3 |
| 45 | - | - | 7.60 | 28.6 | 6.90 | 41.1 | 10.47 | 10.8 |
| 60 | - | - | 7.81 | 28.6 | 7.04 | 44.0 | 10.48 | 10.9 |
| 75 | - | - | 7.77 | 29.5 | 7.10 | 45.2 | 10.55 | 11.6 |
| 15 | 15 | - | 7.16 | 18.7 | 6.22 | 27.2 | 10.58 | 12.0 |
| 30 | 15 | - | 7.47 | 23.3 | 6.82 | 39.5 | 10.64 | 12.6 |
| 45 | 15 | - | 7.83 | 28.0 | 7.07 | 44.6 | 10.89 | 15.2 |
| 60 | 15 | - | 8.02 | 28.4 | 7.16 | 46.4 | 10.76 | 13.9 |
| 75 | 15 | - | 7.88 | 30.3 | 7.28 | 48.9 | 10.76 | 12.1 |
| 75 | 15 | 24 | 8.01 | 28.1 | - | - | - | - |

Hamissa, M. R. and M. E. Abdel Salam (1999). "Fertilizer Management for Cotton in Egypt". Advances in Agric. Res. In Egypt. Special issue, Vol. 2, No. 1, 53-113.

**Table D-6: Effect of Number of Hoeings on Yield and Its Components**

| Character | Number of Hoeings | | | |
|---|---|---|---|---|
| | **1** | **2** | **3** | **4** |
| Open bolls per plant | 8.40 | 8.46 | 9.35 | 9.70 |
| Boll weight (gm) | 2.63 | 2.52 | 2.67 | 2.59 |
| Seed cotton yield per plant (gm) | 20.90 | 21.30 | 25.00 | 23.80 |
| Number of plants at harvest (1000/F) | 50.30 | 49.60 | 49.20 | 48.80 |
| Seed cotton yield (K/F) | 6.68 | 6.70 | 7.77 | 7.36 |

Mohamed, H. M. H., et al. (1989). Ann. Agric. Sci. Moshtohor, 27 (4); 2035-51.

## 3. MOA Recommendations for Cotton Cultural Practices

Date of Sowing:

1) Recommendations for Earlier Years:
- Upper Egypt: First half of February in south Upper Egypt, and second half of February in Middle Egypt.
- South Delta: Last week of February & 1st week of March.
- Middle & North Delta: First half of March; up to 20th March.

2) 1995 Recommendations:
- Upper Egypt: First half of March
- Egypt Delta: Second half of March.
  (Usually planting begins early in far south (Feb.) proceeds northwards - in north delta rain may delay sowing).

3) 1998 Recommendations:
   Date of sowing to be determined according to accumulated soil temperature: “To sow when a total accumulative temp. degrees of 160 is completed for ten successive days, measured at 5cm. soil depth at 8:00 am.”

Ridging and distance between hills should be determined based on soil fertility, variety and preceding crop:

- Soils of medium fertility: 11 ridges per 2 kaspas (710cm), 20- 25cm distance between hills, for all varieties.
- Fertile soil: Increase the distance between hills to 25cm for all varieties.
- Soils of poor fertility, saline or with drainage problems: 12 – 13 ridges, 20cm between hills, for all varieties.
- When sowing on beds (120cm width), and sowing on both sides of bed:
  - Soil of medium fertility:
    - Using 6 beds (per 2 kasapas), distance between hills = 20 – 25cm.
    - Using 8 beds (per 2 kasapas), distance between hills = 25cm.
  - Fertile soil:
    - Using 6 beds (per 2 kasapas), distance between hills = 25cm.
    - Using 8 beds (per 2 kasapas), distance between hills = 30cm.

- Depth of sowing: 3 – 5cm according to soil type : 3cm in heavy soil, 5cm in light soil.
- Rate of seeding: 7-8 seeds per hole in case of ordinary seed, 4-5 seeds in case of delineated seed.

Thinning:

Best at 2 plants per hill. Should be done at time of El-Mahayat irrigation (the first irrigation after sowing irrigation), at the time of appearance of the second true leaf of the plant.

Irrigation:

- The first irrigation after sowing, El Mahayat.
- The second irrigation 20 days after Al-Mahayat.
- Every 12 – 15 days thereafter.
- In fields close to rice fields or of high soil water-table, the period between the last 3 irrigations of the crop should be increased to 3 weeks.
- The last irrigation when 80% of the bolls reach full maturity.
- Care should be taken during July and August.

Fertilization:

1) Nitrogen:
- 62kg/feddan to be applied in two parts; the first after thinning and before irrigation, and the second before the second irrigation.
- The rate is to be increased to 75kg/feddan for Giza 85.
- Urea as a nitrogen fertilizer should not be used in sandy or calcareous soils.
- The rate should be reduced by 20% when farmyard manure is applied at the rate of $20m^3$/feddan.
- When cotton is grown after vegetables (usually heavily fertilized) the rate should be reduced to one half to be applied before the second irrigation.

2) Phosphorous:
- To be applied during land preparation before ploughing.
- 150kg/feddan monosuperphosphate (15% $P_2O_5$), or
- 60kg/f concentrated superphosphate (37% $P_2O_5$).

3) Potassium:
- Some Egyptian soils are rich in potassium, so check. Plants need potassium when they start flowering through maturation. The rise in water-table retards Potassium absorption, thus, supplement foliar feeding is needed.
- 50kg/feddan potassium sulphate (48% $K_2O$) after thinning, to be increased to 100kg/feddan in soils poor in potassium especially sandy and calcareous soils.
- Foliar application is recommended at the rate of 5kg/feddan potassium sulphate at the beginning of flowering to be repeated after 15 days.

**Chart of Recommended Planting Dates and Expected Growth of Cotton**

On the charts below note that the recommended planting dates are quite different, but the fruiting events are close. Upper Egypt is earlier for each event, but the length of each event is about the same. Note also that actual events will vary much from this chart.

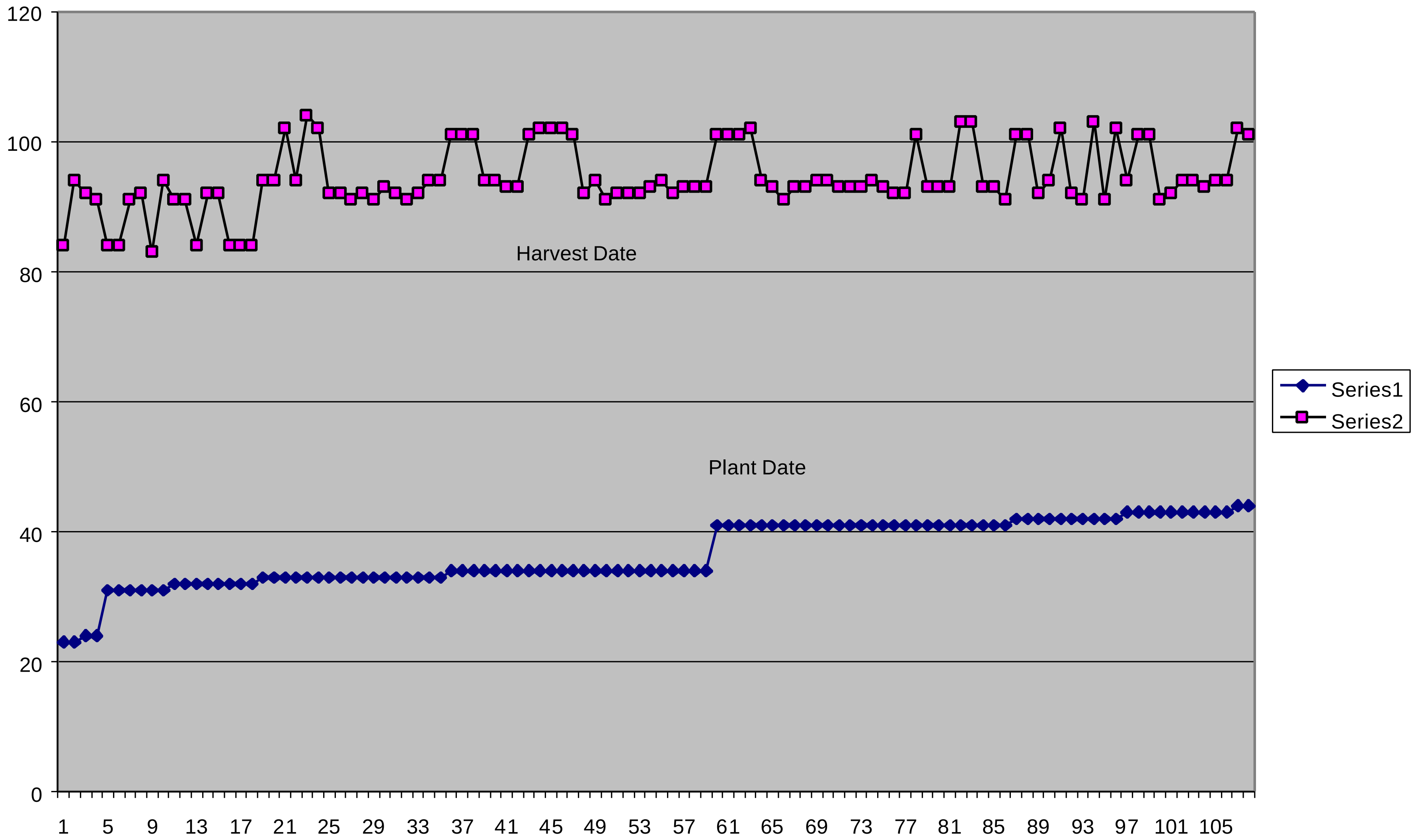
**Table D-7: Recommended Planting and Expected Growth Activities**
**Upper Egypt and Early Areas**

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Planting** | | 2/14-2/28 | | | | | | | | | | |
| **Squares** | | | | | 10-May | 20-Jun | | | | | | |
| **Bloom** | | | | | | 01-Jun | 10-Jul | | | | | |
| **Small Bolls** | | | | | | 04-Jun | 14-Jul | | | | | |
| **Large Bolls** | | | | | | 25-Jun | | 07-Aug | | | | |
| **Open Bolls** | | | | | | | 20-Jul | 31-Aug | | | | |
| **Harvesting** | | | | | | | | 15-Aug | 10-Sep | | | |

**Table D-8: Recommended Planting and Expected Growth Activities**
**Lower Egypt and Later Areas**

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Planting** | | | 3/1-3/20 | | | | | | | | | |
| **Squares** | | | | | 20-May | 30-Jun | | | | | | |
| **Bloom** | | | | | | 10-Jun | 20-Jul | | | | | |
| **Small Bolls** | | | | | | 13-Jun | 23-Jul | | | | | |
| **Large Bolls** | | | | | | | 05-Jul | 17-Aug | | | | |
| **Open Bolls** | | | | | | | | 01-Aug | 10-Sep | | | |
| **Harvesting** | | | | | | | | 15-Aug | Sep-31 | | | |

## Chart (1): Plant and Harvest Dates



The above Plant and Harvest Dates chart was derived from the 1998 crop cutting data which had both planting and harvesting dates. This was only about a fifth of the samples over all varieties and areas. The data is a month-week value for planting or harvest. For example, value 23 means month 2 (February) week 3 ($3^{rd}$ week of month) and value 101 means month 10 (October) week 1 (first week of the month). It is interesting to notice that the very early cotton may be harvested a little earlier. However, cotton planted after early March is all harvested about the same as cotton planted later.

## 4. Other Factors and Variables that Might Affect Cotton Growth, Yield and Production

During discussions with experts and among the team there were many suggestions and much speculation as to the important factors affecting cotton. Most of them have been discussed in the first part of this section. There was some information gathered on the crop cutting forms concerning these factors. The team thought that they could study these variables to assist in their model development. It was found that only one year's data was available and that many data values for the variables were not filled out. The team did study the available data on:

- Previous Crop,
- Fertilizer Use,
- Irrigation Use,
- Temperature,
- Humidity,
- Insect and Disease Attack,
- Plant and Harvest data (weekly data discussed in the section above).

Unfortunately, only a small proportion of the 1998 forms had these data items completed. Upon our study we found that the information collected on the forms were not definitive. For example, "was the temperature suitable or not", "was the humidity suitable or not", "was there infected bolls or not." These yes-no type questions do not tell us enough information to be very helpful in model development. Those questions on fertilizer and previous crop had too few data items to be very helpful.

As in any research effort the team investigated hundreds of items and computed volumes of analyses. They did find some significant relationships but none conclusive. Many of these just confirmed expectations or reaffirmed other information already discovered. Some of the regressions computed may be helpful in future work.

There is potential in gathering data on the above characteristics. One needs to be more creative to capture meaningful relationships in the future. Proper formulations of questions could enable gathering information that would help in understanding cotton growth and in model development. In addition, enumerators need to be trained to properly gather all information on their sample.

For example the weather data on the crop cutting form asked if the temperature and humidity were suitable or not. The analysis showed that the temperature and humidity had significant influence on large bolls for two varieties of cotton. If average weekly or monthly temperatures were appended to the data set, then perhaps stronger relationships of cause and effect could be established to strengthen the forecast models. The team did investigate the availability of weather data. MOA publishes climate data through 32 stations scattered over all the country. All Governorates that produce cotton have at least one station. The following table contains names of these stations.

**Table D-9: Weather Station Location by Governorate**

| Governorate | Station Name |
|---|---|
| Qena | Luxor |
| Sohag | Sohag |
| Assuit | Assuit |
| | Manfalot |
| Minya | Minya |
| Beni-Suef | Beni-Suef |
| Fayoum | Etsa |
| Giza | Dokki |
| | Badrasheen |
| Qalubia | Shobra Al Khima |
| | Shibeen Al Chanter |
| | Shalkan |
| Menofia | Menofia |
| Gharbia | Ktour |
| | Kafer Al Zayat |
| Sharkia | Abu Kebir |
| Dakahlia | Aga |
| Ismailia | Ismailia |
| Damietta | Kafr Saad |
| Port Said | Port Said |
| Kafr Al Sheikh | Sidi Salem |
| | Sugar Beet |
| Beheira | Delengat |
| | Al Bostan |
| Alexandria | Nozha |

The daily published data include:
1. Temperature (Max., Min.)
2. Relative humidity (Max., Min.)
3. Soil Temperature
    One. At depth 5 cm (Max., Min.)
    Two. At depth 10 cm (Max., Min.)
    Three. At depth 20 cm (Max., Min.)
4. Rain quantity (mm)
5. Evaporation (mm)

The following map shows the locations. If a data set is created with the designated temperature and humidity readings for stations near our sample plots, this data could be analyzed with our sample counts to improve the models. It is recommended that 1999 weather data be entered and used with this year's data to begin the development of such models.

Weather Station map 1 here

Weather Station map 2 here

# ANNEX E: COTTON YIELD FORECASTING EXPERIENCE OF AERI AS OF 1998

## Cotton Yield Forecasting Experience of AERI as of 1998[1]

The forecasting program is one of the planned studies (1997 – 2002) of sampling research section in AERI for cotton and wheat.

The cotton yield forecasting started with a pilot survey in Kafr El Sheikh governorate in 1984, extended to more governorates until year 1987, then stopped. Then it started again in 1992, and stopped in 1993 to restart again in 1994 until 1998 to stop again in 1999.

### Procedure for the study

1) Cotton crop forecasting was conducted in 5 governorates (Gharbia, Kafr El Sheikh, Sharkia, Menofia, and Fayoum). The cotton area of these governorates represents about 41% of all 1997 cotton area. The average yield of these 5 governorates is about the same as the country average.

**Table E-1: Average Yield of Sample Governorates & National Level Cotton Yield (Kentar/Feddan)**

| Year | Sample (5 Governorates) | National |
|---|---|---|
| **1992** | 7.23 | 7.15 |
| **1993** | 7.81 | 7.78 |
| **1994** | 5.58 | 6.00 |
| **1995** | 5.80 | 6.26 |
| **1997** | 6.47 | 6.80 |
| **Average** | **6.54** | **6.62** |

Source: Calculated from final cotton yields estimates of MALR reports 1992 – 1997.

2) Selection of Districts: For every governorate, 3 districts were selected.

3) Selection of Villages: Two villages were selected within each district.

4) Sample Size: 300 plots (1m x 3m) distributed over the 5 governorates, 60 plots each. Within each governorates 60 plots were allocated to the three important districts, 20 plots for each district. Two villages were selected within the districts and 10 plots for each village. Fields were selected randomly within the village.

[1] Dr. Emam El Gamassy: Cotton Crop Forecasting Reports, AERI, ARC, MOLAR, 1998

**Table E-2: Sample Design – Cotton Yield Forecasting 1998 (AERI)**

| Governorate | District | # Villages | # Fields |
|---|---|---|---|
| **Gharbia** | Tanta | 2 | 20 |
| | Santa | 2 | 20 |
| | Zifta | 2 | 20 |
| **Kafr El Sheikh** | Kellin | 2 | 20 |
| | Kafr El Sheikh | 2 | 20 |
| | Dessouk | 2 | 20 |
| **Sharkia** | Abu Kebir | 2 | 20 |
| | Zagazig | 2 | 20 |
| | Minya El Kamh | 2 | 20 |
| **Menofia** | Quessna | 2 | 20 |
| | Tala | 2 | 20 |
| | Menouf | 2 | 20 |
| **Fayoum** | Senouris | 2 | 20 |
| | Tamya | 2 | 20 |
| | **Fayoum** | 2 | 20 |
| **Total** | | **30** | **300** |

5) Plot Size: Plot size was $3m^2$ with 1m x 3m dimension (the 3m dimension was perpendicular with cotton rows).

6) Work Schedule: The field work of cotton forecasting started at the beginning of July with a cotton cultivator survey in the selected villages followed by the random selection of the fields. In the last ten days of July the designated plots within the selected fields were located and marked with sticks and strings. The collection of forecasting data (form attached) took place during the first visit from 20 – 31 July. The second and the third visits occurred at the same date in successive months until the final harvest (one or two pickings) was completed.

7) Data Collection Procedure:
   1) First visit (last 10 days of July): Layout the forecasting plot within the selected field randomly (1m x 3m).
   2) Collect data of :
      - Number of rows.
      - Number of plants
      - Number of open bolls or partially open bolls (rarely in July).
      - Number of large green bolls (> 2.25 cm).
      - Number of small green bolls and blooms (< 2.25 cm).
      - Number of infected bolls.

      The counting starts from southwest corner from bottom of the first plant to top.

**Forecast Modeling:**

Cotton yield forecasting attempts to calculate the expected yield before harvesting begins in October, possibly from as early as the end of July. The final production is established by ginning data during April of the following year. That means that the forecast estimates come 8 months earlier than the final estimates.

Many models are used for cotton forecasting: Statistical models, survival models and maximum bearing fruits model. The survival model is the most frequently used in the forecasting of cotton yield in AERI. This process uses data from the previous years.

July Forecasting for cotton: From data collected on green bolls (large and small) in the trial plot (1m x 3m), the average number of bolls at the sample level were estimated for the five governorates. With the help of historical measurements from the previous years for cotton average weight of bolls and average harvest loss, the forecasting of yield can be calculated.

Parameters for cotton yield forecasting (1992 to 1997 utilized for 1998) used with survival ratio model or maximum bearing fruits were:

a) July Visit:
   1) Number of current green bolls (large and small)
   2) Average survival ratios of green bolls on plants to harvesting date.
   3) Average weight of cotton per boll (gram).
   4) Average of cotton harvest loss (kentar/feddan).
   5) Co-efficient to transform from sample to country level.
   6) Average number of open bolls per plant.

b) August Visit:
   The survival ratios of green bolls and totally and partially open bolls to open bolls at the season harvesting.

c) September Visit:
   The survival ratios between partially open bolls and totally open bolls.

The following are the historical measurements of cotton forecasting that were conducted in the previous years within forecasting activity of AERI used for calculating 1998 cotton forecast and the current measurements of July, August, and September 1998 visits.

**First: Historical Measurements of Forecasting**

1) The relationship between open boll numbers at the end of harvest season and green boll numbers at current month (survival ratios)

**Table E-3: Survival Ratios**

| Years | Survival Ratios of Green Bolls | | |
|---|---|---|---|
| | July | August | September |
| **1990** | 115.5 | | |
| **1992** | 118.5 | | |
| **1993** | - | - | - |
| **1994** | 84.9 | 76.72 | 100.0 |
| **1995** | 95.6 | 82.79 | 100.0 |
| **1996** | 83.9 | 80.57 | 100.0 |
| **1997** | 102.4 | 92.04 | 100.0 |
| | | | 100.0 |
| **Average** | 97.06* | 86.80** | 100.0 |

* Average 1992,1994,1995,1996, and 1997.

** Average 1995, 1996, and 1997

2) Average weight of cotton per boll
   Table (4) shows the average weight of cotton per boll from the laboratory measurements for the years 1994, 1995,1996, and 1997. The average of these years is about 2.424 gm./boll.

**Table E-4: Average Weight of Cotton Per Boll (Gram)**

| Years | Average Weight of Cotton Per Boll (Gram) | | | |
|---|---|---|---|---|
| | July | August | September | October |
| **1990** | 2.470 | 2.470 | 2.470 | |
| **1991** | - | - | - | |
| **1992** | 2.767 | 2.767 | 2.767 | |
| **1993** | - | - | - | |
| **1994** | 2.188 | 2.188 | 2.000 | |
| **1995** | 2.650 | 2.650 | 2.000 | |
| **1996** | 2.602 | 2.602 | 2.602 | |
| **1997** | 2.255 | 2.255 | 2.255 | |
| **1998** | | | 2.126 | 2.48 |
| **Average 1994-1997** | **2.424** | **2.424** | | |

3) Average cotton loss per feddan (kentar).
   Table (5) shows the average cotton loss per feddan (kentar) during the years 1992 to 1997. It was about 0.07 kentar/feddan.

**Table E-5: Estimation of Cotton Loss 1992-1997 (kentar/feddan)**

| Years | Average Cotton Loss (kentar/feddan) |
|---|---|
| 1992 | 0.08 |
| 1993 | - |
| 1994 | 0.05 |
| 1995 | 0.12 |
| 1996 | 0.04 |
| 1997 | 0.08 |
| **Average** | **0.07** |

4) Transformation coefficient from sample level to national level (T.C.)
From Table (1) cotton yield per feddan of five sample governorates during period 1992-1997 is about 6.54 kentar/feddan.
This average is less than the national yield of the same period by about 1%. Therefore, the (T.C) is about 1.0122.

5) Average number of open boll per plant
Table (6) shows the average number of open bolls per plant from sample survey (1997). The average was 11.112 bolls per plant for the five governorates of the study.

**Table E-6: The Average Number of Open Bolls Per Plant (1997)**

| Forecasting Governorates | Average Number of Open Bolls/Plant (1997) |
|---|---|
| Gharbia | 8.49 |
| Kafr El Sheikh | 11.17 |
| Sharkia | 10.01 |
| Menofia | 14.13 |
| Fayoum | 11.76 |
| **Sample Average** | **11.112** |

**Second: The Current Measurements of Cotton Forecasting**

**1) July Visit 1998**
Table (7) shows the results of cotton forecasting measurements of July visit 1998.

a) Number of plants per plot ($3m^2$).
The average number of plant per forecast plot is about 32.7133 plant, the upper confidence limit is 33.533 and the lower limit is 31.893 for the sample level.

b) Number of infected bolls per plot: The infected bolls are about 1.95 bolls per plot on average (about) 0.54% of the total bolls of the plot. This indicates that infection percent by the end of July 1998 is very small and, hence, there will be no production problems this year.

c) Green bolls number per plot ($3m^2$)
The average of green bolls per plot is about 362.383 this year, with 375.539 upper limit and 349.227 as a confidence lower limit.

d) Number of green bolls per plant.
   The average of green bolls per plant is about 11.08 bolls the current year (1998). In comparison with the same period last year (11.11 bolls per plant) there is about a 3% decrease.

