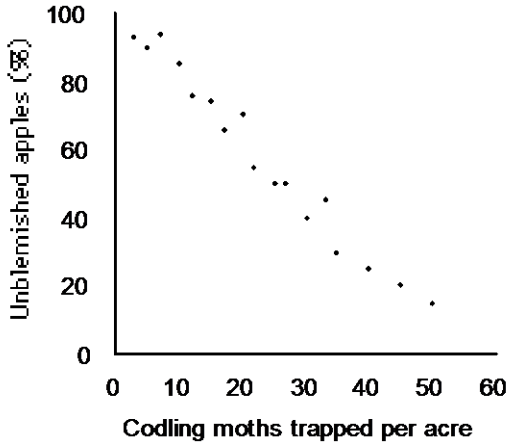
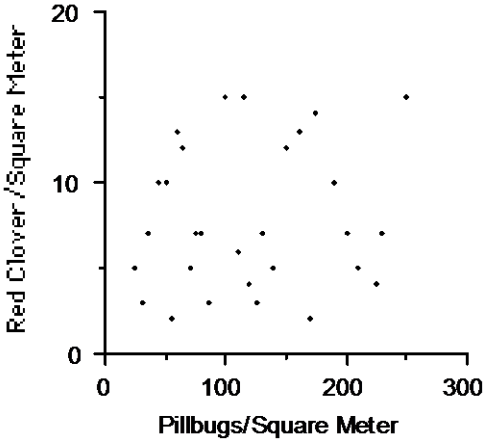
Figure 2: Relationship between incidence of an apple parasite and fruit harvest



Notice that in this example as the number of parasites increases, the harvest of unblemished apples decreases. If this were a perfect negative correlation all of the points would fall on a line with a negative slope. The more linear the data points, the more negatively correlated are the two variables.

No Correlation

Figure 3: Relationship between density of pillbugs and red clover



Notice that in this example there seems to be no relationship between the two variables. Perhaps pillbugs and clover do not interact with one another.

The mathematical formula for computing ***r*** is:

$$r = \frac{n\sum xy - \left(\sum x\right)\left(\sum y\right)}{\sqrt{n\left(\sum x^2\right) - \left(\sum x\right)^2}\sqrt{n\left(\sum y^2\right) - \left(\sum y\right)^2}}$$

Where n is the number of pairs of data.

A correlation greater than .8 is generally described as strong , whereas a correlation less than .5 is generally described as weak.

Coefficient of Determination, r 2 or R2 :

- ✓ The *coefficient of determination, r^2*, is useful because it gives the proportion of the variance (fluctuation) of one variable that is predictable from the other variable. It is a measure that allows us to determine how certain one can be in making predictions from a certain model/graph.
- ✓ The *coefficient of determination* is the ratio of the explained variation to the total variation.
- ✓ The *coefficient of determination* is such that $0 \leq r^2 \leq 1$, and denotes the strength of the linear association between *x* and *y*.
- ✓ The coefficient of determination represents the percent of the data that is the closest to the line of best fit. For example, if r = 0.922, then r 2 = 0.850, which means that 85% of the total variation in y can be explained by the linear relationship between x and y (as described by the regression equation). The other 15% of the total variation in y remains unexplained.
- ✓ The coefficient of determination is a measure of how well the regression line represents the data. If the regression line passes exactly through every point on the scatter plot, it would be able to explain all of the variation. The further the line is away from the points, the less it is able to explain.

C. Qualitative or judgmental methods

- **Delphi Method**
- **Market Research**

Delphi Method

- ♦ The Delphi method is a process of gaining consensus from a group of experts While maintaining their anonymity.
- ♦ It is forecasting techniques applied to subjective nature demand values.
- ♦ It is useful when there is no historical data from which to develop statistical models and when managers inside the firm have no experience.
- ♦ Several knowledgeable persons are asked to provide estimates of demand or forecasts of possible advances of technology.
- ♦ A coordinator sends questions to each member of the panel of outside experts, and they are unknown to each other. Anonymity is important when some members of the tend to dominate discussion or command a high degree of respect in their field. The members tend to respond to the questions and support their responses freely. The coordinator prepares a statistical summary of the responses along with a summary of arguments for a particular response. If the variation

among the opinions too much the report is sent to the same group for another round and the participants may choose to modify their previous responses. This process will be continuing until consensus is obtained. So Delphi method is a iterative process.

Market Research

- It is systematic approach to determine external consumer interest in a service or product by creating and testing hypothesis through data-gathering surveys.
- It includes all research activities in marketing problem:
    - Gathering, recording and analyzing the utility and marketability of the product
    - The nature of the demand
    - The nature of competition
    - The methods of marketing
    - Other aspects of movements of product from the stage of to the point where they get consumed.
- Market research gathers records and analysis all facts about problems relating to the transfer and sale of goods and services from producer to consumer.
- Market Research procedure
  Define the problem clearly
  Develop a clear set of research objectives.
  Supervise the task of collecting the data from the existing consumers.
  Extract meaningful information from the collected data.
  Prepares a report presenting the major findings and recommendations coming from the study.
- It may be used to forecast demand for the short, medium and long-term. Accuracy is excellent for the short term, good for the medium term and only fair for the long term.

Forecast Error:

Forecast error
Difference between forecast and actual demand.

MAD (mean absolute deviation):

$$MAD = \frac{\sum_{t=1}^{n} |D_t - F_t|}{n}$$

where

t = period number
D_t = demand in period t
F_t = forecast for period t

n = total number of periods

Question: What is the MAD value given the forecast values in the table below?

Month	**Sales**	**Forecast**
1	220	
2	250	255
3	210	205
4	300	320
5	325	315

Solution

Month	**Sales**	**Forecast**	**Abs Error**
1	220		
2	250	255	5
3	210	205	5
4	300	320	20
5	325	315	10
			40

$$MAD = \frac{\sum_{t=1}^{n} |D_t - F_t|}{n} = \frac{40}{4} = 10$$

Note that by itself, the MAD only lets us know the mean error in a set of forecasts

Mean absolute percent deviation (MAPE)

$$MAPE = \frac{1}{n} \frac{\sum_{t=1}^{n} |D_t - F_t|}{D_t} * 100$$

Demand Behavior:

- Trend
    - a gradual, long-term up or down movement of demand
- Random variations
    - movements in demand that do not follow a pattern
- Cycle