**Table E-7: Some Measurement Estimates of Forecasting Sampling Survey of Cotton 1998, (July Visit)**

| Governorate | # Plants/Plot ($3m^2$) | # Plants/Feddan | #Bolls/Plot ($3m^2$) | # Infected Bolls/Plot | Infection (%) |
|---|---|---|---|---|---|
| Gharbia | 35.583 | 49,816 | 470.200 | - | - |
| Kafr El Sheikh | 34.733 | 48,626 | 255.983 | 1.417 | 0.55 |
| Sharkia | 29.883 | 41,836 | 298.567 | 1.500 | 0.50 |
| Menofia | 26.000 | 36,400 | 320.687 | 0.667 | 0.21 |
| Fayoum | 37.367 | 52,314 | 466.300 | 6.167 | 1.32 |
| **Average** | **32.713** | **45,799** | **362.383** | **1.950** | **0.54** |

Source: Agricultural Research Center, Agricultural Economic Research Institute, Results of cotton forecasting survey 1998 July visit.

**Table E-8: Cotton Yield Forecasting Estimates 1998 Using Survival Ratio* (July Visit Data)**

| Item | Unit | Period | Average | Upper Limit | Lower Limit |
|---|---|---|---|---|---|
| Number of green bolls/plot | No. | July 1998 | 362.383 | 375.539 | 349.227 |
| Survival ratio for July | % | Ave.1994 to 1997 | 97.06 | 97.06 | 97.06 |
| Number of expected open bolls/plot | No. | 1998 | 351.729 | 364.498 | 338.960 |
| Average weight of cotton (with seeds)/boll | gm. | Ave.1994 to 1997 | 2.424 | 2.424 | 2.424 |
| Weight of cotton/plot | gm. | 1998 | 852.591 | 883.544 | 821.639 |
| Total weight of cotton/feddan (F=24k) | mk | 1998 | 7.579 | 7.854 | 7.304 |
| Correction factor of area (22k/24k) | Coeff. | 1998 | 0.9167 | 0.9167 | 0.9167 |
| Total weight of cotton/feddan | mk | 1998 | 6.947 | 7.20 | 6.695 |
| Cotton loss/feddan | mk | Avr.1994 to 1997 | 0.07 | 0.07 | 0.07 |
| Net cotton yield/feddan | mk | 1998 | 6.877 | 7.130 | 6.695 |
| Transformation coefficient from sample to national level | Coeff. | 1997 | 1.0122 | 1.0122 | 1.0122 |
| Net yield of country | mk | 1998 | 6.961 | 7.216 | 6.706 |

Source: ARC, AERI, opp. cit

$$\text{* Survival Ratio} = \frac{\text{Number of green bolls (historical average of July visit)}}{\text{Number of open bolls (historical average, end season)}}$$

**Results of Cotton Yield Forecasting Year 1998**

**By Survival Model:**

From Table (8) it is expected that the average yield of cotton on the national level will be about 6.961 metric kentar (mk) with confidence (95%) limits of about 7.216 mk upper and about 6.706 lower limit.

**Total Production of Cotton on the National Level 1998**

The total production consists of two components: The area under cotton x yield per feddan.
During July the estimated area is a preliminary estimate from the Central Administrative Agricultural Economics (CAAE) and Survey Authority.

Table (9) shows the expected total production based on the estimated area about 800,000 feddans (prelim.) to the 5.569 million metric kentar (mk) with confidence upper limit 5.773 mk and lower limit about 5.365 mk. The coefficient to transform from seed cotton to lint cotton is about 118%. The expected lint cotton will be about 6.571 million mk with an upper limit of 6.812, and lower limit 6.331 (con. 95%).

**The Expected Seeds**

As shown in Table (9), the expected seed average is about 546,000 tons, with an upper limit of about 566,000 tons and a lower limit of about 526,000 tons. Expected oil is about 98,280 tons, with an upper limit of about 101,880 tons and a lower limit of about 94,680 tons.

**Table E-9: Expected Production of Seed Cotton, Seeds, and Oil in Egypt, 1998**

| Item | Seed Cotton (million metric kentar) | Lint Cotton (after ginning) (million metric kentar) | Seeds (000 ton) | Oil in seeds (%) | Oil (000 ton) |
|---|---|---|---|---|---|
| **Average** | 5.569 | 6.571 | 546 | 18 | 98.28 |
| **Upper limit** | 5.773 | 6.812 | 566 | 18 | 101.88 |
| **Lower limit** | 5.365 | 6.331 | 526 | 18 | 94.68 |

Area cultivated about 800,000 feddan.
Forecasting visit of July.

**Table E-10: Cotton Forecasting with Maximum Bearing Fruit Model**
**Expected Number of Open Bolls (July Visit), 1998**

| Governorate | # Plants/Feddan (000 plant) | # Open Bolls/Plant 1997 | Expected # Open Bolls/Feddan 1998 (000 boll) |
|---|---|---|---|
| **Gharbia** | 49.816 | 8.49 | 422.938 |
| **Kafr El Sheikh** | 48.626 | 11.17 | 543.152 |
| **Sharkia** | 41.836 | 10.01 | 418.778 |
| **Menofia** | 36.400 | 14.13 | 514.332 |
| **Fayoum** | 52.314 | 11.76 | 615.213 |
| **Average Sample** | **45.799** | **11.11** | **508.918** |

Source: ARC, AERI, Sampling Research Section, results of cotton forecasting activity, 1997 and 1998.

**Table E-11: Cotton Yield Forecasting for 1998**
**By Maximum Bearing Fruit Model (July Visit)**

| Item | Unit | Period (Season) | Average | Upper Limit | Lower Limit |
|---|---|---|---|---|---|
| Number of plants/feddan | 000 plant | 1998 | 45.799 | 46.946 | 44.650 |
| Average number of open bolls/plant | Boll | 1997 | 11.112 | 11.112 | 11.112 |
| Expected number of open bolls/feddan | 000 boll | 1998 | 508.918 | 521.664 | 496.151 |
| Average weight of cotton/boll | Gram | Average * | 2.424 | 2.424 | 2.424 |
| Cotton yield/feddan (24 kirats) | KG | 1998 | 1233.618 | 1264.513 | 1202.269 |
| Cotton yield/feddan (24 kirats) | Kentar | 1998 | 7.832 | 8.029 | 7.636 |
| Coefficient of adjust area to (22k/24k) | Coef. | Coef. | 0.9167 | 0.9167 | 0.9167 |
| Cotton yield/feddan (22 kirats) | Kentar | 1998 | 7.180 | 7.360 | 7.00 |
| Cotton loss/feddan | Kentar | Average * | 0.07 | 0.07 | 0.07 |
| Net yield/feddan | Kentar | 1998 | 7.110 | 7.290 | 6.930 |
| Transformation coefficient sample to national level | Coef. | 1997 | 1.0122 | 1.0122 | 1.0122 |
| Net yield national level | Kentar | 1998 | 7.197 | 7.379 | 7.014 |

* Average of years (1994, 1995, 1996, and 1997).
Source: ARC, opp.cit

**Cotton Forecasting with Statistical Model 1998, July Visit**

$\hat{Y} = 89.76 + 1.12\ X_1 + 0.56\ X_2 + 0.41\ X_3$
$\hat{Y}$ = Expected number of opened bolls at the end of cotton season.
$X_1$ = Number of plants within plot ($3m^2$) first visit.
$X_2$ = Number of green large bolls within plot ($3m^2$) first visit.
$X_3$ = Number of small bolls within plot ($3m^2$) first visit.
$\hat{Y}$ = 89.76 + 1.12 (32.713) + 0.56 (300.783) + 0.41 (165.517) = 362.699 expected open bolls at season end.

**Table E-12: Some Measurements Estimates of Forecasting Sampling Survey of Cotton, 1998 (August Visit)**

| Governorate | No. Plants /Plot ($3m^2$) | No. Plants /Feddan | No. Bolls /Plot ($3m^2$) | No.Infected Bolls/Plot ($3m^2$) | Infection (%) |
|---|---|---|---|---|---|
| **Gharbia** | 35.083 | 49.116 | 496.383 | 7.767 | 1.65 |
| **Kafr El Sheikh** | 34.733 | 48.626 | 255.983 | 1.417 | 1.24 |
| **Sharkia** | 29.883 | 41.836 | 306.767 | 1.733 | 0.56 |
| **Menofia** | 25.967 | 36.354 | 429.633 | 7.333 | 1.71 |
| **Fayoum** | 37.200 | 52.080 | 478.017 | 29.183 | 4.01 |
| **Average** | **32.573** | **45.602** | **403.803** | **10.033** | **2.48** |

Source: AERI, opp.cit.

**Table E-13: Cotton Yield Forecasting for 1998 Using Survival Ratio (August Visit's Data)**

| Item | Unit | Period (Season) | Average | Upper Limit | Lower Limit |
|---|---|---|---|---|---|
| Number of bolls/plot | No. | Aug. 1998 | 403.803 | 414.896 | 392.710 |
| Survival Ratio to August | % | Average* | 86.80 | | |
| Expected number of open bolls/plot | 1998 | 1998 | 350.501 | 360.129 | 340.872 |
| Average weight of cotton/boll | gm. | Average* | 2.424 | | |
| Cotton weight/plot | Gm. | 1998 | 849.614 | 872.954 | 826.274 |
| Total weight of cotton/feddan (24 k) | mk | 1998 | 7.552 | 7.760 | 7.345 |
| Coefficient of net area (22 k/24k) | Coef. | 1998 | 0.9167 | | |
| Total weight of cotton(22 k) | mk | 1998 | 6.923 | 7.113 | 6.733 |
| Cotton loss/feddan | mk | Average* | 0.07 | | |
| Net cotton yield/feddan | mk | 1998 | 6.853 | 7.043 | 6.663 |
| Transformation coefficient sample to national level | Coef. | 1997 | 1.0122 | | |
| Net yield of cotton | mk | 1998 | 6.937 | 7.129 | 6.744 |

* Average of years (1994, 1995, 1996, and 1997).
Source: AERI, opp.cit

**Table E-14: Some Measurements of Cotton Forecasting, 1998 (September Visit)**

| Governorate | No. Plants /Plot ($3m^2$) | No. Plants /Feddan | No. Bolls (LGB, POB OB) | No. Infected Bolls/Plot | Infection (%) |
|---|---|---|---|---|---|
| **Gharbia** | 35.083 | 49116 | 356.333 | 38.583 | 10.83 |
| **Kafr El Sheikh** | 34.733 | 48626 | 214.967 | 3.950 | 1.84 |
| **Sharkia** | 29.883 | 41836 | 241.067 | 13.300 | 5.50 |
| **Menofia** | 25.967 | 36354 | 328.700 | 28.567 | 8.69 |
| **Fayoum** | 37.200 | 52080 | 324.000 | 26.617 | 8.22 |
| **Average** | **32.573** | **45602** | **293.133** | **22.203** | **7.57** |

**Table E-15: Average Weight of Cotton Per Boll, 1998 (September Visit)**

| Governorate | Average Weight of Cotton/Boll (gm.) |
|---|---|
| **Gharbia** | 2.238 |
| **Kafr El Sheikh** | 2.233 |
| **Sharkia** | 2.339 |
| **Menofia** | 1.908 |
| **Fayoum** | 1.821 |
| **Average Sample** | **2.126** |

**Table E-16: Cotton Yield Forecasting for 1998
Using Survival Ratio (September Visit)**

| Item | Unit | Period (Season) | Average | | |
|---|---|---|---|---|---|
| Number of bolls/plot | No. | Sep. 1998 | 293.133 | | |
| Survival Ratio of September | % | Average * | 100 | | |
| Expected number of open bolls/plot ($3m^2$) | No. | 1998 | 293.133 | | |
| Average weight of cotton/boll | gm. | 1998 | 2.161 | | |
| Weight of cotton/plot | gm. | 1998 | 623.201 | | |
| Weight of cotton/feddan | mk | 1998 | 5.54 | | |
| Cotton loss/feddan | mk | Average * | 0.07 | | |
| Net weight of cotton/feddan | mk | 1998 | 5.47 | | |
| Transformation coefficient sample to national level | Coef. | 1997 | 1.0122 | | |
| Transformation coefficient national level | mk | 1998 | 5.537 | | |

* Average of years (1994, 1995, 1996, and 1997).

***Institute of Agricultural Economic Research***
***Sampling Research Section***
***Cotton Forecasting Research***

**Cotton Plot Counting Form (1m x 3m)**
**Visit of Month: ________.**

Governorate:
District:
Village:
Variety:
Cultivator Name:
Trial Number:
Date of Cultivation:
Visit Date:

**Counting Plot Data (1m x 3m)**

1) Number of rows or lines [ ]

2) Number of plants [ ]

3) Number of open bolls [ ]

4) Number of partially open bolls [ ]

5) Number of burrs and infected bolls [ ]

6) Number of large green bolls [ ]

7) Number of small green bolls [ ]

8) Number of first 20 open bolls [ ]
(or less if there is no 20 bolls in plot)

Starting time of trial [ ]

Ending Time [ ]

Name of enumerator:

# ANNEX F: DETAILED RESULTS OF APPLYING REGRESSION ANALYSIS TO DETERMINE MODEL COEFFICIENTS

**Regression Analysis to Determine Model Coefficients**
**Statistical Analysis:**

**Table F-1: Identity of Sample Governorates, Districts, Villages, Varieties and Months**

| Governorate | District | Village | Variety | July | August | September |
|---|---|---|---|---|---|---|
| Dakahlia (1) | Belkas (11) | Ahmadia (1) | G86 | X | X | X |
| | | Basandila (2) | G86 | X | X | X |
| | | Demellash (3) | G86 | | X | X |
| | Manzala (12) | Amara (1) | G85 | X | X | X |
| | | Mershak (2) | G85 | | X | X |
| | | Kafr Gamalia (3) | G85 | | X | X |
| Behira (2) | Damanhour(21) | Bastara (1) | G89 | X | X | X |
| | | Sunhour (2) | G89 | | X | X |
| | | Amaria (3) | G89 | | X | X |
| | Abou Homos (22) | Nakhla Baharia (1) | G70 | X | X | X |
| | | Besentiway (2) | G70 | X | X | X |
| | | Berket Ghatas (3) | G70 | | X | X 10/7 |
| | Rahmania (23) | Simakhrat(Nabila)(1) | G88 | X | X | X |
| | | Simakhrat (Al Wakil) (2) | G88 | | X | X |
| | | Kafr Ghoniem (3) | G88 | | X | X |
| Beni Suef (3) | Ahansia (31) | Omara (1) | G80 | X | X | X |
| | | Kafr Abu Shohba (2) | G80 | X | X | X |
| | | Kolla (3) | G80 | | X | X |
| | Wasta (32) | Keman (1) | G80 | X | X | X |
| | | Manshi Abu Sier (2) | G80 | X | X | X |
| | | Abu Sir Al Malak (3) | G80 | | X | X |
| Assuit (4) | Abu Tig (41) | Abu Tieg (Azab) (1) | G83 | X | X | X |
| | | Abu Tieg (Sarhan)(2) | G83 | X | X | X |
| | | Dwina (3) | G83 | | X | X |
| | Abnob (42) | Swalem Abnob (Bagdadi) (1) | G83 | X | X | X |
| | | Swalem Abnob (Khalil) (2) | G83 | X | X | |
| | | Beni Ibrahim (3) | G83 | | X | X |

**N.B.** The number between brackets is a code used in data entry and analysis.

The collected data using Form 2 which was entered as a worksheet through Excel. The Excel file contains the counts by plant within hill, then all plant data was added together to have a summary of each hill.

Next step we transfer data to SPSSWIN files adding codes for governorates, district, variety and village. The table shows when villages were visited. Generally villages coded 1 and 2 were visited three times and villages coded 3 were only visited.

For each visit the collected data are: squares, blooms, small green bolls, large green bolls, partially open bolls, open bolls, damaged bolls and burrs.

| | |
|---|---|
| Sqi | Squares |
| Bli | Blooms |
| SGBi | Small green bolls |
| LGBi | Large green bolls |
| POBi | Partially open bolls |
| OBi | Open Bolls |
| DBi | Damaged bolls |
| BRi | BR |

| | | |
|---|---|---|
| Where i = | 7 | July |
| | 8 | August |
| | 9 | September |

It is expected that blooms and small green bolls in July are correlated with large and partially open bolls in August and September. A stepwise regression analysis was used to avoid the multi-collinearity between variables.

**Analysis Steps:**

**I. For both plants and hills data analyze for each village (experimental plot), July Visits**
OB9 =f (SQ7, BL7, SGB7, LGB7, POB7, OB7, DB7, BR7)
OBPOB9 =f (SQ7, BL7, SGB7, LGB7, POB7, OB7, DB7, BR7)

**II. For both plants and hills data analyze for each village (August Visits)**
OB9 =f (SQ8, BL8, SGB8, LGB8, POB8, OB8, DB8, BR8)
OBPOB9 =f (SQ8, BL8, SGB8, LGB8, POB8, OB8, DB8, BR8)

**III. For both plants and hills data analyze for each village (July and August Visits)**
OB9 =f (SQ7, BL7, SGB7, LGB7, DB8, OB8, BR8)
OBPOB9 =f (SQ7, BL7, SGB7, LGB7, DB8, OB8, BR8)

**IV. For hills data only analyze for each village (July and August Visits)**
OBPOBLGB =f (SQ7, BL7, SGB7, LGB7, POB7, OB7, DB7, BR7)
OBPOBLGB =f (SQ8, BL8, SGB8, LGB8, POB8, OB8, DB8, BR8)
OBPOBLGB =f (SQ7, BL7, SGB7, LGB7, DB8, OB8, BR8)

**V. For variety data only (July and August Visits)**
Same analysis as in I, II, III.

Next tables contains SPSSWIN regression runs:

**Table F-2: Regression Analysis Based on July visit by Hill Dependant (Open Bolls + Partially Open Bolls)**

| Gov. | Dist. | Plot # | Variety | Constant | Large green bolls | Small green bolls | Squares | R |
|---|---|---|---|---|---|---|---|---|
| | | | | | LGB7 | SGB7 | SQ7 | |
| 1 | 11 | 1 | G86 | 7.326 | | | 0.971 | 0.720 |
| 1 | 11 | 2 | G86 | 1.964 | | 0.778 | | 0.749 |
| 1 | 12 | 1 | G85 | 1.353 | 1.433 | | | 0.902 |
| 1 | 12 | 2 | G85 | 5.978 | | 0.561 | | 0.476 |
| 2 | 21 | 1 | G89 | -2.961 | | 1.206 | | 0.870 |
| 2 | 22 | 1 | G70 | 0.592 | | 1.205 | | 0.856 |
| 2 | 22 | 2 | G70 | 4.136 | 1.849 | | 0.219 | 0.885 |
| 2 | 23 | 1 | G88 | 4.039 | 1.330 | | 0.989 | 0.709 |
| 3 | 31 | 1 | G80 | -0.676 | | 0.744 | 0.647 | 0.777 |
| 3 | 31 | 2 | G80 | 7.201 | | | 1.225 | 0.779 |
| 3 | 32 | 1 | G80 | 6.631 | | | 0.446 | 0.459 |
| 4 | 41 | 1 | G83 | 6.768 | | 0.511 | | 0.818 |
| 4 | 41 | 2 | G83 | 3.334 | | 0.626 | | 0.778 |
| 4 | 42 | 1 | G83 | 9.089 | 0.743 | | | 0.510 |
| 4 | 42 | 2 | G83 | 4.937 | 0.513 | | | 0.821 |

**Table F-3: Regression Analysis Based on July visit by Hill Dependant (Open Bolls)**

| Gov. | Dist. | Plot # | Variety | constant | Large green bolls | Small green bolls | Squares | R |
|---|---|---|---|---|---|---|---|---|
| | | | | | LGB7 | SGB7 | SQ7 | |
| **1** | **11** | **1** | **G86** | 7.625 | | | 0.905 | 0.707 |
| **1** | **11** | **2** | **G86** | 2.389 | | 0.717 | | 0.737 |
| **1** | **12** | **1** | **G85** | 1.402 | 1.312 | | | 0.815 |
| **1** | **21** | **1** | **G89** | -3.239 | | 1.122 | | 0.876 |
| **2** | **22** | **1** | **G70** | 0.979 | | 1.013 | | 0.857 |
| **2** | **22** | **2** | **G70** | 3.255 | | 0.764 | | 0.779 |
| **2** | **23** | **1** | **G88** | 3.256 | 1.304 | | 0.861 | 0.721 |
| **3** | **31** | **1** | **G80** | -1.274 | | 0.735 | 0.656 | 0.786 |
| **3** | **31** | **2** | **G80** | 6.553 | | | 1.218 | 0.776 |
| **3** | **32** | **1** | **G80** | 6.539 | | 0.445 | | 0.456 |
| **4** | **41** | **1** | **G83** | 6.550 | | 0.510 | | 0.816 |
| **4** | **41** | **2** | **G83** | 3.606 | | 0.597 | | 0.768 |
| **4** | **42** | **1** | **G83** | 9.089 | 0.743 | | | 0.510 |
| **4** | **42** | **2** | **G83** | 4.567 | 0.473 | | | 0.806 |

Using open bolls and partially open bolls as dependent variable in estimating yield with the hill data generally gives higher R values than using open bolls.

**Table F-4: Regression Analysis Based on August visit by Hill Dependant (open bolls + partially open bolls)**

| Gov. | Dist. | Plot # | Variety | constant | Open bolls | Partially open bolls | Damage Bolls | Large green bolls | Small green bolls | R |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | OB8 | POB8 | DB8 | LGB8 | SGB8 | |
| 1 | 11 | 2 | G86 | 10.548 | | | | 2.041 | | 0.535 |
| 1 | 11 | 3 | G86 | 2.412 | | | | | 0.308 | 0.610 |
| 1 | 12 | 1 | G85 | 7.493 | | 4.341 | | | | 0.607 |
| 1 | 12 | 2 | G85 | 5.514 | 2.749 | | | | | 0.689 |
| 2 | 21 | 1 | G89 | 25.581 | | | | -1.527 | | 0.699 |
| 2 | 21 | 2 | G89 | 3.070 | | | 2.591 | 1.810 | | 0.748 |
| 2 | 21 | 3 | G89 | 7.512 | | | | | 2.697 | 0.681 |
| 2 | 22 | 2 | G70 | 0.455 | 1.165 | | | | | 0.983 |
| 2 | 23 | 1 | G88 | 2.369 | 0.868 | | | | | 0.939 |
| 2 | 23 | 2 | G88 | 11.323 | 2.612 | | | | | 0.725 |
| 2 | 23 | 3 | G88 | 12.834 | 0.871 | | | 0.550 | | 0.906 |
| 3 | 31 | 1 | G80 | 11.143 | | 3.584 | | | | 0.526 |
| 3 | 31 | 3 | G80 | 10.020 | | | | 0.656 | | 0.609 |
| 3 | 32 | 2 | G80 | -3.203 | 1.406 | | 1.638 | | | 0.876 |
| 3 | 32 | 3 | G80 | 5.133 | 0.614 | | | | | 0.673 |
| 4 | 41 | 1 | G83 | 2.604 | 0.899 | 2.426 | | | | 0.958 |
| 4 | 41 | 2 | G83 | 0.582 | 0.783 | | | | 1.211 | 0.899 |
| 4 | 41 | 3 | G83 | 5.586 | | 2.892 | 1.220 | | | 0.811 |
| 4 | 42 | 1 | G83 | 14.569 | | | | | 4.499 | 0.563 |
| 4 | 42 | 3 | G83 | -1.148 | 0.831 | | | | | 0.886 |

**Table F-5: Regression Analysis Based on August visit by Hill Dependant (open bolls)**

| Gov. | Dist. | Plot # | Variety | constant | Open bolls | Partially open bolls | Large green bolls | Small green bolls | Damage bolls | R |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | OB8 | POB8 | LGB8 | SGB8 | DB8 | |
| 1 | 11 | 1 | G86 | 3.981 | | | 0.590 | | | 0.847 |
| 1 | 11 | 2 | G86 | 0.764 | | | 0.808 | | | 0.885 |
| 1 | 11 | 3 | G86 | 1.110 | | | 0.142 | | | 0.643 |
| 1 | 12 | 1 | G85 | -1.655 | | 2.334 | 0.696 | | | 0.953 |
| 1 | 12 | 2 | G85 | 4.846 | 2.403 | | | | | 0.695 |
| 2 | 21 | 1 | G89 | 2.617 | | 3.184 | 0.960 | | | 0.926 |
| 2 | 21 | 2 | G89 | 1.283 | | 0.829 | 0.462 | | | 0.830 |
| 2 | 21 | 3 | G89 | 1.858 | 1.334 | | 0.352 | | | 0.869 |
| 2 | 22 | 1 | G70 | -0.991 | | | 0.969 | | | 0.756 |
| 2 | 22 | 2 | G70 | 1.000 | 1.000 | | | | | 1.000 |
| 2 | 23 | 1 | G88 | 2.032 | 0.779 | | | | | 0.922 |
| 2 | 23 | 2 | G88 | 1.994 | 2.380 | | 0.296 | | | 0.822 |
| 2 | 23 | 3 | G88 | 11.406 | 0.876 | | | 0.454 | | 0.871 |
| 3 | 31 | 1 | G80 | 5.285 | | 2.827 | 0.629 | | | 0.707 |
| 3 | 31 | 2 | G80 | 5.870 | | | 0.577 | 0.752 | | 0.760 |
| 3 | 31 | 3 | G80 | 8.080 | | | | | 2.256 | 0.489 |
| 3 | 32 | 2 | G80 | -3.389 | 1.037 | | | | 1.636 | 0.881 |
| 3 | 32 | 3 | G80 | 5.198 | 0.486 | | 1.249 | | | 0.788 |
| 4 | 41 | 1 | G83 | 2.264 | 0.908 | 2.293 | | | | 0.960 |
| 4 | 41 | 2 | G83 | 0.502 | 0.893 | | 1.319 | | | 0.900 |
| 4 | 41 | 3 | G83 | 5.632 | | 2.768 | | | 1.219 | 0.801 |
| 4 | 42 | 1 | G83 | 14.569 | | | | 4.499 | | 0.563 |
| 4 | 42 | 3 | G83 | -1.333 | 0.841 | | | | | 0.890 |

**Table F-6: Regression Analysis Based on July and August visits by Hill Dependant (open bolls)**

| Gov. | Dist. | Plot # | Variety | constant | Partially open bolls | Large green bolls | Small green bolls | Damage bolls | Squares | Small green bolls | Squares | R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | POB8 | LGB8 | SGB8 | DB8 | SQ8 | SGB7 | SQ7 | |
| 1 | 11 | 1 | G86 | 3.981 | | 0.590 | | | | | | 0.847 |
| 1 | 11 | 2 | G86 | 0.764 | | 0.808 | | | | | | 0.885 |
| 1 | 11 | 3 | G86 | 1.814 | | 0.134 | | | -0.376 | | | 0.775 |
| 1 | 12 | 1 | G85 | -0.454 | 1.326 | 0.888 | | | 2.208 | | -0.855 | 0.988 |
| 1 | 12 | 2 | G85 | 0.697 | 2.291 | 0.266 | | | | 0.371 | | 0.892 |
| 2 | 21 | 1 | G89 | 1.171 | | | | -1.333 | | 1.107 | | 0.937 |
| 2 | 22 | 1 | G89 | 0.979 | | | | | | 1.013 | | 0.857 |
| 2 | 22 | 2 | G70 | 1.689 | | | 1.935 | | | 0.561 | | 0.894 |
| 3 | 31 | 1 | G80 | 1.077 | 3.146 | | | | | 0.645 | 0.759 | 0.837 |
| 3 | 31 | 2 | G80 | 6.553 | | | | | | | 1.218 | 0.776 |
| 3 | 32 | 1 | G80 | 6.539 | | | | | | 0.445 | | 0.456 |
| 3 | 32 | 2 | G80 | 4.080 | | | | 2.287 | | | | 0.758 |
| 4 | 41 | 1 | G83 | 6.670 | | | | | | 0.567 | -2.199 | 0.874 |
| 4 | 41 | 2 | G83 | 3.606 | | | | | | 0.597 | | 0.768 |
| 4 | 42 | 1 | G83 | 14.569 | | | 4.499 | | | | | 0.563 |

**Table F-7: Regression Analysis Based on July and August visits by Hill Dependant (Open & partially open bolls)**

| Gov. | Dist. | Plot # | Variety | constant | Partially open bolls | Large green bolls | Small green bolls | Damaged bolls | Squares | Large green bolls | Small green bolls | Squares | R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | POB8 | LGB8 | SGB8 | DB8 | SQ8 | LGB7 | SGB7 | SQ7 | |
| 1 | 11 | 1 | G86 | 3.680 | | 0.618 | | | | | | | 0.841 |
| 1 | 11 | 2 | G86 | -0.020 | | 0.950 | | | -0.999 | | | | 0.917 |
| 1 | 11 | 3 | G86 | 1.001 | | 0.182 | | | | | | | 0.699 |
| 1 | 12 | 1 | G85 | 0.633 | | 1.131 | | | 2.097 | | | -1.459 | 0.983 |
| 1 | 12 | 2 | G85 | 0.578 | 2.460 | 0.290 | | | | | 0.518 | | 0.884 |
| 2 | 21 | 1 | G89 | 2.196 | | | | -1.559 | | | 1.189 | | 0.941 |
| 2 | 22 | 1 | G89 | 0.592 | | | | | | | 1.205 | | 0.856 |
| 2 | 22 | 2 | G70 | 4.136 | | | | | | 1.849 | | 0.219 | 0.885 |
| 3 | 31 | 1 | G80 | -1.470 | 2.978 | | | | | | 0.652 | 0.622 | 0.890 |
| 3 | 31 | 2 | G80 | 7.201 | | | | | | | | 1.225 | 0.779 |
| 3 | 32 | 1 | G80 | 6.631 | | | | | | | 0.446 | | 0.459 |
| 3 | 32 | 2 | G80 | 4.336 | | | | 2.293 | | | | | 0.752 |
| 4 | 41 | 1 | G83 | 6.889 | | | | | | | 0.569 | -2.222 | 0.877 |
| 4 | 41 | 2 | G83 | 3.653 | | | 0.862 | | | | 0.432 | | 0.828 |
| 4 | 42 | 1 | G83 | 14.569 | | | 4.499 | | | | | | 0.563 |

The aggregate function over all varieties and governorates by hill is as follows:

N.B. (ALL RESULTS ARE HIGHLY STATISTICALLY SIGNIFICANT)
Dxx is a dummy variable represent variety Giza xx

**I. July visit**

OB9 = -1.875 + 0.416 SGB7 + 0.428 LGB7 - 1.015 DB7 + 1.302 POB7
+ 0.187 SQ7 + 7.413 D80 + 8.481 D83 +7.227 D86 + 8.723 D89
+ 3.319 D70

$R^2$ = 0.512 STANDARD ERROR OF ESTIMATE = 6.197

OBPOB9 = 5.024 + 0.488 SGB7 +0.467 LGB7 – 1.225 DB7 + 1.484 POB7
+ 4.878 D89

$R^2$ = 0.410 STANDARD ERROR OF ESTIMATE = 6.943

**II. August visit**

OB9 = 1.128 + 0.540 OB8 +0.378 LGB8 - 1.701 BL8 +0.344 SGB8
+ 1.401 POB8 – 3.765 D70 +3.883 D80 +4.699 D83

$R^2$ = 0.514 STANDARD ERROR OF ESTIMATE = 6.342

OBPOB9 = 3.762 + 0.603 OB8 + 0.348 LGB8 – 1.952 BL8 + 0.361 SGB8
+ 1.357 POB8 + 0.274 DB8 – 5.060 D70 - 2.982 D86

$R^2$ = 0.511 STANDARD ERROR OF ESTIMATE = 6.612

**III. July and August visits**

OB9 = - 0.315 + 0.366 SGB7 -2.013 BL8 + 0.407 LGB7 + 0.382 SGB8
+ 1.232 POB9 + 1.755 POB7 + 0.210 LGB8 + 4.554 D80 + 5.253 D83

$R^2$ = 0.622 STANDARD ERROR OF ESTIMATE = 5.509

OBPOB9 = -0.992 + 0.346 SGB7 –2.195 BL8 + 0.388 LGB7 + 1.828 POB7
+ 0.009 SQ7 + 0.346 SGB8 + 1.369 POB8 + 0.241 LGB8 + 5.171 D80
+ 6.332 D83 + 4.013 D89

$R^2$ = 0.639 STANDARD ERROR OF ESTIMATE = 5.533

**Table F-8: Regression Analysis Based on July visit by Plant Dependant (open bolls)**

| Gov. | Dist | Plot # | Variety | constant | Large green bolls | Small Green Bolls | BL | Squares | R |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | LGB7 | SGB7 | BL7 | SQ7 | |
| 1 | 11 | 1 | G86 | 4.394 | | | | 0.779 | 0.532 |
| 1 | 11 | 2 | G86 | 2.391 | | 0.592 | | | 0.590 |
| 1 | 12 | 1 | G85 | -2.925 | 1.125 | 0.806 | 2.891 | | 0.842 |
| 2 | 21 | 1 | G89 | -0.003 | | 0.956 | | | 0.905 |
| 2 | 22 | 1 | G70 | -0.131 | | | 3.195 | | 0.836 |
| 2 | 22 | 2 | G70 | 2.095 | 1.465 | | | 0.211 | 0.837 |
| 2 | 23 | 1 | G88 | 4.235 | 0.981 | 0.617 | | | 0.584 |
| 3 | 31 | 1 | G80 | 2.619 | | 0.816 | | | 0.549 |
| 3 | 31 | 2 | G80 | 4.277 | 0.813 | | | | 0.500 |
| 3 | 32 | 1 | G80 | 1.688 | 0.682 | 0.352 | | | 0.544 |
| 3 | 32 | 2 | G80 | 4.239 | | 1.338 | | | 0.586 |
| 4 | 41 | 1 | G83 | 4.536 | | 0.433 | | | 0.602 |
| 4 | 41 | 2 | G83 | 3.142 | | 0.383 | 3.589 | | 0.599 |
| 4 | 4 | 2 | G83 | 2.849 | 0.368 | | | | 0.530 |

**Table F-9: Regression Analysis Based on July visit by Plant Dependant (open bolls and partially open bolls)**

| Gov. | Dist | Plot # | Variety | constant | Large green bolls | Small Green Bolls | BL | Squares | R |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | LGB7 | SGB7 | BL7 | SQ7 | |
| 1 | 11 | 1 | G86 | 4.403 | | | | 0.801 | 0.540 |
| 1 | 11 | 2 | G86 | 2.303 | | 0.639 | | | 0.602 |
| 1 | 12 | 1 | G85 | 1.600 | 1.286 | | 4.082 | | 0.690 |
| 2 | 21 | 1 | G69 | 0.527 | | 1.000 | | | 0.890 |
| 2 | 22 | 1 | G70 | 0.055 | | | 3.462 | | 0.811 |
| 2 | 22 | 2 | G70 | 2.479 | 1.749 | | | 0.259 | 0.860 |
| 2 | 23 | 1 | G88 | 3.660 | | 0.639 | | 0.674 | 0.609 |
| 3 | 31 | 1 | G80 | 1.408 | | 0.629 | | 0.488 | 0.614 |
| 3 | 31 | 2 | G80 | 4.589 | 0.798 | | | | 0.493 |
| 3 | 32 | 1 | G680 | 1.775 | 0.687 | 0.342 | | | 0.541 |
| 3 | 32 | 2 | G80 | 4.471 | | 1.324 | | | 0.576 |
| 4 | 41 | 1 | G83 | 4.737 | | 0.428 | | | 0.592 |
| 4 | 41 | 2 | G83 | 3.250 | | 0.388 | 3.543 | | 0.589 |
| 4 | 42 | 2 | G83 | 3.351 | 0.366 | | | | 0.504 |

**Table F-10: Regression Analysis Based on August visit by Plant Dependant (Open bolls)**

| Gov. | Dist | Plot # | Variety | constant | BR | Open bolls | Partially open bolls | Large green bolls | Small Green Bolls | Damage Bolls | BL | Squares | R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | BR8 | OB8 | POB8 | LGB8 | SGB8 | DB8 | BL8 | SQ8 | |
| 1 | 11 | 1 | G86 | 1.361 | | | | 0.649 | | | | 2.820 | 0.889 |
| 1 | 11 | 2 | G86 | 0.725 | | | | 0.766 | | | | | 0.892 |
| 1 | 12 | 1 | G85 | -1.447 | | | 1.924 | 0.720 | | | | 2.193 | 0.928 |
| 1 | 12 | 2 | G85 | 1.134 | | 1.375 | 1.409 | 0.149 | | 0.694 | 6.098 | | 0.889 |
| 1 | 12 | 3 | G85 | 1.738 | | | 3.459 | | | | | | 0.847 |
| 2 | 21 | 1 | G89 | 1.410 | | 0.724 | 2.779 | 0.733 | | | | | 0.922 |
| 2 | 21 | 2 | G89 | 0.649 | | | 0.698 | 0.321 | | 0.808 | | | 0.773 |
| 2 | 21 | 3 | G89 | 1.568 | | 0.994 | 1.820 | 0.427 | -0.810 | | | -0.588 | 0.879 |
| 2 | 22 | 1 | G70 | 1.821 | | | | 0.527 | | | | | 0.518 |
| 2 | 22 | 2 | G70 | 1.272 | | | | 0.389 | | | | | 0.783 |
| 2 | 22 | 3 | G70 | 1.994 | | | | 0.636 | | | | -2.585 | 0.712 |
| 2 | 23 | 1 | G88 | 1.427 | | | | 0.755 | | | | | 0.792 |
| 3 | 23 | 2 | G88 | 2.069 | | 1.602 | | 0.382 | | | | | 0.701 |
| 3 | 31 | 1 | G80 | 1.558 | | | | 0.550 | 0.470 | | | | 0.645 |
| 3 | 31 | 2 | G80 | 5.224 | 3.366 | | | | 0.729 | | | | 0.450 |
| 3 | 32 | 1 | G80 | 0.071 | | 0.998 | | | | | -1.552 | | 0.983 |
| 3 | 32 | 2 | G80 | -1.414 | | 0.892 | | | 2.093 | 0.883 | | | 0.756 |
| 3 | 32 | 3 | G80 | 0.941 | | 0.577 | | | 0.471 | | | | 0.857 |
| 4 | 41 | 1 | G83 | 0.812 | | 0.935 | 2.717 | | | | | | 0.932 |
| 4 | 41 | 2 | G83 | 4.555 | 1.504 | | | | 0.948 | | | | 0.525 |
| 4 | 42 | 3 | G83 | -0.795 | | 0.854 | | | | | | | 0.859 |

**Table F-11: Regression Analysis Based on August visit by Plant Dependant (Open bolls and partially open bolls)**

| Gov. | Dist | Plot # | Variety | constant | Open bolls | Partially open bolls | Damage Bolls | Small Green Bolls | BL | Squares | R |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | OB8 | POB8 | DB8 | SGB8 | BL8 | SQ8 | |
| 1 | 11 | 2 | G86 | 3.281 | | | 0.959 | 1.082 | | | 0.645 |
| 1 | 11 | 3 | G86 | 1.415 | | | | 0.313 | -2.230 | | 0.534 |
| 1 | 12 | 2 | G85 | 2.514 | 2.230 | | 1.270 | | 8.675 | | 0.837 |
| 1 | 12 | 3 | G85 | 2.189 | | 3.295 | | | | | 0.845 |
| 2 | 21 | 1 | G89 | 4.327 | 1.744 | 2.465 | | | | | 0.832 |
| 2 | 21 | 2 | G89 | 1.994 | 0.922 | | 1.655 | | | | 0.618 |
| 2 | 21 | 3 | G89 | 7.404 | 1.129 | 2.164 | | | | -0.943 | 0.714 |
| 2 | 22 | 2 | G70 | 2.986 | | 3.592 | | 0.982 | | | 0.799 |
| 2 | 23 | 1 | G88 | 10.414 | | | | 1.266 | | | 0.401 |
| 2 | 23 | 2 | G88 | 4.892 | 2.075 | | | 0.555 | | | 0.681 |
| 2 | 23 | 3 | G88 | 2.153 | -0.362 | 1.394 | | 0.647 | | | 0.679 |
| 3 | 31 | 1 | G80 | 3.794 | | | | 0.614 | | | 0.495 |
| 3 | 31 | 2 | G80 | 5.116 | 0.604 | | | 0.541 | | | 0.454 |
| 3 | 32 | 1 | G80 | 0.159 | 0.994 | | | | -1.589 | | 0.980 |
| 3 | 32 | 2 | G80 | -1.199 | 0.913 | | 0.851 | 2.052 | | | 0.750 |
| 3 | 32 | 3 | G80 | 1.202 | 0.560 | | | 0.484 | | | 0.855 |
| 4 | 41 | 1 | G83 | 1.019 | 0.920 | 2.993 | | | | | 0.930 |
| 4 | 41 | 2 | G83 | 5.490 | | | | 1.158 | | | 0.436 |
| 4 | 42 | 3 | G83 | -0.724 | 0.848 | | | | | | 0.856 |

## Table F-12: Regression Analysis Based on July and August visits by Plant Dependant (open bolls)

| Gov. | Dist | Plot # | Variety | constant | Open Bolls | Partially Open Bolls | Large Green Bolls | Small Green Bolls | Damage Bolls | BL | Squares | Large Green Bolls | Small Green Bolls | BL | Squares | R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | OB8 | POB8 | LGB 8 | SGB8 | DB8 | BL8 | SQ8 | LGB7 | SGB7 | BL7 | SQ7 | |
| 1 | 11 | 1 | G86 | 1.361 | | | 0.649 | | | | 2.820 | | | | | 0.889 |
| 1 | 11 | 2 | G86 | 0.725 | | | 0.766 | | | | | | | | | 0.892 |
| 1 | 12 | 1 | G85 | -0.640 | | 1.376 | 0.898 | | | | 1.922 | | | | -0.766 | 0.957 |
| 1 | 12 | 2 | G85 | 0.816 | 1.616 | 1.186 | 0.173 | | 0.826 | 8.411 | -2.823 | | | | | 0.916 |
| 1 | 12 | 3 | G85 | 1.738 | | 3.459 | | | | | | | | | | 0.847 |
| 2 | 21 | 1 | G89 | 0.041 | | 1.388 | | | | | | | 0.797 | | | 0.927 |
| 2 | 21 | 2 | G89 | 0.649 | | 0.698 | 0.321 | | 0.808 | | | | | | | 0.773 |
| 2 | 22 | 1 | G70 | -0.131 | | | | | | | | | | 3.195 | | 0.836 |
| 2 | 22 | 2 | G70 | 1.272 | | | 0.389 | | | | | | | | | 0.783 |
| 2 | 23 | 1 | G88 | 0.936 | | | 0.769 | | | | 12.602 | | | | | 0.841 |
| 2 | 23 | 2 | G88 | -0.926 | 1.516 | | 0.646 | | | -8.578 | | | | | | 0.776 |
| 3 | 31 | 1 | G80 | -0.481 | | | 0.402 | 0.424 | | | | | 0.569 | | | 0.738 |
| 3 | 31 | 2 | G80 | 4.029 | | | | 0.434 | | | | 0.699 | | | | 0.550 |
| 3 | 32 | 1 | G80 | 0.071 | 0.998 | | | | | -1.552 | | | | | | 0.983 |
| 3 | 32 | 2 | G80 | 4.239 | | | | | | | | | 1.338 | | | 0.586 |
| 4 | 41 | 1 | G83 | 0.812 | 0.935 | 2.717 | | | | | | | | | | 0.932 |
| 4 | 41 | 2 | G83 | 3.142 | | | | | | | | | 0.383 | 3.589 | | 0.599 |

**Table F-13: Regression Analysis Based on July and August visits by Plant Dependant (open & partially open bolls)**

| Gov. | Dist | Plot # | Variety | constant | Open Bolls | Partially open bolls | Large green bolls | Small green Bolls | Damaged bolls | BL | Squares | Large green bolls | Small green Bolls | BL | Squares | R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | OB8 | POB8 | LGB8 | SGB8 | DB8 | BL8 | SQ8 | LGB7 | SGB7 | BL7 | SQ7 | |
| 1 | 11 | 1 | G86 | 1.392 | | | 0.656 | | | | 2.804 | | | | | 0.887 |
| 1 | 11 | 2 | G86 | 0.557 | | | 0.822 | | | | | | | | | 0.902 |
| 1 | 12 | 1 | G85 | -0.309 | | 1.294 | 0.981 | | | | 1.639 | | | | -0.942 | 0.961 |
| 1 | 12 | 2 | G85 | 0.944 | 1.903 | 1.030 | 0.181 | | 1.162 | 11.406 | -4.093 | | | | | 0.927 |
| 1 | 12 | 3 | G85 | 2.189 | | 3.295 | | | | | | | | | | 0.845 |
| 2 | 21 | 1 | G89 | 0.527 | | | | | | | | | 1.000 | | | 0.890 |
| 2 | 21 | 2 | G89 | 1.664 | | | 0.635 | | | | | | | | | 0.727 |
| 2 | 22 | 1 | G70 | 0.055 | | | | | | | | | | 3.462 | | 0.811 |
| 2 | 22 | 2 | G70 | 1.534 | | | 0.469 | | | | | | | | | 0.803 |
| 2 | 23 | 1 | G88 | 1.305 | | | 0.851 | | | | 11.33 9 | | | | | 0.885 |
| 2 | 23 | 2 | G88 | 0.091 | 1.852 | | 0.393 | 0.423 | | | | | | | | 0.801 |
| 3 | 31 | 1 | G80 | -0.176 | | | 0.392 | 0.621 | | -1.699 | | | 0.534 | | | 0.782 |
| 3 | 31 | 2 | G80 | 4.356 | | | | 0.409 | | | | 0.690 | | | | 0.539 |
| 3 | 32 | 1 | G80 | 0.159 | 0.994 | | | | | -1.589 | | | | | | 0.980 |
| 3 | 32 | 2 | G80 | 4.471 | | | | | | | | | 1.324 | | | 0.576 |
| 4 | 41 | 1 | G83 | 1.019 | 0.920 | 2.993 | | | | | | | | | | 0.930 |
| 4 | 41 | 2 | G83 | 2.532 | | | | 0.831 | | | | | 0.367 | | | 0.597 |

**I. July visit**

OB9 = 7.288 + 0.370 SGB7 + 0.374 LGB7 + 0.779 BL7 +0.138 SQ
0.138 SQ7 – 3.999 D80 – 4.449 D86 – 6.012 D70 - 3.304 D83
–3.754 D89

$R^2$ = 0.329 STANDARD ERROR OF ESTIMATE = 4.913

OBPOB9 = 6.512 + 0.382 SG7 +0.367 LGB7 +0.979 BL7 – 4.679 D70
-4.026 D89 – 3.163 D80 - 3.724 D86 – 2.1712 D83

$R^2$ = 0.334 STANDARD ERROR OF ESTIMATE = 4.733

**II. August visit**

OB9 = 3.841 + 0.499 OB8 - 0.240 BD8 +0.466 SGB8 + 0.998 POB8
– 0.271 SQ8

$R^2$ = 0.253 STANDARD ERROR OF ESTIMATE = 5.102

OBPOB9 = 4.468 + 0.436 OB8 + 1.268 POB8 + 0.549 SGB8 –0.288 SQ8
+ 0.278 DB8 - 1.308 D86

$R^2$ = 0.259 STANDARD ERROR OF ESTIMATE = 5.311

**III. July and August visits**

OB9 = 5.128 + 0.514 OB8+ 0.200 SGB7 +0.804 BL7 + 0.271 LGB7 +0.144 SQ7
+0.410 SGB8 +0.617 POB8 -6.151 D70 – 4.525 D89 –3.431 D80
– 3.615 D83 –2.301 D86

$R^2$ = 0.473 STANDARD ERROR OF ESTIMATE = 4.277

OBPOB9 = 5.932 + 0.199 SGB7 + 0.783 BL7 + 0.268 LGB7 + 0.187 SQ7
+0.439 SGB8 +0.527 OB8 + 0.652 POB8 –6.702 D70 – 4.234 D80
-4.479 D83 – 4.342 D89 – 3.091 D86

$R^2$ = 0.4.68 STANDARD ERROR OF ESTIMATE = 4.440

**Table F-14: Regression Analysis (July)**
**by Hill Dependent (Ob+Pob+Lgb) Sept.**

| Gov. | Dist | Plot # | Variety | Constant | Large Green Bolls | Small Green Bolls | Squares | R |
|---|---|---|---|---|---|---|---|---|
| | | | | | LGB7 | SGB7 | SQ7 | |
| 1 | 11 | 1 | G86 | 7.046 | | | 1.141 | 0.750 |
| 1 | 11 | 2 | G86 | 1.924 | | 0.905 | | 0.751 |
| 1 | 12 | 1 | G85 | -0.457 | | 2.278 | | 0.818 |
| 1 | 12 | 2 | G85 | 7.055 | | | 0.534 | 0.586 |
| 2 | 21 | 1 | G89 | 2.762 | | 0.888 | 0.313 | 0.950 |
| 2 | 22 | 1 | G70 | 2.384 | | | 0.490 | 0.737 |
| 2 | 22 | 2 | G70 | 12.663 | | | 0.851 | 0.938 |
| 2 | 23 | 1 | G88 | 0.996 | 1.199 | | 1.451 | 0.750 |
| 3 | 31 | 1 | G80 | 2.693 | | 0.691 | 0.715 | 0.828 |
| 3 | 31 | 2 | G80 | 7.569 | | | 1.249 | 0.764 |
| 3 | 32 | 1 | G80 | 6.604 | | 0.559 | | 0.532 |
| 4 | 41 | 1 | G83 | 6.713 | | 0.584 | -2.136 | 0.885 |
| 4 | 41 | 2 | G83 | 2.719 | | 0.679 | | 0.795 |
| 4 | 42 | 1 | G83 | 9.089 | 0.743 | | | 0.510 |
| 4 | 42 | 2 | G83 | 5.441 | 0.512 | | | 0.844 |

**Table E-15: Regression Analysis (August)**
**by Hill Dependent (Ob+Pob+Lgb) Sept.**

| Gov. | Dist | Plot # | Variety | Constant | Open Bolls | Partially Open Bolls | Large Green Bolls | Small green Bolls | Small green Bolls | Squares | R |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | OB8 | POB8 | LGB8 | SGB8 | SGB7 | SQ7 | |
| 1 | 11 | 1 | G86 | 2.518 | | | 0.740 | | | | 0.894 |
| 1 | 11 | 2 | G86 | -0.322 | | | 1.032 | | | | 0.911 |
| 1 | 11 | 3 | G86 | 2.038 | | | 0.290 | | | | 0.742 |
| 1 | 12 | 1 | G85 | -0.768 | | 1.353 | 0.923 | | | | 0.962 |
| 1 | 12 | 2 | G85 | 6.215 | | | 0.675 | | | | 0.676 |
| 2 | 21 | 1 | G89 | 10.583 | | 1.939 | 0.973 | | | | 0.902 |
| 2 | 21 | 2 | G89 | 3.516 | | | 0.812 | | | | 0.742 |
| 2 | 21 | 3 | G89 | 4.165 | 1.105 | | 0.855 | | | | 0.967 |
| 2 | 22 | 1 | G70 | -0.514 | | | 1.546 | | | | 0.827 |
| 2 | 22 | 2 | G70 | 12.663 | | | | | | 0.851 | 0.938 |
| 2 | 23 | 1 | G88 | 1.930 | | | 0.983 | | | | 0.944 |
| 3 | 31 | 1 | G80 | 4.083 | | | 0.702 | 0.640 | | | 0.793 |
| 3 | 31 | 2 | G80 | 6.031 | | | 0.658 | 0.713 | | | 0.793 |
| 3 | 32 | 1 | G80 | 6.604 | | | | | 0.559 | | 0.532 |
| 3 | 32 | 2 | G80 | -8.544 | 1.720 | | | 3.155 | | | 0.860 |
| 3 | 32 | 3 | G80 | 6.266 | 0.441 | | 1.535 | | | | 0.808 |
| 4 | 41 | 1 | G83 | 2.728 | 0.908 | 2.459 | | | | | 0.953 |
| 4 | 41 | 2 | G83 | -0.032 | 0.814 | | 1.003 | 0.756 | | | 0.930 |
| 4 | 41 | 3 | G83 | 7.476 | 1.392 | | | | | | 0.581 |
| 4 | 42 | 1 | G83 | 14.569 | | | | 4.499 | | | 0.563 |
| 4 | 42 | 3 | G83 | -1.012 | 0.825 | | | | | | 0.882 |

**Table E-16: Regression Analysis (July+August)**
**By Hill Dependent (Ob+Pob+Lgb) Sept.**

| Gov. | Dist. | Plot # | Variety | Constant | Open Bolls | Partially Open Bolls | Large Green Bolls | Small Green Bolls | Squares | Small Green Bolls | Squares | R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | OB8 | POB8 | LGB8 | SGB8 | SQ8 | SGB7 | SQ7 | |
| 1 | 11 | 1 | G86 | 2.518 | | | 0.740 | | | | | 0.894 |
| 1 | 11 | 2 | G86 | -0.322 | | | 1.032 | | | | | 0.911 |
| 1 | 11 | 3 | G86 | 2.038 | | | 0.290 | | | | | 0.742 |
| 1 | 12 | 1 | G85 | -0.501 | | | 0.992 | | | | | 0.948 |
| 1 | 12 | 2 | G85 | 6.215 | | | 0.675 | | | | | 0.676 |
| 2 | 21 | 1 | G89 | 5.869 | | | | | | 0.886 | | 0.898 |
| 2 | 22 | 1 | G70 | -0.514 | | | 1.546 | | | | | 0.827 |
| 2 | 22 | 2 | G70 | 12.668 | | | | | | | 0.851 | 0.938 |
| 3 | 31 | 1 | G80 | 4.948 | | 2.856 | | | | | 0.813 | 0.865 |
| 3 | 31 | 2 | G80 | 7.569 | | | | | | | 1.249 | 0.764 |
| 3 | 32 | 1 | G80 | 6.604 | | | | | | 0.559 | | 0.532 |
| 3 | 32 | 2 | G80 | -8.544 | 1.720 | | | 3.155 | | | | 0.860 |
| 4 | 41 | 1 | G83 | 2.728 | 0.908 | 2.459 | | | | | | 0.953 |
| 4 | 41 | 2 | G83 | -1.129 | 0.625 | | | 1.019 | | 0.253 | | 0.929 |
| 4 | 42 | 1 | G83 | 14.569 | | | | 4.499 | | | | 0.563 |

**Dependent Variable ( Open + Partially open + Large Green Bolls)**
**By Hills**

**July Visit:**
OBPOBLGB= 5.138 + 1.266 POB7 + 0.467 LGB7 + 0.448 SGB7 +0.497 SQ7

R = 0.735 Standard error of estimate = 6.451

**August Visit:**
OBPOBLGB= 3.681 +0.578 OB8 +1.561 POB8 -6.172 D86 + 0.712 LGB8
+ 0.191 SGB8 +2.017 BL8 +0.344 SQ8 + 3.408 D70
+ 1.329 D80
R = 0.741 Standard error of estimate = 7.855

**July and August visit:**
OBPOBLGB= 2.516 + 0.315 OB8 +1.457 POB8 +0.446 LGB8 + 1.626 POB7
+ 0.225 LGB7 + 0.296 SGB7 + 0.325 SQ7 – 3.602 D86

R = 0.821 Standard error of estimate = 5.551

# ANNEX G: INTERVIEWS AND VISITS TO GOVERNORATES

**Interviews And First Visits To Governorates**

July 20, 1999

1. **Dakahlia Governorate -** Mohamad El Sayed Abed – Head of Sampling Office
- Sampling office headquarters is in Mansoura. They have three sub-locations: Dikirness in the north supervises Manzala, Matoria, Meet Soweed and Dikirness.
- Sinbillawein in the south supervises Miet Gamr, Tomi El Amdid and Sinbillawein.
- Mansoura supervises Talka, Belkas, Sherbin, Aga and Mansoura.

The government has about 120 people working in it. They have 1 computer supplied by GTZ for their work.

**Table G-1: Number of Employees Dakahlia Sampling Office**

| Classes | Numbers | Education or Training |
|---|---|---|
| Agricultural Specialist 1 | 44 | B.S.C. |
| Agricultural Specialist 2 | 6 | B.S.C. |
| Agricultural Specialist 3 | 2 | B.S.C. |
| Agricultural Technician 1 | 18 | Agr Secondary School |
| Agricultural Technician 2 | 4 | Agr Secondary School |
| Agricultural Technician 3 | 3 | Agr Secondary School |
| Agricultural Technician 4 | 2 | Agr Secondary School |
| Administration | 9 | Commercial School |
| Laborers | 4 | N.A. |
| Drivers | 2 | N.A. |
| **Total** | **94** | |

Abdel Hamid Mochtar Shehatah engineer gave discussion of the **theoretical procedures** used to forecast the cotton crop.

Sample selection: All cotton fields are stratified based on the type of tube (or tile) drainage within the district. The optimum allocation determines the number of Crop-cutting samples needed in each stratum. The forecast plot samples were taken in 50% of the Crop-cutting samples but now only 5 experiments are done in each stratum.

Plot Location: First the crop-cutting unit is located in the field by measuring the designated distance along the edge and into the field. Measurement usually begins at the southwest corner of the field. The crop-cutting plot is nearly 3 X 3.5 meters. In the direction of the planted rows the length is exactly 3 meters. The perpendicular boundaries are as near to 3.5 meters as possible, being located in the bottom of the furrows. The corners of the crop-cutting plot are marked with wooden stakes at the corners with string stretched between the tops.

The forecast plot is located exactly 1 meter from the far corner of the crop-cutting plot. The forecast plot is exactly 1 X 3 meters and begins at the 1 meter mark regardless where it falls. It could be anywhere from the bottom to top of the furrow, even splitting the planted rows. Note that the rows can be perpendicular or parallel to the direction of the plot. Wooden sticks are placed at the four corners of the plot and string runs between the stakes. The beginning and ending plants in each row of the forecast plot are marked with colored tags that wrap around the plant stalks.

The following counts and measurements are taken during the last ten days of July, August and September plus a final harvest visit (usually October):

- Number of plants
- Large open bolls
- Damaged open bolls (infected bolls)
- Partially open bolls
- Large unopened bolls
- Small bolls
- Blooms
- Squares
- Pick and weigh up to 20 open bolls
- Send to laboratory, to dry and weigh

Each month the burrs from picked cotton and any damaged fruit are removed and carried away from the unit.

Beyond the forecast plot two rows are identified and marked. A Calculation Row on which the same counts as the forecast plot is taken. A Tag Row where fruit are tagged based on when they appear on the plant and their stage of development. In July large bolls are tagged with red tags and small bolls and blooms are tagged with yellow tags. White tags are placed on new fruit that appear in August and orange tags in September. Each month the maturity or disposition of the fruit is recorded. This information can be used to determine the survival of the fruit.

A recent modification is to lay the plot out along the planted row, being the width of a furrow and having a length of (3 meters/furrow width).

**Current Forecasting Procedures**

The actual procedures used now differ greatly from the above theoretical and have gone through several changes. The forecast plot is located in relation to a Crop-cutting plot as before, but has different dimensions. The plot runs parallel to the planted rows along the bottoms of the furrows. The *row width* usually includes plants along two tops. The length is (3 meters /row width). The only counts made within the unit are the number of large bolls and small bolls on one visit during the last 10 days of August. From 1991 to 1996 two monthly visits were made and in 1997 and 1998 only the August visit was made.

The reason for these procedure changes was lack of incentives, equipment, transportation and training. (In the 80's they received 30 LE/month which is like 300 LE now.) Also the sample size has been reduced from 50% of Crop-cutting samples to at least 5 samples per district. This usually consists of one sample per stratum and is usually from the first cluster of the stratum.

**Observations of Field Procedures**

District - Belkas, Village - Demillash, Hode - Al Behira, Cluster number 41. The field chosen for demonstration of procedures was the first planted field in the district. It was well advanced and in excellent condition. It has 22 cotton farmers, they selected for Crop-cutting field number 12 with six feddans and field number 19 with area of one feddan. Field 12 was chosen for the forecast plot belonging to Ahmed Mohamad. Since the field was 6 feddans it was divided into three possible sample fields. The third was selected for the forecast plot. The dimensions were taken and found to be 16 X 115 meters. A subjective set of coordinates were chosen for location of the Crop-cutting and forecast plot plots. The Crop-cutting plot was approximately 3 X 3.3 meters containing 5 rows. The forecast plot was 1 meter from the Crop-cutting and ran in the direction of the planted rows. The field had flat tops with two planted rows of cotton. Therefore, the forecast plot went from bottoms of the adjacent furrows. The width of plot was 1.15 and length was 2.6 meters making 3 square meters. Because the furrows were not parallel minor adjustments were needed in the placement of stakes to get the required area.

Counts were taken in the forecast plot:

| | |
|---|---|
| o Number of plants | 38 |
| o Number of large bolls | 11 |
| o Number of small bolls and blooms | 146 |
| o Number of squares | 345 |

The time spent in the field was about two hours with some specific completion times below:

| | |
|---|---|
| o Layout the plot | 35 minutes |
| o Number of large bolls | 10 minutes |
| o Number of small bolls and blooms | 18 minutes |
| o Squares | 12 minutes |
| | 75 minutes |

**Observations of Demonstrations**

Indicated a great need for training of the staff. Demonstrators seemed to be unsure of some of the procedures and work. Measurements to locate the plot were not taken precisely. Measurements were taken over the plants instead of near the ground. This made 5-10 cm differences in the measurement. Measured only three sides of the plot. No diagonal measurements of the plot were taken to check on correct crop area. Stakes were not exactly in the middle if the furrow bottoms and plot sides were not perpendicular.

Planting patterns differed from one field to another. Clear instructions need to be given to enumerators on how to layout the plots for each type. There were not written instructions, random table, or recording forms. There was not a diagram drawn of the field and sample plot locations. The only equipment that they used was the measuring tape and boll gauge. Each type of fruit was counted separately meaning that the plants had to be handled five times. While the researcher did try to separate the counted plant parts from the uncounted, there was still a little duplication of counted items.

One serious problem was walking and standing in the sample plots. This will break plant stems, knock off bolls and blooms, and disturb the growth and production of the plants in the unit. One might argue that if the unit is used only one time what difference does it make. Care should be taken in the field to minimize the damage to the crop. The farmer will not be happy if he finds his plants trampled and broken whether in the plot or outside. It is essential that if there is going to be more than one visit that the plants be permitted to grow and produce as nearly to the natural environment as possible.

The team did verify the Crop-cutting and forecast plot measurements and take the diagonal measurements. They found that two additional forecast plot plots were done in each district but the reason for this was never explained. District offices are frequently asked to gather data and submit it up the administrative chain without knowing why they are doing it or ever seeing that it is ever used. If the data taker knows why he is doing the work and the use to be made of the data, he might take pride in the work and do a better job.

July 21, 1999

**Dakahlia Governorate – Sampling Sub-Office – Dikernes District**

Siad Mohamad Zeid is in charge of this office which covers Dikernes, Manzela, Matera, and Meet Suwade districts. There are 12 engineers covering these districts. They have only 7 motorcycles. They rent a car for 15 days during the summer and winter seasons to fill the need to carry their staff to the field. The cost is 40 LE/day.

They do Crop-cutting for wheat, sugar beets, fava bean, onions, potatoes and canola during the winter season. During the summer they do Crop-cutting for cotton, maize, soybeans and rice.

Because the only cotton laboratory is in Assuit, they would like to set up a lab in their office. They have space and could serve as Lower Egypt's laboratory. The laboratories need to receive samples from other governorates, so communication by vehicle and telephone need to be good.

They have only irregular local telephone service. They need a car and telephone service that would permit communication with Governorate and National offices.

A prime example of lack of instruction and communication: They collected cotton forecast data for three months and picked the cotton to send to the lab. They had the summary sheets and cotton in the office because they were never asked to forward it up the administrative chain. What did the governorate and national offices use to make the forecast for these districts?

Dr Hamada Alle a new Ph.D. went through the theoretical procedure for forecasting. This was similar to that above. He did offer some interesting thoughts and observations on cotton procedures:

- He uses the calculation row as a check for comparison with tag row data. Children and/or farmers will sometimes pull tags off of the plants.
- The boll shape for some varieties changes as they mature or they dry. A boll may measure as large on one visit and small on a later visit.
- More than one visit is hard as farmers will sometimes pull the plants and/or tags.
- Irrigation will sometimes soak the sting around the plot. Need to have higher stakes.
- The experiments take effort.
- Picking of cotton in the plots without payment to the farmers.
- Lack of transportation. They have no cars at all. The four districts are far apart. Roads in rural areas are very narrow and rough.

- In August we can forecast, but July is too early to forecast.
- Date of planting affects the production.
- The previous crop affects the yield. Fava beans prior to cotton seems to improve the yield.
- Waiting to harvest wheat delays planting cotton. Some wheat varieties with shorter growing season are advantageous with cotton rotation.
- Interplanting onions with cotton can affect the yield. May need to consider this in sample selection or forecasting.
- Last year very hot weather reduced growth and maturation of cotton, and high humidity increased insect and disease attacks. A high percentage of large bolls did not open.

**General Observation**

Early planted cotton generally produces better than late planted. Late planted following berseem and beans gives better production than early planting after potatoes and wheat.

**Observation of Field Procedures** (Manzella district, Mershak village, cluster # 42)

The field had 8 feddans but had just been irrigated. Since this field was to be used for demonstration only, another field was chosen. Cluster numbers 18 and 43 were chosen in Hode Abdel Latiff Awai. The owner was Aziza Kaddeh and the field was 8 feddans. The field was divided into three parcels for sampling purposes. The dimensions of the field were 37 X 58 meters. The random numbers selected were 26 X 29. They used a cross staff and stakes to identify the plots. The Crop-cutting plot was 3.75 X 3.85 meters. The reason for use of this size plot was not known. No diagonal measurements were taken. The forecast plot was 0.8 X 3.75 meters. The diagonal was 3.93 meters.

All counts were made and recorded for each hill of cotton. This required researcher to handle the plant only once. Total counts in the forecast plot were:

- Number of plants 30
- Number of large bolls 26
- Number of small bolls 172
- Number of blooms and squares 331

The team later broke this count into blooms = 25 and squares = 306

The time spent in the field was about one hour and 32 minutes with some specific completion times below:

- Layout of Crop-cutting plot 45 minutes
- Layout the forecast plot 15 minutes
- All counts 32 minutes

The team verified measurements and two row counts.

Observations about demonstration plot – Measurements were initially taken above plants, but final measurements were done near the ground. Stakes had no points so were hard to put in ground and get to stay. Usual practice is to consider a canal to divide a cotton field if it is 1 meter or more wide. These fields were divided by only 0.5 meter canals. There were no written instruction or field forms to use. There were no boll gauges or counters used. The office did not have scales to weigh cotton. On the whole this demonstration showed more familiarity with the proper field procedures.

**Table G-2: Cotton Forecast - Variety, Area and Sample Size for Study Districts**

| Governorate | District | Variety | Area Feddans (000) | Forecast Sample Size |
|---|---|---|---|---|
| Beheira | Damanhour | G89 | 23017 | 8 |
| | Abu Homos | G70 | 34482 | 11 |
| | Rahmania | G88 | 1051 | 5 |
| Dakahlia | Belkas | G86 | 30187 | 6 |
| | Manzala | G85 | 20436 | 5 |
| Beni Suef | Wasta | G80 | 2480 | 7 |
| | Ahnassia | G80 | 5800 | 5 |
| Assuit | Abnoub | G83 | 4000 | 5 |
| | Abu Tig | G83 | 2159 | 5 |

## 2. Beheira Governorate

July 24, 1999

Anas Mohamad Shafei Omara – Head of Sampling Office

The Sampling office headquarters is in Damenhour with four sub-sampling offices:

- Damenhour – supervises Shafrakhit, Rohmania, Hosh Eisa, Mahmoudia, Delingat, and Damanhour.
- Kafr El Dowar – supervises Abou Homos, Gonaklis, Abu El Matmer and Kafr El Dowar.
- Kom Hamada – supervises Itay El Baroud and Kom Hamada.
- Edco – supervises Rashid and Edco.

**Table G-3: Number of Employees in Damanhour and Branch Statistical Bureaus**

| Type | Governorate | Kafr El Dawar | Damanhour | Kom Hamada | Edco | Total |
|---|---|---|---|---|---|---|
| First | 17 | 7 | 16 | 5 | 6 | 51 |
| Second | 1 | 4 | 1 | 1 | 2 | 9 |
| Third | 2 | 4 | 8 | 3 | 2 | 19 |
| Fourth | 2 | 3 | | 1 | | 6 |
| Fifth | 5 | | 1 | 1 | | 7 |
| Sixth | 1 | | | | | 1 |
| Contract | 6 | 1 | 11 | 2 | 1 | 21 |
| **Total** | **34** | **19** | **37** | **13** | **11** | **114** |

They make estimates of production for:

- Summer crops – Potatoes, Sunflower, Peanuts, Sesame, Maize, Cotton, Rice, and Soybeans.
- Winter crops – Potatoes, Canola, Millet, Onion, Fava Beans, Wheat, Sugarbeets, Tomatoes, and Garlic.
- Nil crops - Potatoes

**Current Procedures**

They started forecasting cotton in 1990. They have used 5 forecast plots per district making a total of 75 plots in 1998 and now 90 plots in 1999. They visit the plot only once in August. The plot is laid out along the planted row, being approximately 1 X 3 meters. The row width varies according to the hill and furrow width. If the distance between furrows of a hill is greater than 70 centimeters then one row is in the forecast plot unit. If the distance between furrows is less than 70 centimeters then two rows are included in the forecast plot.

After the data is collected, it is sent to Cairo. The Governorate office does not process the data. They pick up to 20 bolls of cotton per sample and send to Cairo for laboratory determinations in Assuit.

There are differences in growth and production in the north and south districts. Affects of weather and insects are often very different. For forecast they do not have any scales to weigh the small samples. For crop cutting their scales will weigh only 10 Kg to the nearest 10 grams. They do not work well.

The problems faced by field office are:

- No incentives or other compensation.
- No training in cotton forecasting – only some training in the field.
- Lack transportation – Have only two cars, but need three. They rent cars for the winter and summer season harvest periods. Shortage of fuel, maintenance and repair funds.
- The offices have 13 motorcycles and need 45 motorcycles to assist staff to do their work.
- No boll gauges
- No scales to weight cotton forecast samples.
- All work is manual because they do not have a computer.
- Workload and crop coverage is increasing creating a shortage of staff.

Mr Abdel Razek Hassan is on the Council for Cotton – He said that the last 10 days of August could give good yield indications. The large bolls are mostly set and weather and insects do not usually cause much damage after this time. From May to the end of July the cotton is affected by the cotton munn a small fly that attacks the small bolls. There is also a worm that eats the cotton leaves during this time. During the month of August the boll weevil attack the small bolls.

*Note: Our second visit should be preceded by training to data takers to recognize and count damaged bolls. These can usually be identified by seeing penetration marks on the sections of small bolls. The number of these infected (damaged) bolls can be used to estimate the amount of reduced production.*

**Observations of Field Procedures (Visit 1)**

July 24, 1999

District Rahmania, Village Semicrat, Hode Abu Nosair. The cotton area is small, only 1059 feddans, so clusters are not needed. The farmers are selected directly from a list of names. They took the first five names on the district list.

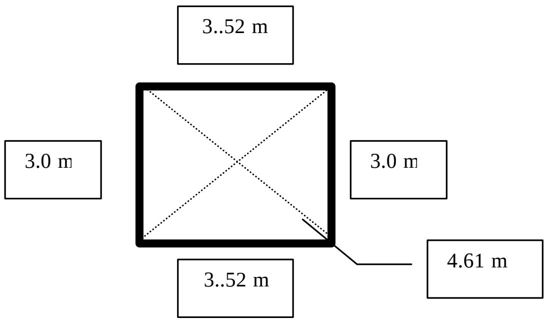
There were three persons from the village and sampling office working with us. Mr. Ibrahim Abd El Wahid Gibali is the Village head. Mr. Mohamad Abd El Fadil Zaid and Mr. Aiad Ali Abo Zid did the plot layout and counts.

The district has 18 samples for Crop-cutting and 5 for forecast plot. The new variety is Giza 88. The local staff is expecting 10 kentars/ feddan this year. Last year the district had Giza 70. Their yield averages 9 kentars per feddan. Their area had a good year last year due to good water supply.

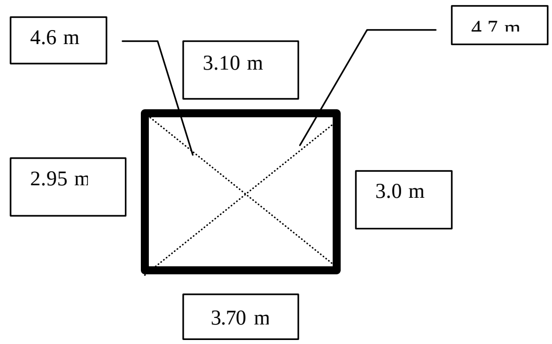
The farmer's name was Kmal El Din Mohamad El Wakil. The field was 1.5 feddans with dimensions of 32 X 200 meters. The rows running parallel to the 200 meter side. The random numbers chosen were 18 and 58.

## Crop Cutting Plot Measurements

Original Plot Lay-out

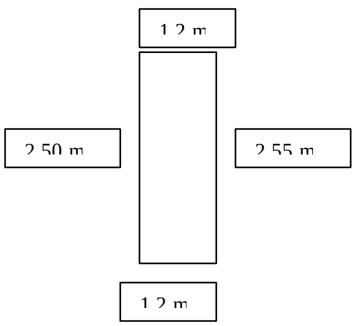



Re-measurement of Plot

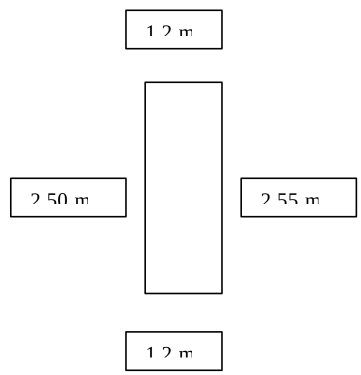



## Forecast Plot Measurements

Original Plot Lay-Out




Re-Measurement of Plot




Counts were taken in the forecast plot:

| | | |
|---|---|---|
| o | Number of plants | 24 |
| o | Number of large bolls | 105 |
| o | Number of medium bolls | 48 |
| o | Number of small bolls | 73 |
| o | Number of blooms | 30 |
| o | Number of squares | 119 |
| o | Damaged bolls | 3 |

Plants were very healthy. There is little sign of insect damage so far. Counts were made for the whole plot for each item. Did not use stakes to mark plot.

Motorcycles are more important than cars for sampling work because roads are narrow and run along narrow canals making it very difficult or impossible for a car to travel. Enumerators need hats and something hard to write on.

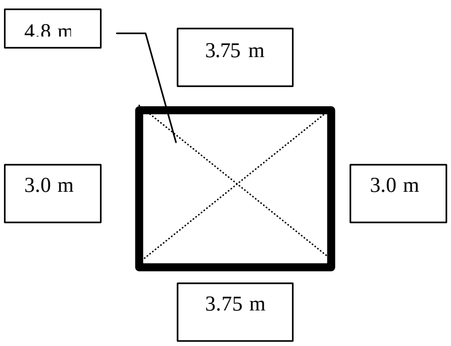
**Observations of Field Procedures (Visit 2)**

July 24, 1999

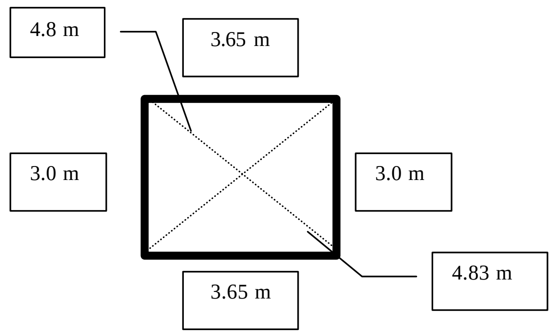
Beheira Governorate – Damanhour District, Village Sanhour, Hode Ganani Thalith, Cluster #64, Field #24. Farmer's name is Wadia Fahim Salib. Variety – Giza 89. Area of field 1 feddans 12 karats = 1.5 feddans of cotton with melons in one corner. Field dimensions are 84 meters by 40 meters. Random number is 51 X 30 Field is cultivated on masateb (flattened hills with two rows of plants along the sides). Average of 3-4 plants per hill.

**Crop Cutting Plot Dimensions**

Original Plot Measurements

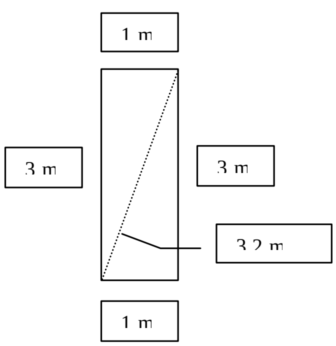



Team Re-Measurements

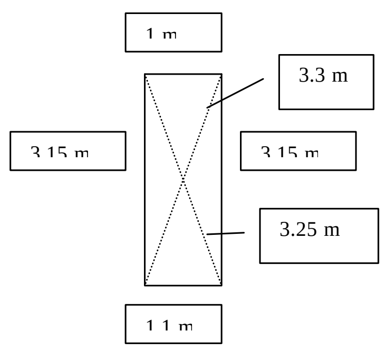



**Forecast Plot Measurements**

Original plot measurements




Team Re-measurements




Total counts in the forecast plot were:

| | |
|---|---|
| o Number of plants | 50 |
| o Number of large bolls | 51 |
| o Number of small bolls | 69 |
| o Number of blooms | 21 |
| o Number of squares | 192 |

The time spent in the field was 1.5 hours.

Observations about demonstration plot – Most leaves had insect damage by the cotton worm. They pulled some plants out of the forecast plot "because there were not supposed to be that many in the hill." We as researchers should not presume what the farmer meant to do and correct for it. We are to measure and report exactly what is in the research plot. Remember these plots are supposed to represent many other fields and whatever situation we find may be occurring in other fields in the governorate. If we correct the plot for what we think the situation is we may not discover real changes in cotton cultural practices.

Staff could greatly benefit from training on how to detect plant and boll infection of insects. The staff did not have enough stakes to lay out both the crop-cutting and forecast plots. They had to pull the stakes used to mark the crop-cutting and use them to lay out the forecast plot.

Sampling Office Staff doing the work:
Mohamad Abraham Hassan
Ali Mohamad Benna
Dr. Abraham Said Fahmi

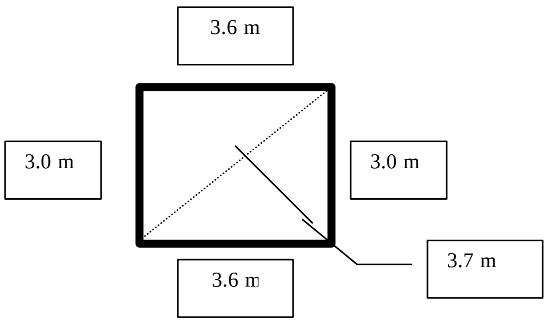
**Observations of Field Procedures (Visit 3)**

July25, 1999

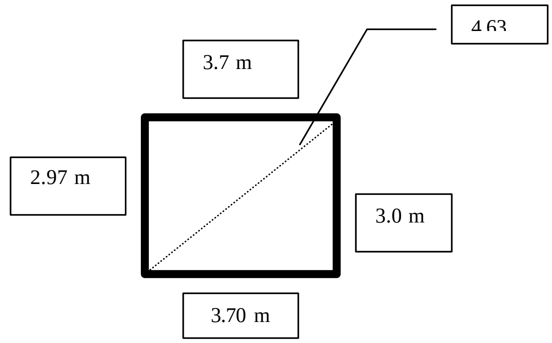
District – Abo Homus
Village - Besentway
Hode – El Remal
Cluster number 19
Selected parcel number - 3
Area – 4 feddans – Six fields – selected field 2
Dimensions of sample field – 42 meters by 30 meters
Random numbers – 14 X 5
Farmers name Sudke Ahmed Morsey
Variety – Giza 70

**Crop Cutting Plot Measurements**

Original Plot Lay-out

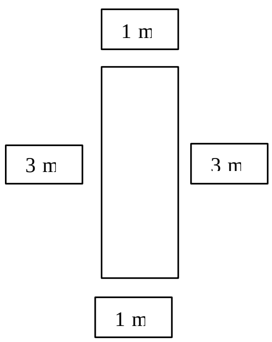



Re-measurement of Plot

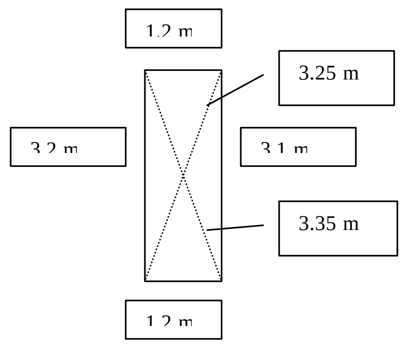



**Forecast Plot Measurements**

Original Plot Measurements




Team Re-Measurements




Total counts in the forecast plot were:

| | |
|---|---|
| o Number of plants | 15 |
| o Number of large bolls | 50 |
| o Number of small bolls | 93 |
| o Number of blooms | 34 |
| o Number of squares | 240 |

There were three persons from the sampling office of Kafr El Dawar working with us. Mr. Adel Mohamad Srour, Damarani Mahmoud Hussain and Minem El Said Hassain.

Field Observation – Location of plot was not from bottoms of rows and between hills. They expect the yield to be 7.5 – 8 Kentars per feddan

Time to count by hill and plant – Row one took 20 minutes and row two 15 minutes.

## 3. Beni Suef Governorate

July 27, 1999

Ibrahim Roctabehe Haroon– Head of Sampling Office. He will write details on the governorate and give to us later.

Sampling office headquarters is in Beni Suef. There are ---- sub-sampling offices ---. Our research locations are ----. The governorate has -- people working in it.

In1998 they had 43,878 feddans of cotton and a yield of 5.04 Kentars per feddan. In 1999 they have Giza 80 variety. Area is 26,877 feddans in Governorate.

| **District** | **Feddans** | **Crop cutting plots** |
|---|---|---|
| El Wasta | 2480 | 22 |
| Bush | 3908 | 30 |
| Beni Suef | 4365 | 32 |
| Ahnassia | 5871 | 40 |
| Beba | 3113 | 22 |
| Samasta | 2000 | 16 |
| Fashn | 5140 | 38 |
| | 26,877 | 200 |

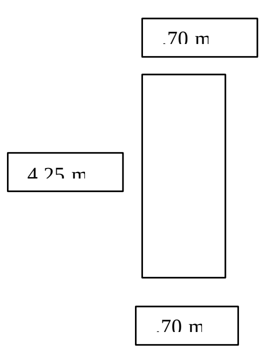
**Observations of Field Procedures (Visit 1)**

July 27, 1999

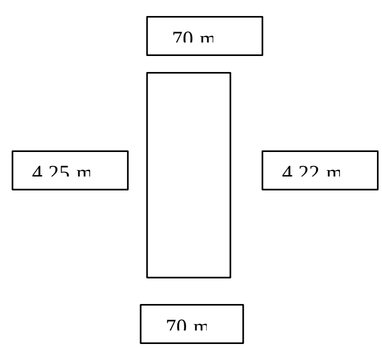
Governorate – Beni Suef
District – Ahnassea
Village – El Omara
Hode – El Asharat
Stratum - A92
Cluster number 18
Farmers name – Ibrahim Abdel Mageed Khallil
(Selected from the 23 farmers in the cluster.)
Field is 1 feddan with dimension 159.5 meters X 23 meters.
Date of planting – April 18, 1999
Random number – 90 X 14
Variety – Giza 80

**Forecast Plot Measurements**

Original Plot Measurements




Team Re-Measurement



Their Total counts in the forecast plot were:

- Number of plants 33
- Number of large bolls 47
- Number of small bolls 135
- Number of blooms 39
- Number of squares 234
- Number of Infected bolls 1
- Total number of bolls 182

They laid out the plots the day before and the team checked them. There was only one row of plants in forecast plot. Six limbs were broken. The measurements and location were determined from the NE corner of field instead of the southwest.

The counting by the team took from 1:45 until 2:35 or 50 minutes.

The district people working with us, Mr. Sayed Kamel Mohamad and Saber Abdel Monem.

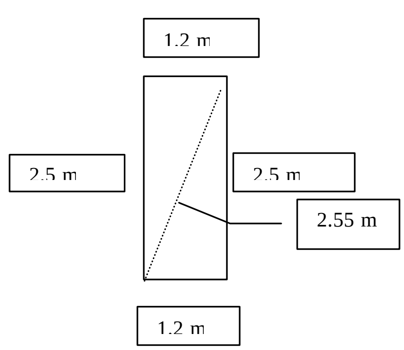
**Observations of Field Procedures (Visit 2)**

July 27, 1999

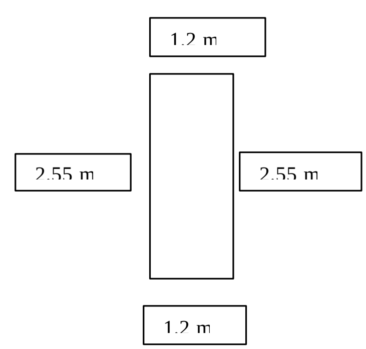
Governorate – Beni Suef
District – Ahnassia
Village – Kafr Abu Shahba
Hode – Nina
Stratum - 82
Cluster number 11
Farmer's name – Mabroka Mohamad Abdel El Gowaad
Field number 4
Field is 1 feddan non-rectangular with dimensions 37 X 115 X 40 X 110.
Random numbers – 20 X 14
Variety – Giza 80

**Forecast Plot Measurements**

Original Plot Measurements




Team Re-Measurement



They laid out the plots the day before and the team checked them. There were two rows on mastaba in forecast plot.  Beans were grown before the cotton. Tomatoes were grown with the cotton.

The counting took from 4:55 until 5:43 or 48 minutes. First row took 15 minutes and second row 31 minutes. The district people working with us.  Mr. Mostafa Taha and Magdi Ahmed Tawfik.

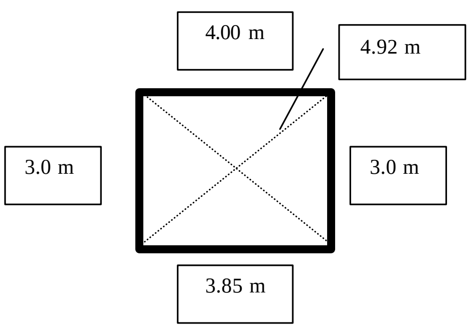
**Observations of Field Procedures (Visit 3)**

July 28, 1999

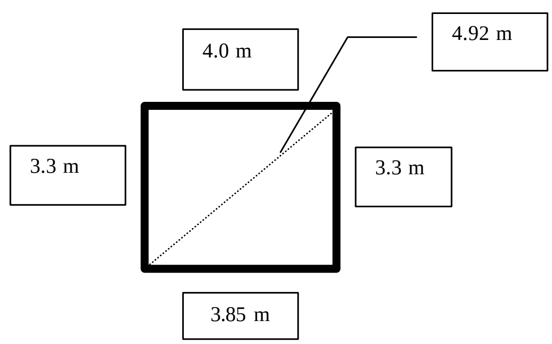
Governorate – Beni Suef
District – El Wasta
Hode – El Morstaral El Garbe
Stratum – 86
Cluster – 3    Parcel - 19
Village – Kimen El Aroosa
Farmer Name – Mohamad Senoosi Said
Field area – 12 Karats = 0.5 Feddans
Field dimensions – 134 meters X 24 meters. Crop cutting plot has 6 rows.  Forecast plot has 2 rows.
Random number – 108 X 0

**Crop Cutting Plot Measurements**

Original Plot Lay-out



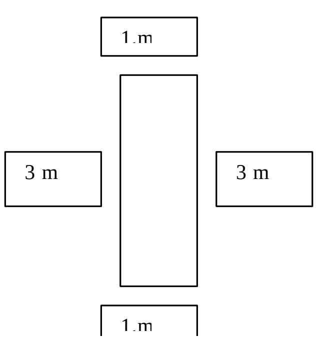

Re-measurement of Plot



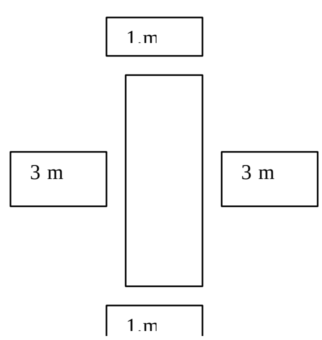

6 rows in plot

**Forecast Plot Measurements**

Original Forecast Plot




Team Re-Measurement



Time to count the forecast plot:
- First Row 20 minutes
- Second Row 15 minutes

Counters:
- First Row Mohamad Abdel El Mohimen
- Second Row Louis Wahabe Bolis

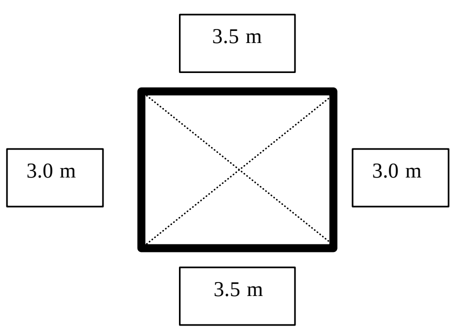
**Observations of Field Procedures (Visit 4)**

July 25, 1999 Staff counts
July 28, 1999 – Team Counts

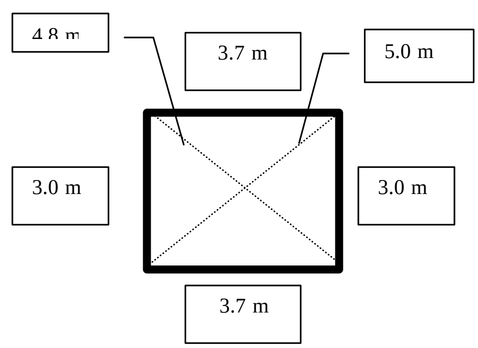
Governorate – Beni Suef
District – El Wasta
Village – Manashy Abo Syr
Hode – El Hager El Westani
Stratum - B
Cluster – 14
Farmer's Name –Mahmoud Mohamad Abdel Kareem
Field – 1 ; Area 5 feddans
Field Dimension – 400 meters by 51 meters. Located on canal with sunflowers on opposite side, Maize on one side, and tomatoes and maize on the other side.
Random Number – 132 X 7
Variety – Giza 80

**Crop Cutting Plot Measurements**

Crop Cutting Plot Dimensions



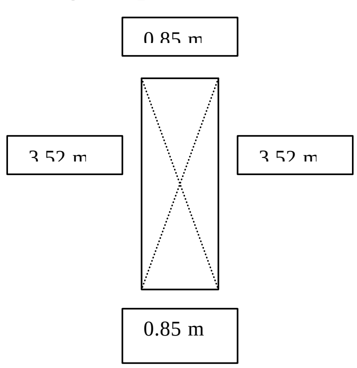

Re-Measurement Plot



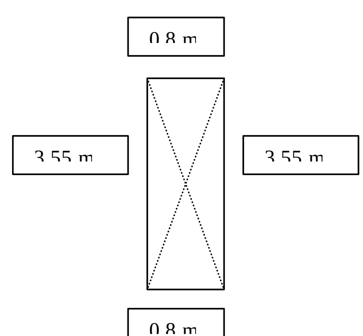

Five Rows

**Forecast Plot Measurements**

Original plot measurements




Team Re-measurements




One Row

Their Total counts in the forecast plot were:

| | |
|---|---|
| o Number of Hills | 10 |
| o Number of plants | 19 |
| o Number of large bolls | 141 |
| o Number of small bolls | 88 |
| o Number of blooms | 27 |
| o Number of squares | 105 |

The time spent in the field was two hours, one to measure field and layout plot and one to count the fruit.

Observations in field:
Forecast plot was laid out parallel to crop cutting plot. There does not seem to be any consistent way that forecast plots relate to the crop cutting plots. They expected this field to yield about 8 kentars/feddan.

Staff doing the work:
Mohamed A. Abdel-Napy, Louis Wahba Bolis

## 4. Assuit Governorate

July 27, 1999

Abd El Fattah Abd Allah Marey – Head of Agriculture Department and Yasen Mohamad – Head of Pesticide Section.

Area of cotton in district is 2,190 feddans in 1999. In 1998 it was 3,000 feddans. He expects next year will be about 5,000 feddans. Yield in 1998 was 7.78 Kentars/feddans. He expects yield to be 10 Kentars for 1999.

Cotton cultivation and planting is done 40% in March, 45% in April, and 15% later. The later plantings run a higher risk of insect and disease.

Mr. Dawod, Head of the sampling office in Assuit said prior to 1991 they were doing experiments to calculate loses. If they were to return to three forecast visits, then visits should begin early especially in districts like Abnoub. They are sometimes required to change sample fields due to circumstances like security considerations or mandates from the central sampling office in Cairo. The reason stated for selecting the first farm in the district was a "theoretical basis". Mr. Ismail Moh. Ismail engineer of regional sampling in south upper Egypt said we must change this theoretical base of selection.

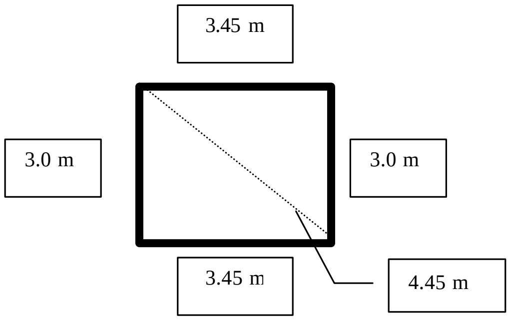
**Observations of Field Procedures (Visit 1)**

July 31, 1999

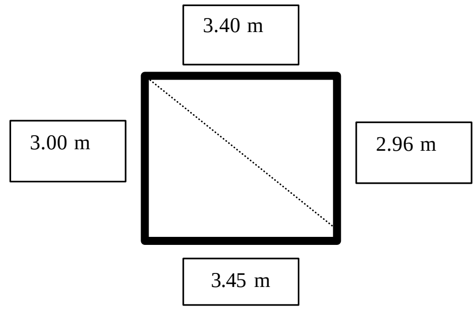
Governorate – Assuit
District – Abu-Tig
Village – Abu-Tig
Hode – Alema Bahary
Cluster number 10
Farmer's name – Azab Hamed Azab
Field is 1.5 feddans, planted March10, 1999. Dimension is 210 X 30 meters
Date of planting – March 10, 1999
Random number – 72 X 24
Variety – Giza 83

**Crop Cutting Plot Measurements**

Original Plot Lay-out



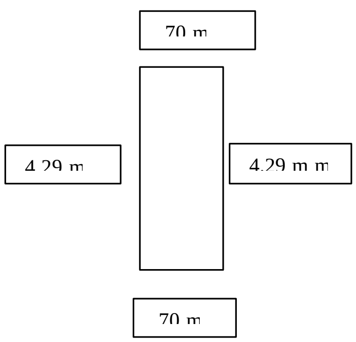

Re-measurement of Plot



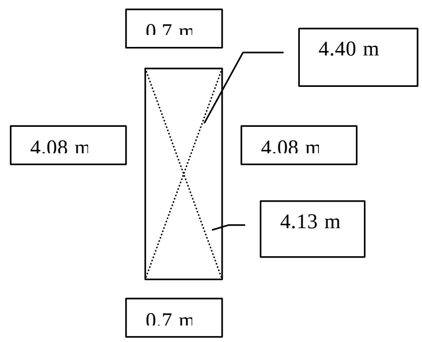

5 rows in plot

**Forecast Plot Measurements**

Original Plot Measurements




Team Re-Measurement




Plot location was in the edge of button not middle bottom (20 cm difference). They used 2.5 cm boll gauges instead of 2.25. About 80 % of small bolls should be considered large bolls. They did not pick 20 open bolls until reminded to do so.

The district people working with us. Mr. Kamal Sied Amer head of sampling branch at Sedfa and Amer Hassen Aly staff of district

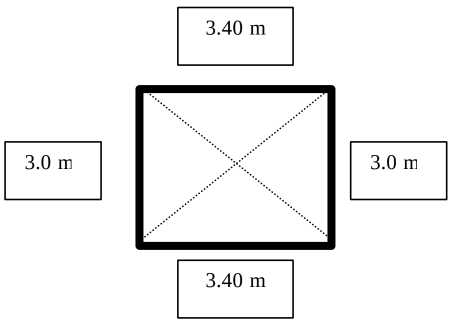
**Observations of Field Procedures (Visit 2)**

July 31, 1999

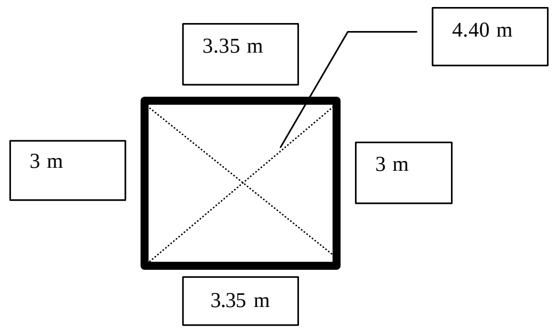
Governorate – Assuit
District – Abu-Tig
Village – Abu-Tig
Cluster number – 10
Parcel number -9
Hode – Alema Bahary
Farmer’s name – Zin El Abidin Sarhan
Field number 4
Planted - March 3, 1999
Previous crop - Onions
Field is 1.5 feddan with dimension 276 X 23.
Random numbers – 33 X 0
Variety – Giza 83

## Crop Cutting Plot Measurements

Original Plot Lay-out



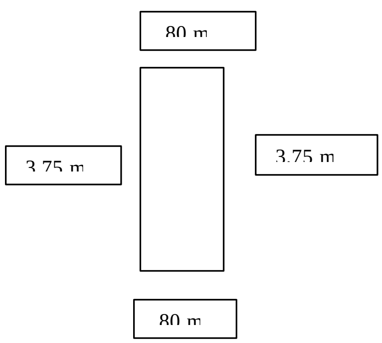

Re-measurement of Plot



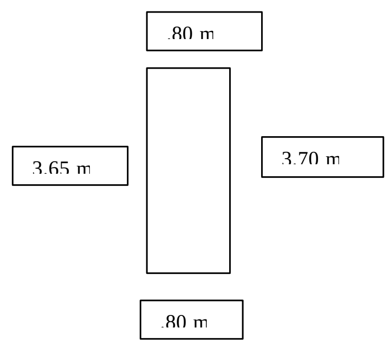

Five rows

## Forecast Plot Measurements

Original Plot Measurements




Team Re-Measurement




They measured only two dimensions instead of all four and need to be more careful of boundaries. If random number is 0 then plot location needs to be middle of the field border not first row.

The district people working with us. Mr. Kamal Sied Amer Head of south branch of Sedfa, Amer Hossin Aly staff of district sampling staff office.

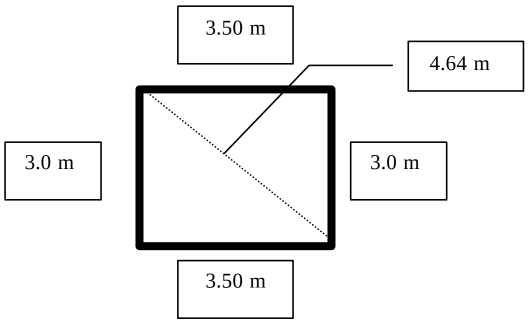
**Observations of Field Procedures (Visit 3)**

August 1, 1999

Governorate – Assuit
District – Abnoub
Hode –
Stratum – B
Cluster – --- Parcel - --
Village – Swalem Abnoub
Farmer Name – Baghdadi Ahmed
Field area – 11 Kerats = approximately 0.5 Feddans
Field Dimensions – 170 meters X 11 meters.
Random number – 154 X 2
Variety – 83

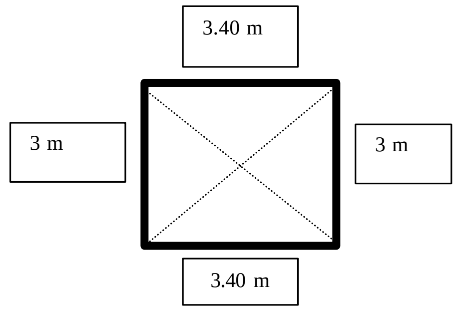
## Crop Cutting Plot Measurements

Original Plot Lay-out




Six Rows

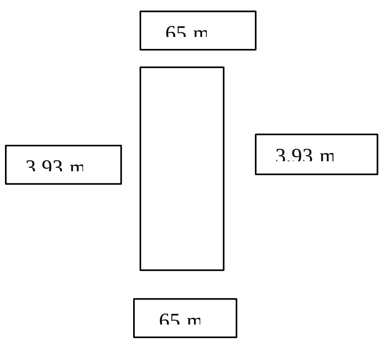
Re-measurement of Plot



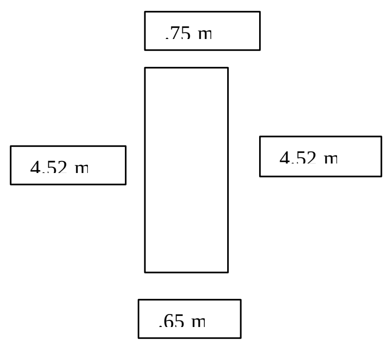

Five Rows

## Forecast Plot Measurements

Adjusted Plot Measurements




Team Re-Measurement




Original crop cutting plot did not start from between hills but on hills. This included 6 rows of cotton instead of the 5 that were supposed to be within the plot. This would have caused an over estimation in production of about 20%.

They are expecting a yield of 6.5 – 7 kentars per feddan.

Staff suggested locating forecasting plots during early May when plants are short. Laying out plot would be simpler and less crop damage would occur. This would work well if farmer would leave the stakes and string in the field.

**Observations of field procedures – Visit 4**

August 1, 1999

Governorate – Assuit
District – Abnoub
Village – Swalem Abnoub
Hode –
Stratum - B
Cluster –
Farmer's Name – Mahmoud Ibrahim Khahl
Field Area 12 karats = 0.5 feddans
Field Dimension – 95 meters by 20 meters.

Random Number – 75 X 1
Variety – Giza 83
Previous crop
Date of Planting
Last years average yield

Plot had been irrigated recently and we could not go in and count. The crop-cutting plot was stated to be 3 X 3.5 meters and the forecast as 1 X 3. The forecast plot contained one row of plants with 18 hills and 43 plants.

Their Total counts in the forecast plot were:

| | | |
|---|---|---|
| o | Number of plants | 43 |
| o | Bolls damaged during work | 7 |
| o | Open bolls | 10 |
| o | Partially open bolls | 2 |
| o | Number of large bolls | 271 |
| o | Number of small bolls | 33 |
| o | Number of squares | 22 |
| o | Total bolls | 424 |

# ANNEX H: FINDINGS AND RESULTS OF GOVERNORATE SAMPLING OFFICES INVESTIGATION

## Table H-1: Partial List of People Visited

| DATE | PERSON VISITED |
|---|---|
| 7/20/1999 | **Dakahlia Governorate -** Mohamad El Sayed Abed – Head of Sampling Office |
| | Abdel Hamid Mokhtar Shehatah engineer gave discussion of the **theoretical procedures** used to |
| 7/21/1999 | **Dakahlia Governorate – Sampling Sub-Office – Dikernes District** Siad Mohamad Zeid is in charge of this office. |
| | Dr Hamada Alle a new Phd went through the theoretical procedure for forecasting. |
| | Farmers names – Mohamed M. Soliman, El Sayed I. El Nahla, Ahmed Badawi Sharshira, Aziza El Kasaby Kaddah, Awada Awad Gadallah, Zaghlol A. Riad, Ramadan H. El Naggar, Qadi'a Fahim Salib, Kamal El Din El Wakil; |
| 7/24/1999 | **Beheira Governorate-**Anas Mohamad Shafei Omara – Head of Sampling Office |
| | There were three persons from the village and sampling office working with us. Mr. Ibrahim Abd El Wahid Gibali is the Village head. Mr. Mohamad Abd El Fadil Zaid and Mr. Aiad Ali Abo Zid did the plot layout and counts. |
| | The farmers name was Kmal El Din Mohamad El Wakil.; Nabila Mohamed El Wakil; Sayed Ali Ismail; Badawia Abu Younis |
| | Farmer's name is Wadia Fahum Salib; Shehata Ibrahim Siam; Ramadan Hamed El Naggar; Mostafa Abdel Khalek Atwa. |
| | Sampling Office Staff doing the work: Mohamad Abraham Hassan, Ali Mohamad Benna, Dr. Abraham Said Fahmi |
| | Farmers name Sudke Ahmed Morsey |
| | There were three persons from the sampling office of Kafr El Dowar working with us. Mr. Adel Mohamad Srour, Damarani Mahmoud Hussain and Minem El Said Hassain. |
| 7/27/1999 | **Kamal Abd Zaher – Vice Minister in Beni Suef** |
| 7/27/1999 | **Beni Suef Governorate-**Ibrahim Roctabehe Haroon– Head of Sampling Office. |
| | Farmers name – Ibrahim Abdel Mageed Khallel |
| | Farmer's name – Mabroka Mohamad Abdel El Gowaad |
| | The district people working with us. Mr. Mostafa Taha and Magdi Ahmed Tawfik. |
| | Farmer Name – Mohamad Senoosi Said |
| | Counters: First Row – Mohamad Abdel El Mohimen; Second Row – Louis Wahabe Bolis |
| | Farmer's Name –Mahmoud Mohamad Abdel Kareem; Rezk Abdallah Zoheir; Magdi Sayed Abdel Aleem; |
| | Staff doing the work: Mohamed A. Abdel-Napy, Louis Wahba Bolis |
| 7/27/1999 | **Assuit Governorate-**Abd El Fattah Abd Allah Marey – Head of Agriculture Department and Yasen Mohamad – Head of Pesticide Section. |
| | Mr. Dawod, Head of the sampling office in Assuit |
| | Farmer's name – Azab Hamed Azab |
| | The district people working with us. Mr. Kamal Sied Amer head of sampling branch at Sedfa and Amer Hassen Aly staff of district |

| | |
|---|---|
| 7/31/1999 | Farmer's name – Zin El Abidin Sarhan |
| | The district people working with us. Mr. Kamal Sied Amer Head of south branch of Sedfa, Amer Hossin Aly staff of district sampling staff office. |
| 8/1/1999 | Farmer Name – Baghdadi Ahmed |
| | Farmer's Name – Mahmoud Ibrahim Khahl; Eid Helmi Gad El Hakk; Eid Mohamed Abdallah; Ibrahim Hussein Abdel Hafiz; Nashaat Sadek Ahmed Ali; Soliman Abdel Zaher Badawi; Gamal Abdel Rahim; Fawzia Mosaad Ibrahim; |
| 7/19/1999 | Dr Ismail Gamal El Din – Director of Current Statistics in EAS, MALR |
| | Mohamad Abass, Current Statistics of EAS, MALR |
| | Abdel Razek Hassan, Director of General Department of Planning Also on Council for Cotton |
| | Said El Aggaty – Current Statistics EAS, MALR |

Nine Sample Office Personnel
Six Ministry Officials
Seventeen Field People
35 Farmers

## Sampling Office Activities
## Dakahlia Governorate

Several visits have been made to Dakahlia governorate sampling office since 20th of July 1999 to answer many questions about forecasting, crop cutting and other activities that are their responsibility.

### Governorate Level

### A: Administrative Information

#### *1) Brief Description*

Dakahlia Governorate is one of the eastern Delta governorates in Lower Egypt. The Mediterranean Sea surrounds it from the north, Qalubia governorate from the south, Damietta, Port Said, and Sharkia governorates from the east, and Kafr El Sheikh and Gharbia form the west.

It consists of 13 districts, total area is about 811,000 feddans. Only about 645,000 feddans is cultivated. The main activity is agriculture especially field crops. Table (7) shows the area cultivated of main crops in the governorate.

#### *2) Sampling Office, Branches, Responsibilities*

Table (2) shows number of employees at the main office and branches. The total is 102 employees; 60 in the main office, 25 in Sinbelaween branch and 17 in Dekernes branch. Most of them in the first class (about 60%) inverse peramid affect current work. We have to train new employees.

**Table H-2: Number of Employees in the Sampling Offices**
**Dakahlia Governorate, 1999**

| Class | Main Office | | Branches | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Hafir Shehab El Din | | Sinbelaween | | Dekernes | | | |
| | | % | No. | % | No. | % | No. | % | No. | % |
| 1st | 42 | 42 | - | - | 10 | 10 | 10 | 10 | 62 | 62 |
| 2nd | 7 | 7 | - | - | 3 | 3 | 1 | 1 | 11 | 11 |
| 3rd | 6 | 6 | - | - | 5 | 5 | 4 | 4 | 15 | 15 |
| 4th | 3 | 3 | - | - | 1 | 1 | - | - | 4 | 4 |
| 5th | - | - | - | - | 2 | 2 | 1 | 1 | 3 | 3 |
| 6th | - | - | - | - | - | - | - | - | - | |
| Contracts | 2 | 2 | - | - | 4 | 4 | 1 | 1 | 7 | 7 |
| **Total** | **60** | **60** | **-** | **-** | **25** | **25** | **17** | **17** | **102** | **100** |

*3) Internal and External Training, Especially on Forecasting*

**Table H-3: Number of Employees Trained on Forecasting in Dakahlia Governorate and the Future Requirements**

| Past Period (1984-1999) | | Future Requirement | |
|---|---|---|---|
| Internal Training | External Training | Internal Training | External Training |
| 24 | 1* | 40 | 10 |

* Trained for one month in USDA. Retired after one month but he will cooperate.

Table (3) shows that only one of the employees has had external training on forecasting at USDA for one month. About 24 have had local field training. No training courses have been held in the governorate. Applied training courses are needed for forecasting.

*4) Available Means of Transportation*

Table (4) shows that Dakahlia governorate has only 2 cars; one in the main office and the second one is in Sinbelaween branch. They need two more vehicles. They have 25 motorcycles; 10 are in the main office, 6 in Sinbelaween branch, 7 in Belkas branch and 2 belongs to Hafer Shehab El Din branch office. The total need is 30 motorcycles. Now they rent cars for about 15 days in summer season and another 15 days in winter season.

**Table H-4: Owned Means of Transportation in Dakahlia Governorate, 1999**

| Item | Main Office | Branches | | | Total | Future Require -ment* |
|---|---|---|---|---|---|---|
| | | Hafir Shehab El Din | Sinbelaween | Dekernes | | |
| | No. | No. | No. | No. | No. | |
| **Cars** | 1 | - | 1 | - | 2 | 4 |
| **Motorcycle** | 10 | 2 | 6 | 7 | 25 | 30 |

*Future requirements in addition to repair or replacement of current means of transportation.

**Table H-5: Rented Cars in Dakahlia Governorate during Season of Work**

| Winter 1999 | | Summer 1998 | | Total Days | | Future Requirements |
|---|---|---|---|---|---|---|
| # Days | LE/Day | # Days | LE/Day | # Days | LE/Day | |
| 15 | 40 | 15 | 40 | 30 | 40 | - |

### *5) Equipment*

Table (6) shows the number of equipment used for both forecasting and crop cutting.

**Table H-6: Equipment Used for Forecasting and Harvesting Experiments**

| Crop Cutting Equipment | | | | Forecast Equipment | | | |
|---|---|---|---|---|---|---|---|
| Type | Present Status | | Future Require | Type | Present Status | | Future Require |
| | No. | Suitability | | | No. | Suitability | |
| **Bags** | | | | **Counter** | 1 | Good | 25 |
| **Measuring tape 20m** | 50 | 40 good<br>10 defected | 15 | **Gauge** | 1 | Good | 25 |
| **Steel Yard Scales** | 36 | 26 good<br>10 defected | 12 | **Steel tape 15m** | - | - | 20 |
| | | | | **Stakes** | - | - | 100 |
| | | | | **Spring balance** | 1 | Good | 15 |
| | | | | **Tags** | Some | | |

Most of this equipment must be replaced or developed.

## B: Technical Questions

### *1) Main Crops for Crop Cutting Forecasting*

Table (7) shows number of experiments for winter crops (1216) and summer crops (1352) conducted by crop cutting techniques in Dakahlia governorate. The staff has to conduct about 2500 cc experiments per year in addition to cotton forecasting sample plots.

**Table H-7: Area of Crop Cutting Crops in Dakahlia Governorate, 1999**

| Winter Crops | | | Summer Crops | | |
|---|---|---|---|---|---|
| **Crop** | **Area /Feddan** | **# Experiment** | **Crop** | **Area /Feddan** | **# Experiment** |
| **Wheat (gen.)** | 230747 | 460 | **Cotton** | 97081 | 340 |
| **Wheat (Special surveys)** | 4600 | 104 | **Paddy (rice)** | 421260 | 519 |
| **Wheat (new lands)** | 5000 | 8 | **Maize** | 64175 | 220 |
| **Kanola** | 70 | 5 | **Maize (special)** | | 123 |
| **Favabeans** | 69423 | 160 | **Maize (exten.)** | | 204 |
| **Favabeans (special)** | 30 | 30 | **Potato** | 7332 | 130 |
| **Barely** | 195 | 5 | **Sunflower** | 307 | 12 |
| **Lentils** | 61 | 6 | **Soybeans** | 25 | 4 |
| **Single onion** | 4142 | 32 | | | |
| **Interplanted onion** | 1731 | 40 | | | |
| **Potato** | 7021 | 86 | | | |
| **Potato (nili)** | 4158 | 82 | | | |
| **Sugar beat** | 27630 | 198 | | | |
| **Total** | **354808** | **1216** | | **590180** | **1352** |

Total area of winter crops is about 355,000 feddans and for summer crops is about 590,000 feddans.

For cotton forecasting, Mr. Abdel Hamid Mokhtar mentioned that they had started forecasting since 1985 for cotton crop using the original method with three visits (July, August and September) and he explained the procedures used. Also he mentioned that they used the adjusted method since 1991 with August visit only. Table (8) shows the years of cotton forecasting.

**Table H-8: Years of Forecasting in Dakahlia Governorate**

| **Crop** | **Forecasting Years** | **Period** |
|---|---|---|
| **Cotton** | 15 | 1985-1999 |
| **Wheat** | - | |
| **Rice** | - | |
| **Maize** | - | |
| **Others** | - | |

### *2) Sample Design for Cotton and Forecasting*

Table (9) demonstrates area under cotton (97081 feddan), varieties (G 85, and G 86), districts (13), strata (39), and sample size (340 plot for CC and 62 plot for FS). Sample allocation, proportional allocation (supposed) due to cotton area for crop cutting (CC) and five sample plot within each district for forecasting, minimum one for each stratum (because lack of budget).

**Table H-9: Sample Design for Crop Cutting and Forecasting Estimation of Cotton in Dakahlia, 1999**

| District | Variety | Strata | Area | Crop Cutting # Clusters | Crop Cutting # Exprmnt. | Forecasting Experiment |
|---|---|---|---|---|---|---|
| **Aga** | G 85 | M.A.A | 4479 | 9 | 18 | 5 |
| | | B | - | - | - | - |
| **Total** | | | **4479** | **9** | **18** | **5** |
| **Belkas** | G 86 | A/86 | 39 | 2 | 4 | 1 |
| | | Belkas | 3368 | 4 | 8 | 2 |
| | | Gebran | 3522 | 4 | 8 | 1 |
| | | El Satamoni | 6606 | 7 | 14 | 1 |
| | | Al Maasara | 5969 | 6 | 12 | 1 |
| | | Al Hafir | 10344 | Direct | 24 | - |
| | | Al Remal | 339 | Direct | 4 | - |
| **Total** | | | **30187** | | **74** | **6** |
| **Dekernes** | G 85 | A/92 | - | - | - | - |
| | | B | 989 | 4 | 8 | 5 |
| **Total** | | | **989** | **4** | **8** | **5** |
| **Mit Swid** | G 85 | A/87 | 769 | 2 | 4 | 1 |
| | | A/93 | 2548 | 6 | 12 | 2 |
| | | B | 5246 | 11 | 22 | 2 |
| **Total** | | | **8563** | **19** | **38** | **5** |
| **Sinbelaween** | G85 | M.A.A | 2822 | 5 | 10 | 2 |
| | | A/80 | 577 | Direct | 4 | 2 |
| | | A/82 | 303 | 2 | 4 | 1 |
| **Total** | | | **3702** | | **18** | **5** |
| **Temi Amdid** | G 85 | M.A.A | 1344 | 3 | 6 | 1 |
| | | A/82 | 293 | 2 | 4 | 1 |
| | | A/83 | 227 | 2 | 4 | 1 |
| | | A/92 | 58 | 1 | 2 | - |
| | | AK | 208 | 2 | 4 | 1 |
| | | B | 146 | 1 | 2 | 1 |
| **Total** | | | **2276** | **11** | **22** | **5** |
| **Sherbin** | G 86 | A/86 | 2 | 1 | 2 | 1 |
| | | A/95 | 199 | 2 | 4 | 1 |
| | | Sherbin | 5294 | 7 | 14 | 2 |
| | | Ras Khalig | 4256 | 6 | 12 | 1 |
| **Total** | | | **9751** | **16** | **32** | **5** |
| **Talkha** | G 86 | A/81 | 39 | Direct | 4 | - |
| | | A/83 | | | | - |
| | | A/86 | 414 | 2 | 4 | - |
| | | 96/97 | 1394 | 2 | 4 | 1 |
| | | 97/98 | 429 | 2 | 4 | 1 |
| | | M El Ghreka A | 697 | 2 | 4 | 1 |
| | | Talkha B | 2398 | 2 | 4 | 1 |
| | | M El Ghreka B | 3962 | 3 | 4 | 1 |
| **Total** | | | **9333** | | **30** | **5** |

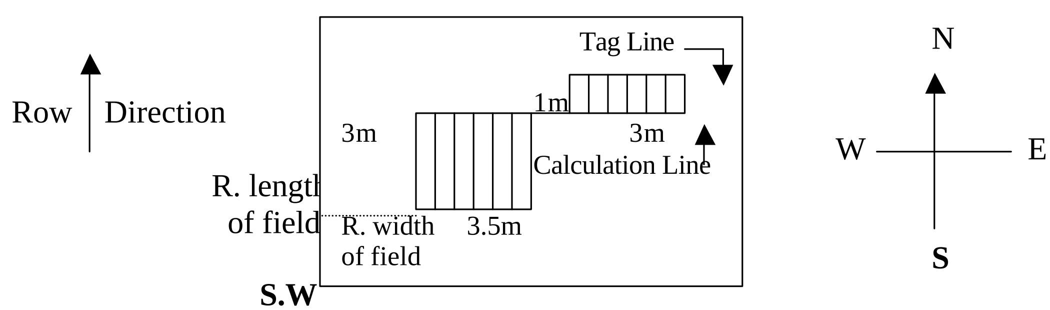
| District | Variety | Strata | Area | Crop Cutting | | Forecasting Experiment |
|---|---|---|---|---|---|---|
| | | | | # Clusters | # Exprmnt. | |
| **Manzala** | G 85 | A/92 | 154 | Direct | 4 | 1 |
| | | Manzala | 5927 | 7 | 14 | 2 |
| | | Gamalia | 9737 | 13 | 26 | 3 |
| | | El Gesr El Waki | 4618 | Direct | 12 | - |
| **Total** | | | **20436** | | **56** | **6** |
| **Mansoura** | G 85 | M.A.A | 919 | Direct | 4 | 2 |
| | | A/82 | - | - | - | - |
| | | A/83 | 243 | Direct | 4 | 1 |
| | | B | 790 | Direct | 4 | 2 |
| **Total** | | | **1952** | **-** | **12** | **5** |
| **Mit Ghamer** | G 85 | M.A.A | 304 | 2 | 4 | 2 |
| | | A/82 | 58 | Direct | 4 | 1 |
| | | B | 1090 | 2 | 4 | 2 |
| **Total** | | | **1452** | | **12** | **5** |
| **Mit El Nasr** | G 85 | M. El Nasr | 1190 | 4 | 8 | 2 |
| | | El Riad | 2771 | 6 | 12 | 3 |
| Total | | | **3961** | **10** | **20** | **5** |
| **Grand Total** | | | **97081** | | **340** | **62** |

***3) Procedures and Techniques Through Time***

The original techniques for cotton forecasting had been used with 3 visits during the period 1985-1988. Sample size is 50% of crop cutting sample size. Plot size $3m^2$ (1m x 3m) beside crop cutting plot with 1m tag line and 1m calculation line.
In the year 1989, two visits only, July and August without tag line.
From 1991 till now, one visit only. Plot size is two rows $3m^2$.

***Original Procedures***

Forecasting plot is associated with crop cutting plot using stakes and strings for layout the plot. This diagram demonstrates the position of the two plots.



The Field

They used colored tag on square and blooms, bolls to follow and calculated survival ratios for every item.

Calculated number of each item in every visit as a plot total with the help of a counter.

### 4) *Modification: when, who and why*

Adjusted techniques of cotton forecasting began in 1989. The new techniques depend only on one visit in August. The width of the plot is one meter perpendicular to the crop cutting experiment. Also, it depends on counting the total number of squares, blooms, small bolls, large bolls, partially opened bolls and totally opened bolls. By taking 20 opened bolls and drying them in the lab oven in Assuit sampling region, they calculated the average weight of one boll. They sent all the information to the Central Department of Sampling in Cairo to calculate cotton yield.

They received all instructions about forecasting or sampling techniques from the Central Department of Sampling in Cairo.

The Central Department of Sampling in Cairo insists on using this adjustment because of the shortage of facilities.

**Table H-10: Methods Used for Forecasting in Dakahlia during the Last Period**

| Original Techniques | Adjustments | | | |
|---|---|---|---|---|
| | When | How | Who | Why |
| Three visits were done during the period from 1985 to 1988 One meter perpendicular to the crop cutting plot. 10 opened bolls were desiccated at the lab oven. | 1989 | One visit during last 10 days of August. The width of the plot is one meter perpendicular to the crop-cutting plot.<br><br>Counting the total number of squares, blooms, small and large bolls, and partially and totally opened bolls. 20 open bolls are taken to desiccate. | The Central Sampling Department in Cairo | Because of the shortage of facilities |
| | 1991-1999 | One or two rows $3m^2$ depend on row width in the opposite corner of crop cutting plot. | The Central Sampling Department in Cairo | To minimize border bias of the plot plants |

### 5) *Opinion about modification*

They prefer adjusted technique and procedures because it is much easier, need less effort and because the old technique is very complicated and need much effort especially tag line. They received simple instructions and forms but not every year.

## District Level

### *1) Sample Selection*

- Cotton forecasting sample: 5 samples for every district; one as a minimum for each stratum can not represent the crop especially within big strata.
- The selection of the first field of selected cluster of crop cutting minimizes cost and efforts.
- In districts, they apply the instructions they receive from the main office.
- Increase sample size.
- Increase the facilities

### *2) Procedures*

Some difficulties for determining boll size, and infected bolls. Need more training.

### *3) Implementation*

- The cultivator sometimes does not cooperate.
- The irrigation makes some problems to implement the forecasting.
- We find oven samples of the year 1998 still in the districts of Dekernes and Belkas. No one sent it to lab.
- Lack of means of transportation
- Lack of incentives.
- Equipment not enough and it is not suitable for work.

### *Why doing this work*

They know the importance of forecasting and like to improve.

**Sampling Office Activities**
**Beheira Governorate**

The team made several visits to the Beheira governorate sampling office since 24th of July 1999. Many questions were raised concerning major problems facing forecasting work in Beheira, which is in addition to their main work of crop cutting estimation. The team prepared some questions. The following is the summary of these visits and discussions:

## Governorate Level

## A: Administrative Information

### *1) Brief Description*

Beheira governorate is one of the biggest governorates in Egypt. It lies in the west of Delta in Lower Egypt, surrounded by Alexandria governorate from the north and the desert from the west.

It consists of 14 districts with total area of about 1,000,000 feddans. The cultivated area is about 684000 feddans of field crops and vegetables. Table (7) shows the area cultivated of main crops in the governorate.

### *2) Sampling Office, Branches, Responsibilities*

Table (2) shows the number of employees at the main office (114) and the branches (4). Like other governorates, the majority of them are in the first class.

**Table H-11: Number of Employees in the Sampling Offices**
**Beheira Governorate, 1999**

| Class | Main Office | | Branches | | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Kafr Dawar | | Damanhour | | Kom Hamada | | Edko | | | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| 1st | 17 | 15 | 7 | 7 | 16 | 14 | 5 | 4 | 6 | 5 | 51 | 45 |
| 2nd | 1 | 1 | 4 | 3 | 1 | 1 | 1 | 1 | 2 | 2 | 9 | 8 |
| 3rd | 2 | 2 | 4 | 3 | 8 | 7 | 3 | 3 | 2 | 2 | 19 | 17 |
| 4th | 2 | 2 | 3 | 3 | - | | 1 | 0 | - | | 6 | 5 |
| 5th | 5 | 4 | - | | 1 | 1 | 1 | 1 | - | | 7 | 6 |
| 6th | 1 | 1 | - | | - | | | | - | | 1 | 1 |
| Contracts | 6 | 5 | 1 | 1 | 11 | 9 | 2 | 2 | 1 | 1 | 21 | 18 |
| **Total** | **34** | **30** | **19** | **17** | **37** | **32** | **13** | **11** | **11** | **10** | **114** | **100** |

### *3) Internal and External Training*

One only out of the 114 employees in Beheira governorate had external training for forecasting in the USDA but now he was retired. No internal training on forecasting except fieldwork with experienced colleagues. We propose to hold training for about 50 employees as internal training and five as external training on forecasting.

**Table H-12: Number of Employees Trained on Forecasting in Beheira Governorate and the Future Requirements**

| Past Period (1984-1999) | | Future Requirement | |
|---|---|---|---|
| Internal Training | External Training | Internal Training | External Training |
| - | 1* | 50 | 15 |

* Retired one year, but can help.

### *4) Available Means of Transportation*

Inspite of the big area of this governorate, they have only 2 cars in the main office. Also they have only 13 motorcycles distributed through 3 sampling branch offices. Edko sampling office has no means of transportation (see table 4). They rent cars for 33 days during each season (see table 5).

**Table H-13: Owned Means of Transportation in Beheira Governorate, 1999**

| Item | Main Office | Branches | | | | Total | Future Require-ment |
|---|---|---|---|---|---|---|---|
| | | Kafr Dawar | Damanhor | Kom Hamada | Edko | | |
| | No. | No. | No. | No. | No. | No. | |
| Cars | 2 | 0 | 0 | 0 | 0 | 2 | 2 |
| Motorcycle | 0 | 3 | 6 | 4 | 0 | 13 | 10 |

**Table H-14: Rented Cars in Beheira Governorate, 1999**

| Summer 1999 | | Winter 1998 | | Total Days | | Future Requirements |
|---|---|---|---|---|---|---|
| # Days | LE/Day | # Days | LE/Day | # Days | LE/Day | |
| 33 | 45 | 33 | 40 | 66 | 40-45 per day | - |

### *5) Equipment*

Table (6) shows the available equipment in Beheira governorate and its quality. They have a shortage of forecasting equipment. They use steelyards to weigh forecast cotton crop, which are not accurate. There was some equipment for crop cutting but advanced ones must replace it.

**Table H-15: Equipment Used for Forecasting and Harvesting Experiments**

| Crop Cutting Equipment | | | | Forecast Equipment | | | |
|---|---|---|---|---|---|---|---|
| Type | Present Status | | Future Require | Type | Present Status | | Future Require |
| | No. | Suitability | | | No. | Suitability | |
| **Bags** | | | | **Counter** | - | - | 25 |
| **Measuring tapes** | 17 | 12 good<br>5 defected | 20 | **Gauge** | - | - | 25 |
| **Steel Yard Scales** | 22 | 18 good<br>4 defected | 12 | **Steel tape 15m** | - | - | 20 |
| | | | | **Stakes** | - | - | 100 |
| | | | | **Spring balance** | - | - | 15 |

## B: Technical Questions

### *1) Main Crops for Crop Cutting Forecasting*

Table (7) shows the winter and summer crops that estimated by crop cutting techniques in Beheira governorate. They conducted about 1458 sample plots for winter crops and about 845 sample plots for summer crops in addition to 110 sample plots for Nili season.

Table (8) shows that the sampling office of Beheira governorate has conducted cotton forecasting samples since 1990 till 1999. They involved of citrus forecasting four about 7 years period 1986-1992.

**Table H-16: Area of Crop Cutting Crops in Beheira Governorate, 1999**

| Winter Crops | | | Summer Crops | | |
|---|---|---|---|---|---|
| Crop | Area/Feddan | # Experiment | Crop | Area/Feddan | # Experiment |
| **Cotton** | 155906 | 430 | **Wheat** | 219235 | 470 |
| **Rice** | 184055 | 440 | **Fava beans** | 52931 | 144 |
| **Maize** | 124832 | 330 | **Potato** | 10715 | 88 |
| **Potato** | 13207 | 182 | **Millet** | 7415 | 32 |
| **Sunflower** | 545 | 32 | **Homos** | 125 | 4 |
| **Soybeans** | 72 | 6 | **Tomato** | 11885 | 55 |
| **Peanuts** | 4315 | 28 | **Garlic** | 3964 | 52 |
| **Sesame** | 387 | 10 | | | |
| **Total** | **438,319** | **1,458** | | **306,270** | **845** |

Nili potato area is 9941. Number of experiments is 100.

**Table H-17: Years of Forecasting in Beheira Governorate**

| Crop | Forecasting Years | Period |
|---|---|---|
| Cotton | 10 | 1990-1999 |
| **Citrus** | 7 | 1986-1992 |

### *2) Sample Design for Cotton and Forecasting*

From table (9) we can see that Beheira governorate cultivate about 15100 feddans of cotton. Most of them are Giza 70 and Giza 89 and some are Giza 88. The number of crop cutting conducted was about 214 samples plot, and 90 forecasting sample plot. Forecasting sample distributed among districts and strata like other governorates. 5 sample plots for each district with a minimum one for each stratum. This is due to lack of facilities. That is why we have no proportional allocation and the sample cannot represent the cotton population.

**Table H-18: Sample Design for Crop Cutting and Forecasting Estimation of Cotton in Beheira , 1999**

| District | Variety | Strata | Area | Crop Cutting | | Forecasting Experiment |
|---|---|---|---|---|---|---|
| | | | | # Clusters | # Experiment. | |
| **Kom Hamada** | | | | | | |
| | | | | | | |
| **Total** | **G89** | **4** | **2056** | **8** | **16** | **5** |
| **Etay El Barod** | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| **Total** | **G89** | **3** | **7985** | **12** | **24** | **5** |
| **Shabrakhit** | | | | | | |
| | | | | | | |
| **Total** | | | | | | |
| **Rahmania** | G88 | | 1059 | 6 | 12 | 5 |
| | G89 | | 6780 | 8 | 16 | 5 |
| | | | | | | |
| **Total** | | | **7839** | **14** | **28** | **10** |
| **Delengat** | | | | | | |
| | | | | | | |
| | | | | | | |
| **Total** | **G89** | **4** | **8481** | **13** | **26** | **5** |

| District | Variety | Strata | Area | Crop Cutting | | Forecasting Experiment |
|---|---|---|---|---|---|---|
| | | | | # Clusters | # Exprmnt. | |
| **Damanhour** | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| **Total** | **G89** | **8** | **23017** | **25** | **50** | **8** |
| **Abu Matamir** | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| **Total** | **G89** | **3** | **7250** | **8** | **16** | **6** |
| **Mahmoudia** | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| **Total** | **G89** | **3** | **10875** | **14** | **28** | **5** |
| **Hosh Eissa** | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| **Total** | **G89** | **6** | **5845** | **12** | **24** | **7** |
| **Abu Homos** | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| **Total** | **G70** | **11** | **34482** | **32** | **64** | **11** |
| **Rashid** | | | | | | |
| | | | | | | |
| | | | | | | |
| **Total** | **G70** | **4** | **3838** | **10** | **20** | **5** |
| **Edko** | | | | | | |
| | | | | | | |
| | | | | | | |
| **Total** | | | | | | |
| **Kafr Dawar** | | | | | | |
| | | | | | | |
| | | | | | | |
| **Total** | **G70** | **8** | **26730** | **28** | | **8** |
| **Grand Total** | | | **150815** | **180** | **340** | **90** |

***3) Procedures and Techniques Through Time***

They work only with the adjusted method for plot size 2 rows width. The length is $3m^2/2$ row width. Counting the total bolls in the plot, we noticed that there was no unique procedure to follow but each one used his own experience. For example, one counted large bolls. There was no ball gauge measurement to determine boll size. They need intensive training.

***4) Modification: when, who and why***

They start only with modified techniques since 1990.

***5) Opinion about modification***

They prefer adjusted technique because it is much easier, and need less effort. They received sample instructions and forms from the Central Administration Sampling Office in Cairo.

## District Level

***1) Sample Selection***

The sample distribution is not reasonable. For example, in Rahmania district 1,059 feddans cultivated of cotton received 5 forecasting plots. In Abu Homos ,which has about 30,000 feddans of cotton, they sampled only 11 forecasting plots.

Sample selection due to crop cutting selection minimizes efforts and cost.

***2) Procedures***

They need more training on work techniques.

***3) Implementation***

Lack of transportation hinders implementation. Sometimes farmers do not cooperate with them, irrigated fields prevent work in the same day, and usually village agricultural staff does not cooperate.

***4) Improve***

- Incentive to sampling staff for cotton forecasting work according to number of visits and size of work.
- Upgrade equipment.
- Means of transportation must be available for all sampling branch offices.
- More field training for the enumerators.

## Sampling Office Activities
## Assuit Governorate

Several visits have been made to Assuit Governorate's Sampling Office to answer many questions about forecasting, crop-cutting and other activities, which are their responsibility.

The main questions and answers were as follows:

### Governorate Level

The questions about governorate level were divided into two sections:

### A: Administrative Questions

***1) Brief description on the governorate location and activities.***

Assuit is one of the northern Upper Egypt governorates, which is surrounded by 4 governorates; Eastern Desert and Red Sea governorate from the east, Western desert and New Valley governorate from the west, Menya governorate from the north and Suhag governorate from the south.

There are 11 districts in Assuit governorate, which are Dyrout, El-Kosseia, Manphalout, Assuit, Abu Tig, Sodfa, El-Ghanayem, Abnoub, El-Fath, Sahel Saleem, and El Badary.

There are many activities in both of agriculture, and industry and trading sectors. The cultivated area is about 357,381 feddans. The main crops are cotton, maize, sorghum, wheat, beans, lentils, homos, onion, garlic, sunflower and others.

There are some land reclamation projects like El-Shagara El-Tayebba, El-Wady El Assuity, and Refa'a El Tahtawy. The next table summarizes the area of the major crops cultivated in Assuit:

***2) Sampling office, branches, responsibilities, number of staff, classification, and experience, …etc.***

Table (2) shows number of employees at the main sampling office in Assuit and its branches in Abnoub, Sodfa, Sahel Saleem and El Koseye. The total number of employees in the sampling office in Assuit is 79 employees. Seventy percent are from the first and second classes and most of them are nearly 60 years old. Their age affects their activities, performance ,capabilities to perform hard work, and willingness to receive new knowledge. On the other hand, the ratio of the young employees is very small, and they have little opportunity to benefit from the experience of their older colleagues.

**Table H-19: Number of Employees in the Sampling Offices, Assuit Governorate (1999)**

| Class | Main Office | | Branches | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Abnoub | | Sodfa | | Sahel Saleem | | El Kosiya | | Total | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| 1st | 8 | 10 | 4 | 5 | 1 | 1 | 2 | 3 | 3 | 4 | 18 | 23 |
| 2nd | 21 | 26 | 2 | 3 | 5 | 6 | 5 | 6 | 4 | 5 | 37 | 47 |
| 3rd | 3 | 4 | 3 | 4 | 3 | 4 | 1 | 1 | 2 | 2 | 12 | 15 |
| 4th | 3 | 4 | 1 | 1 | 2 | 3 | 2 | 3 | - | - | 8 | 10 |
| 5th | - | - | 1 | 1 | 2 | 3 | - | - | - | - | 3 | 4 |
| 6th | - | - | - | - | 1 | 1 | - | - | - | - | 1 | 1 |
| **Total** | 35 | 44 | 11 | 14 | 14 | 18 | 10 | 13 | 9 | 11 | 79 | 100 |

### *3) Internal and external training, especially on forecasting*

Table (3) shows clearly that only one of the Assuit sampling staff has received any internal or external training on forecasting. Mr. Sayed Gadel Mowla, the former manager of sampling region in Assuit received external training in the USA in 1986 and shared his training with his colleagues in the region at that time. The current manager of the sampling region stated that approximately 40 of the employees need training on forecasting and sampling with 5 of them to receiving external training.

**Table H-20: Number of Employees Trained on Forecasting in Assuit Governorate, and the Future Requirements of Training**

| # Employees Trained | Training Type | | # Employees Need Future Training | |
|---|---|---|---|---|
| | Internal Training | External Training | Internal Training | External Training |
| 1 | - | 1* | 35 | 5 |

* Retired but still cooperate with the work.

### *4) Available means of transportation*

Although all of the sampling offices of the 4 governorates in the study complained of a shortage of transportation, the team noticed the problem less in the Assuit governorate.

**Table H-21: Number of Cars and Motorcycles Currently in the Main Office and the Branches, and Their Future Requirements for Them.**

| Item | Assuit | Abnoub | Sodfa | Sahel Saleem | El Kosseia | Total | Future Require-ments |
|---|---|---|---|---|---|---|---|
| | No. | No. | No. | No. | No. | | |
| Cars | 1 | 1 | 1 | - | - | 3 | 2 |
| Motorcycle | 1 | 3 | 7 | 4 | 3 | 18 | 5 |

The Assuit sampling office rent some vehicles to cover their requirements for transportation to achieve forecasting and crop cutting experiments. Table (5) shows number of vehicles rented, number of days rented and the cost.

**Table H-22: Rented Transportation in Assuit Sampling Region, 1999**

| Summer Season | | | Winter Season | | | Total | | Future Requirements | |
|---|---|---|---|---|---|---|---|---|---|
| # Cars | # Days | Cost (LE/Day) | # Cars | # Days | Cost (LE/Day) | # Days | Cost (LE/Day) | # Days | Cost (LE/Day) |
| 2 | 15 | 35 | 2 | 15 | 35 | 60 | 2100 | 20 | 700 |

***5) Equipment of both crop cutting and forecasting***

The team noticed that the sampling office of Assuit governorate is more fortunate than the other 3 regions of the study because they have some more equipment for forecasting and crop cutting. There is a general lab for drying the cotton samples for all the governorates. At this laboratory, there are 5 ovens to dry cotton, two of them are in use and the other three are storing at this lab. There is one electronic scale to weigh the cotton samples, and 25 thermometers as spare parts for the ovens.

Table (6) shows the number of equipment used for forecasting and crop cutting experiments.

**Table H-23: Equipment Used for Forecasting and Crop Cutting in Assuit Sampling Office, 1999**

| Crop Cutting Equipment | | | | Forecasting Equipment | | | |
|---|---|---|---|---|---|---|---|
| Variety | Present Status | | Future Requirement | Variety | Present Status | | Future Requirement |
| | No. | Suitability | | | No. | Suitability | |
| Bags | 8 | Yes | 8 | Left over crop cutting equip. + electronic scale | 1 | Yes | 2 |
| 1 Scale (5kg.) | 8 | No | 8 | 1 kg scale | 14 | Yes | - |
| 1 Scale (15kg.) | 8 | Yes | - | Ovens | 5 | Yes | - |
| Measuring Tape (20m) | 8 | Yes | 8 | Thermostat | 25 | Yes | - |
| Strings | 20 | No | 100 | Boll Gauge | 5 | No | 100 |
| | | | | Twine | - | - | 10kg/year |
| | | | | Plastic Bags | - | - | 2kg/year |

The team noticed that the Engineers in Abu Tig branch have boll gauges (rings) to measure green cotton bolls, but they are not suitable for measuring cotton bolls because they are 2.5cm measurement.

The table above clearly shows that the equipment is insufficient and some of them are not suitable. It is very necessary to provide more equipment for both forecasting and crop cutting requirements.

**B: Technical Questions**

***1) Main crops for crop cutting and forecasting***

Table (7) shows that the sampling office of Assuit governorate make crop cutting for most of the crops that are cultivated there. In 1999, they had 490 experiments of crop cutting for about 180,519 feddan cultivated with the winter crops that are wheat, beans, lentils, homos, onion, kamon, and garlic. Also, they had 442 crop cutting experiments for about 238,804 feddans cultivated with the summer crops that are maize, sorghum, peanuts, sesame, soybeans, and sunflower.

**Table H-24: Area of Crop Cutting Crops in Assuit, 1999**

| Winter Crops | | | Summer Crops* | | |
|---|---|---|---|---|---|
| **Crop** | **Area/Feddan** | **# Experiments** | **Crop** | **Area/Feddan** | **# Experiments** |
| **Wheat** | 132158 | 322 | **Cotton** | 25,983 | 200 |
| **Beans** | 18888 | 48 | **Maize** | 85513 | 176 |
| **Lentils** | 3828 | 24 | **Sorghum** | 140399 | 188 |
| ***Homos*** | 18593 | 12 | **Peanuts** | 3510 | 24 |
| **Onion** | 6533 | 50 | **Sesame** | 4615 | 32 |
| **Kamon** | - | 22 | **Soybeans** | 648 | 14 |
| **Garlic** | 519 | 12 | **Sunflower** | 119 | 8 |
| **Total** | **180519** | **490** | | **234804** | **642** |

* Exclude cotton crop.

They had conducted forecasting since 1985 for cotton crop using the original procedure with three visits during the period 1985-1989. Starting 1989, they used the adjusted method with one visit only at August. Also, they had forecasting for wheat in 1985, for citrus from 1985 to 1992, and for lentils in 1987.

**Table H-25: Years of Forecasting in Assuit Governorate**

| Crop | # Forecasting Years | Period |
|---|---|---|
| Cotton | 15 | 1985 – 1999 |
| Wheat | 1 | 1985 |
| Citrus | 2 | 1985 –1992 |
| Lentils | 1 | 1987 |

***2) Sample design for cotton estimation and forecasting***

In 1999, Assuit cultivated 25,983 feddans of Giza 83 cotton. They had 200 experiments of crop cutting and 55 experiments of forecasting, for estimating and forecasting the yield of cotton per feddan and the expected total production.

Table (9) shows that crop cutting and forecasting experiments were done in all districts of Assuit governorate.

There were 5 forecasting experiments of in every district and between 6 – 34 crop cutting experiments in each district.

**Table H-26: Sample Design for Crop Cutting and Forecasting Estimation of Cotton in Assuit, 1999**

| District | Variety | Strata | Area Feddan | Crop Cutting # Clusters | Crop Cutting # Exprmnt. | Forecasting Experiment |
|---|---|---|---|---|---|---|
| **Abu Tig** | G 83 | A/82 | 768 | 2 | 4 | 2 |
| | | A/85 | 200 | 2 | 4 | 1 |
| | | A/92 | 237 | 2 | 4 | 1 |
| | | B | 880 | 2 | 4 | 1 |
| **Total** | | | **2085** | **8** | **16** | **5** |
| **Sodfa** | G83 | A/85 | 596 | 4 | 8 | 3 |
| | | B | 349 | 2 | 4 | 2 |
| **Total** | | | **945** | **6** | **12** | **5** |
| **El Ghanayem** | G 83 | A/82 | - | - | - | - |
| | | A/85 | - | - | - | - |
| | | B | 433 | 3 | 6 | 5 |
| **Total** | | | **433** | **3** | **6** | **5** |
| **Abnob** | G 83 | B | **3861** | **13** | **26** | **5** |
| **El Fatth** | G 83 | B | **1750** | **6** | **12** | **5** |
| **Sahel Seleem** | G 83 | B | **711** | **4** | **8** | **5** |
| **El Badary** | G 83 | A/82 | - | - | - | - |
| | | A/83 | - | - | - | - |
| | | B | 404 | 3 | 6 | 5 |
| **Total** | | | **404** | **3** | **6** | **5** |
| **Dierout** | G 83 | A/77 | 634 | 2 | 4 | 1 |
| | | A/79 | - | - | - | - |
| | | A/80 | 201 | 2 | 4 | 1 |
| | | A/81 | - | - | - | - |
| | | A/82 | 15 | - | - | - |
| | | A/82\ | 15 | - | - | - |
| | | A/90 | - | - | - | - |
| | | A/92 | - | - | - | - |
| | | B | 1431 | 5 | 10 | 3 |
| **Total** | | | **2296** | **9** | **18** | **5** |
| **El Kosiya** | G83 | A/75 | 347 | 2 | 4 | 1 |
| | | A/76 | 546 | 2 | 4 | 1 |
| | | /82 | 606 | 2 | 4 | 1 |
| | | 82 | - | - | - | - |
| | | 82 | 986 | 4 | 8 | 1 |
| | | B | 2286 | 7 | 14 | 1 |
| **Total** | | | **4771** | **17** | **34** | **5** |
| **Manfalot** | G 83 | A/82 | 99 | 2 | 4 | 1 |
| | | B | 4351 | 14 | 28 | 4 |
| **Total** | | | **4450** | **16** | **32** | **5** |
| **Assuit** | G 83 | A/92 | 202 | 2 | 4 | 1 |
| | | B | 4075 | 13 | 26 | 4 |
| **Total** | | | **4277** | **15** | **30** | **5** |
| **Grand Total** | | | **25983** | **100** | **200** | **55** |

### *3) Procedures and techniques through time*

The original techniques for cotton forecasting had been used with 3 monthly visits during the period from 1985 – 1988. The width of the plot was one meter parallel to the crop cutting experiment. By counting the number of both small and large green bolls, partially opened bolls and totally opened bolls, and taking 10 opened bolls, they could calculate the average net weight per boll and forecasting cotton yield.

### *4) Modification – when, who and why?*

Adjusted techniques of cotton forecasting began in 1989. The new techniques required only one visit in August. The width of the plot was one meter perpendicular to the crop cutting experiment. Also, it depends on counting the total number of squares, blooms, small bolls, large bolls, partially opened bolls and totally opened bolls. By taking 20 opened bolls and drying them in the lab oven in Assuit sampling region, they calculated the average weight of one boll. They sent all these information to the Central Department of Sampling in Cairo to calculate cotton yield.

They received all instructions about forecasting or sampling techniques from the Central Department of Sampling in Cairo.

The Central Department of Sampling in Cairo insisted on these adjusted techniques because of the shortage of funds and equipment.

**Table H-27: Methods Used for Forecasting in Assuit During the Last Period**

| Original Techniques | Adjustments | | | |
|---|---|---|---|---|
| | When | How | Who | Why |
| Three visits were done during the period from 1985 to 1988 One meter parallel to the crop cutting plot. 10 opened bolls were desiccated at the lab oven. | 1989 | One visit during the last 10 days of August. The width of the plot is one meter perpendicular to the crop cutting plot. Counting the total number of squares, blooms, small and large bolls, and partially and totally opened bolls. 20 open bolls are taken to desiccate. | The Central Sampling Department in Cairo | Because of the shortage of funds and equipment |
| | 1991 | One or two rows $3m^2$ depend on row width in the opposite corner of crop cutting plot. | The Central Sampling Department in Cairo | To minimize border bias of the plot plants |

***5)    Opinion about modification***

They prefer the adjusted technique because it is easier, and needs less effort and because they do not have enough facilities to do more.

They received instructions and forms of the adjustments from the Central Department of Sampling in Cairo.

**District Level**

***1)    Sample Selection***

They did not agree with the way of sample selection. They took 5 experiments for 4771 feddans in El Kosyia district as a sample, and the same number for 404 feddans in El Badary district. They prefer to select sample size according to the area of crop in each district.

***2)    Procedures***

Visits to the field either for forecasting or for crop cutting are causing a lot of trouble for farmers, sampling staff, and governorate office because most of the farmers do not have any education on the importance of this work for him and for the national economy.

***3)    Implementation***

Sometimes the national office requires more experiments to the big area strata, or require changing the village or the farmer to avoid troubles, violence or threats.

***4)    Improvements needed***

1. Scientific sample selection method.
2. Improvement in procedures and implementation.
3. Giving incentives to the sampling staff.

***5)    Why doing this work?***

They know that it is very important work for the development and planning of agricultural trade policy and for the local industry.

**Open Questions**

- Engineers who are responsible for forecasting experiments must have additional incentives.

- Advanced equipment must be available in every branch.

- The first visit in Upper Egypt must be done at the end of June to have time for both a second and a third visit, because they begin the cotton forecasting at the end of August.

**Sampling Office Activities**
**Beni Suef Governorate**

The study team visited the sampling office of Beni Suef governorate several times and met with Eng. Ibrahim Haroon, Head of Sampling Office, as well as all other staff. The purpose was to answer many questions about the forecasting and the crop cutting activities for which they are responsible. Also some open questions about the obstacles they face during their work.

The main questions and their answers were as follows:

**Government Level**

**A: Administrative Questions**

***1) Brief description about the governorate, location and activities.***

Beni Suef is one of the northern governorates in Upper Egypt. It is surrounded by four governorates; Eastern desert and Red Sea governorate from the east, Western desert and Fayoum governorate from the west, Giza governorate from the north, and Menya governorate from the south.

The total area of Beni Suef governorate is about 9576 $km^2$ and is the $9^{th}$ largest based on area. The population is about 1.836 million people, and, therefore, Beni Suef is $16^{th}$ based on population.

Beni Suef has seven districts, which are El Wasta, Nasser, Beni Suef, Ahnasia, Beba, Semasta, and El Fashn.

The total cultivated area is about 314,767 feddans, and the main crops are cotton, maize, soybeans, sesame, sunflower, sorghum, and potato. Table (7) gives the area of major crops in Beni Suef.

***2) Sampling office, branches, representatives and staff number, classifications, experience, …etc.***

The sampling branch offices are responsible to the main sampling office in Beni Suef district. These branches are El Wasta sampling branch office, and Beba sampling branch office.

The total number of the sampling staff in Beni Suef governorate is 27 employees. 52% of the employees are on first class and 22% are on second class. Most of them are near 60 years old. The main problem of the distribution of these classes is that it is reflected on the sampling staff performance and discharging activities, receiving new experiences and capability on doing hard work.

**Table H-28: Number of Employees in the Sampling Office in Beni Suef Governorate, 1999**

| Class | Beni Suef | | El Wasta | | Beba | | Total | |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % |
| 1st | 9 | 33 | 3 | 11 | 2 | 7 | 14 | 51 |
| 2nd | 3 | 11 | 1 | 4 | 2 | 7 | 6 | 22 |
| 3rd | - | - | - | - | 1 | 4 | 1 | 4 |
| 4th | - | - | - | - | 1 | 4 | 1 | 4 |
| 5th | 5 | 11 | - | - | - | - | 5 | 19 |
| Total | 17 | 63 | 4 | 15 | 6 | 22 | 27 | 100 |

***3) Internal and external training especially on forecasting***

Table (3) shows that none of the Beni Suef sampling staff has had any internal or external training on forecasting. They are not ready to accept any training programs by the Central Management of Agricultural Economics in Cairo because they consider it to be useless. They would accept local training programs presented by the foreign projects in Egypt. They would like external training program for at least five of them.

**Table H-29: Number of Employees Trained on Forecasting in Beni Suef Governorate, and Their Future Requirements of Training**

| # Employees Trained on Forecasting | Training Type | | Future Requirements | |
|---|---|---|---|---|
| | Internal Training | External Training | Internal Training | External Training |
| - | - | - | 15 | 5 |

***4) Means of Transportation Available***

The transportation problem of the Beni Suef sampling offices was the most urgent of all. the governorates included in the study. The roads are very narrow and the distance between the various districts is too long.

Table (4) demonstrates the shortage of transportation in Beni Suef sampling region. There are only two vehicles in the main sampling office, and one of them is very old and useless. They need to replace this old vehicle and have a third added.

There are only eight motorcycles; three of them are in the main office in Beni Suef, three are in El Wasta branch, and two are in Beba branch. They need seven more to cover their future requirements of motorcycles.

**Table H-30: Vehicles Owned in Beni Suef Sampling Region (1999)**

| Variety | Beni Suef | El Wasts | Beba | Total | Future Requirements |
|---|---|---|---|---|---|
| | No. | No. | No. | | |
| Cars | 2 | - | - | 2 | 2 |
| Motorcycle | 3 | 3 | 2 | 8 | 7 |

To cover their requirements for transportation to accomplish the forecasting and crop cutting experiments during the summer, Beni Suef sampling branches rent two vehicles for 20 days each at the cost of LE. 45/day/vehicle. In winter, they rent another two vehicles for 20 days each with the same cost, which means LE.3600 per year. If they cannot buy additional vehicles, they will need to rent 3 vehicles/season each for 20 days. This will cost an additional LE.1800 per year.

**Table H-31: Means of Rented Transportation in Beni Suef Sampling Region, 1999**

| Summer | | | Winter | | | Total | | Future Requirements | |
|---|---|---|---|---|---|---|---|---|---|
| # Cars | #Days/ Car | LE/ Day | # Cars | #Days/ Cars | LE/ Day | Car days | Cost (LE) | Car Days | Cost (LE) |
| 2 | 20 | 45 | 2 | 20 | 45 | 80 | 3600 | 120 | 5400 |

### *5) Equipment of both crop cutting and forecasting*

Table (6) shows the equipment used for forecasting or crop cutting experiments and future requirements. There are only 8 bags each containing 5kg. steel yard scale and a measuring tape of 20 meters length. The condition of all equipment is very bad. This study team noticed that they do not even have the cheap equipment such as strings, twine, plastic bags, etc. These are very important to the survey work. Also, they do not have boll gauges (rings) to measure green cotton bolls. Actually most of them cannot distinguish between the large green bolls and the small green ones. It is very important to provide the requirements of both forecasting and crop cutting survey of Beni Suef sampling offices.

**Table H-32: Equipment Used for Forecasting and Crop Cutting in Beni Suef Sampling Office, 1999**

| Crop Cutting Equipment | | | | Forecasting Equipment | | | |
|---|---|---|---|---|---|---|---|
| Variety | Present Status No. | Present Status Suitability | Future Requirement | Variety | Present Status No. | Present Status Suitability | Future Requirement |
| Bags | 8 | Yes | 25 | Left crop cutting equipment + 1kg scale | - | - | 8 |
| Scales (5kg.) | 8 | No | 25 | Twine | - | - | 10kg/year |
| Metrical Measure | 8 | Yes | 25 | Plastic Bags | - | - | 2kg/year |
| Strings | - | - | 100 | Boll gauge | - | - | 20 |

**B: Technical Questions**

***1) Main crops for crop cutting and forecasting***

Table (7) provides area and number of experiments in Beni Suef governorate for all crop cutting main crops. In 1999, they had 262 experiments for crop cutting on about 16,040 feddans cultivated with the summer crops. Also, they had 428 crop cutting experiments on about 136,631 feddans cultivated with the winter crops.

**Table H-33: Area of Crop Cutting Crops in Beni Suef, 1999**

| Summer Crops | | | Winter Crops* | | |
|---|---|---|---|---|---|
| Crop | Area/Feddan | # Experiments | Crop | Area/Feddan | # Experiments |
| **Cotton** | 26,877 | 200 | **Onion** | 13936 | 94 |
| **Soybeans** | 2520 | 24 | **Garlic** | 5561 | 32 |
| **Sunflower** | 297 | 16 | **Beans** | 2698 | 18 |
| **Peanuts** | 377 | 8 | **Wheat** | 114020 | 280 |
| *Sesame* | 624 | 12 | **Grains** | 416 | 4 |
| **Maize** | 10560 | 180 | | | |
| **Sorghum** | 1002 | 14 | | | |
| **Rice** | 604 | 4 | | | |
| **Homos** | 56 | 4 | | | |
| **Total** | **42,917** | **462** | | **136,631** | **428** |

They have conducted forecasting since 1987[1] for cotton crop using the adjusted method of only one visit in August. They do not have forecasting for any other crops.

[1] As mentioned in the report of the head office of Beni Suef sampling region.

**Table H-34: Years of Forecasting in Beni Suef Governorate**

| Crop | # Forecasting Years | Period |
|---|---|---|
| Cotton | 13 | 1987 – 1999 |

### *2) Sample design for cotton estimation and forecasting*

In 1999, Beni Suef cultivated 26,877 feddans of cotton of G80. For estimating and forecasting the yield of cotton per feddan and the expected total production, they had 200 experiments of crop cutting and 35 experiments of forecasting.

Table (9) shows that these crop cutting and forecasting experiments were done in all districts of Beni Suef governorate.

There had 5 experiments of forecasting in every district and between 16-40 experiments of crop cutting.

**Table H-35: Sample Design for Crop Cutting and Forecasting Estimation of Cotton in Beni Suef, 1999**

| District | Variety | Strata | Area | Crop Cutting | | Forecasting Experiment |
|---|---|---|---|---|---|---|
| | | | | # Clusters | # Exprmnt. | |
| **El Wasta** | G 80 | A/89 | 136 | 2 | 4 | 1 |
| | | A/86 | 180 | 2 | 4 | 1 |
| | | A/82 | 534 | 2 | 4 | 1 |
| | | A/81 | 92 | 2 | 4 | 1 |
| | | B | 1538 | 3 | 6 | 1 |
| **Total** | | | **2480** | **11** | **22** | **5** |
| **Nasser** | G 80 | A/78 | 1754 | 5 | 10 | 1 |
| | | A/80 | 140 | 2 | 4 | 1 |
| | | A/81 | 666 | 3 | 6 | 1 |
| | | B | 1348 | 5 | 10 | 2 |
| **Total** | | | **3908** | **15** | **30** | **5** |
| **Beni Suef** | G 80 | A/78 Mosa | 123 | 2 | 4 | 1 |
| | | A/78 Hakama | 352 | 2 | 4 | 1 |
| | | B | 3890 | 12 | 24 | 3 |
| **Total** | | | **4365** | **16** | **32** | **5** |
| **Ahnasia** | G 80 | A/78 | 135 | 2 | 4 | 1 |
| | | A/81 | 115 | 2 | 4 | 1 |
| | | A/82 | 241 | 2 | 4 | 1 |
| | | A/92 | 516 | 2 | 4 | 1 |
| | | B | 4864 | 12 | 24 | 1 |
| **Total** | | | **5871** | **20** | **40** | **5** |
| **Beba** | G 80 | A/78 | 416 | 2 | 4 | 1 |
| | | A/81 | 354 | 2 | 4 | 1 |
| | | A/82 | 212 | 2 | 4 | 1 |
| | | B | 2131 | 5 | 10 | 2 |
| **Total** | | | **3113** | **11** | **22** | **5** |
| **Semasta** | G 80 | A/78 | 133 | 2 | 4 | 1 |
| | | A/83 | 538 | 2 | 4 | 1 |
| | | A/84 | 512 | 2 | 4 | 1 |
| | | B | 817 | 2 | 4 | 2 |
| **Total** | | | **2000** | **8** | **16** | **5** |
| **El Fashn** | G 80 | A/83 | 32 | 2 | 4 | 1 |
| | | A/K2 | 57 | 2 | 4 | 1 |
| | | A/78 AH | 228 | 2 | 4 | 1 |
| | | A/78B.S | 908 | 3 | 6 | 1 |
| | | B | 3915 | 10 | 20 | 1 |
| **Total** | | | **5140** | **19** | **38** | **5** |
| **Grand Total** | **G 80** | | **26,877** | **100** | **200** | **35** |

### *3) Procedures and techniques through time*

The Chief Director of Beni Suef Sampling office did not remember that they had used the original techniques for cotton forecasting at the beginning (1987/88).

### *4) Modification – when, who and why?*

These techniques depend only on one visit in August. The plot area is $3m^2$ in one or two rows of the crop cutting plot. Also, it depends on counting the total number of squares, blooms, small bolls, large bolls, partially opened bolls and opened bolls. Then they send this information with 20 opened bolls to the Central Department of Sampling in Cairo.

They received all instructions about cotton forecasting or sampling techniques from the Central Department of Sampling in Cairo.

The Central Department of Sampling in Cairo compelled to pervade these techniques because of the shortage of facilities.

**Table H-36: Methods Used for Forecasting in Beni Suef During the Last Period**

| Original Techniques | Adjustments | | | |
|---|---|---|---|---|
| | **When** | **How** | **Who** | **Why** |
| They did not use the original techniques in Beni Suef | 1987 | One visit during the last 10 days of August. The area of the plot is $3m^2$. Its width is 1m or less in one row or two perpendicular of the crop cutting plot. Counting the total number of various types of bolls. 20 open bolls are taken to desiccate | The Central Sampling Department in Cairo | Because of the shortage of facilities |

### *5) Opinion about modification*

Since 1987, they have not applied any modifications. There is no development or any trial to provide forecasting for any other crop

## District Level

### *6) Sample Selection*

They do not agree with the sample selection procedures. For example, a district has 5 experiments and 5 strata. If one stratum has 100-200 feddans and another has 4000-5000 feddans, one experiment in each strata is not sufficient to represent these strata.

### *7) Procedures*

They do not agree with measuring the fourth side of the plot. Their point of view is that taking only one length and width from thesouthwest of the plot is quite enough. Also, there is no need to put 4 strings at the four corners of the plot, and it is enough to know the length of the plot and the first and last plant in it.

### *8) Implementation*

They have many problems with implementation. For example, if the two widths lines of the plot are not equal, does it to take two rows or one row?

### *9) Improvements needed*

1. Selecting a dry farm instead of an irrigated one if Engineers find the farm irrigated.
2. It is very necessary to provide the special equipment needed for experiments like colored ribbons, boll gauges, shoes, uniforms, farm book for the season, and internal and external training.
3. Developing experimental equipment to be more suitable for the requirements of work and engineering use.

### *10) Why doing this work?*

Most of the farmers do not know why specialists are doing such work. This is because the lack of knowledge and their carelessness of the instructions they receive.

There is lack of cooperation among the Engineers and the Agricultural Management. Also, they need more incentives.

With no doubt, the sampling Engineers understand the importance of the work, and this is the first step we need to apply the new developing techniques that we are looking for.

### C: Open Questions

There are many field problems, which are:

- Farmers are very angry because of the damage caused by engineers during their work.

- Sometimes children pull off the strings from the plot after the first visit or after irrigation, and hence engineers need to measure the field again to reach the plot.

- What is the optimal solution incase engineers found the selected farm irrigated before the first visit? Can they select another one?