8.1 Roof Members:

The roof framing members is composed of rafters, trusses, king posts etc. after the framing is completed; a roof covering is placed on the members to protect the building from the influence of the weather. Examples of roof covering include: Corrugated iron sheets, long span aluminum sheets, asbestos roofing sheets, cement bonded roofing tiles, treated wood etc. These roof covering vary in cost and durability.

8.2 Rafters

This is a roof framing member and are usually spaced to modular dimensions. They are mostly cut from timber of adequate dimension but some times may be steel in the case of a factory. Rafters are very important in roof framing, they are influenced by length, intermediate supports, spacing and expected roof and ceiling loads.

8.3 Trusses

A truss is a structure composed of members assembled to form one or more connected triangles, thus producing a rigid frame capable of supporting a heavy load over a considerable span. The most commonly used wood trusses for agricultural construction are pitch designs with span ranging from 7 – 18m. The king post truss is simple and economical for relatively short spans. Other types of trusses are shown in the figure below.

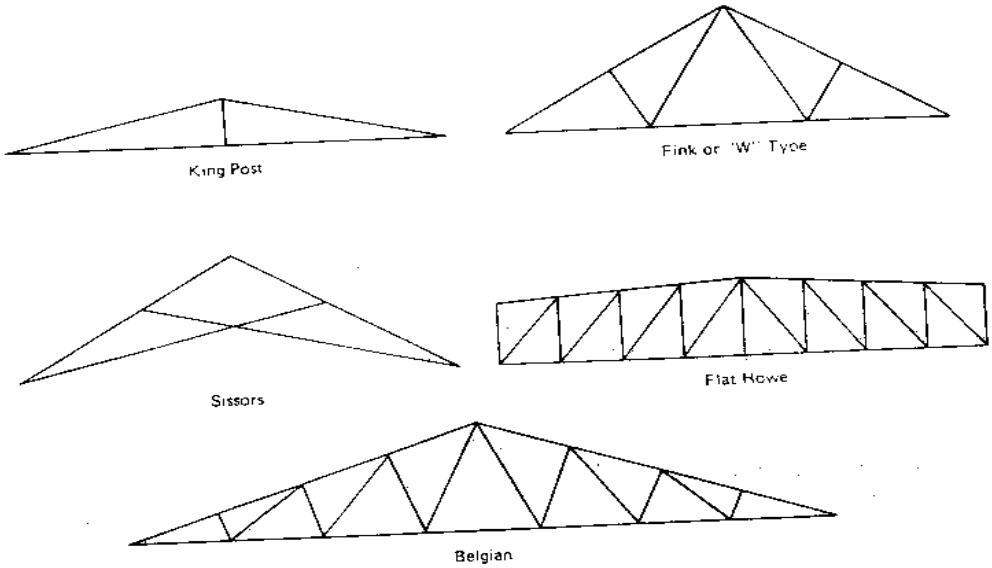

Figure 9: Types of Trusses

9.0 Agricultural Building Environment

The quality of the environment in Agricultural building is important as its influence on animal production, labour efficiency and the value of products in storage has become economically significant. The control of the moisture, temperature, light, dust and odours within buildings is essential for high production, maintenance of quality of stored produce, disease control, worker comfort, building and equipment longevity and safety from explosion. As a result of the above, it is pertinent that a knowledge of the basic factors involved in heat transfer and temperature control is necessary before a system can be designed and equipment chosen to control the environment in an Agricultural building

Ventilation which involves moving air through a building either by natural convection currents or with fans will provide adequate conditions at reasonable cost for many Agricultural enterprises. In other cases, supplemental heat, refrigeration or atmosphere modification are required to maintain an optimum environment. Some examples of environmental control scenarios are presented below: -

(1) In a free-stall dairy barn, temperature is of little consideration, a simple system using natural convection removes sufficient moisture to prevent condensation.
(2) In a cage poultry house, wall and ceiling insulation conserves enough animal heat to maintain a warm temperature while ventilation removes excess moisture and odours.
(3) In a farrowing house, low animal density and the need for a warm room temperature make the use of supplemental heat necessary, ventilation controls moisture and odours.
(4) Fruits for storage are harvested earlier in the season during relatively warm weather. To provide the required storage temperatures, refrigeration systems are essential. In addition, atmosphere modification is used to achieve maximum storage periods.

9.1 Physiology Consideration

Before designing a system for environmental control, it is important to understand the physiological characteristics for the enterprise to be housed. These include heat and moisture needed as well as that produced by the animals or product.

Poultry and other farm animals are homoeothermic, i.e. they maintain relatively constant body temperature usually within $1^0 – 2^0$C range. The hypothalamus gland is the body temperature regulator and stimulates mechanisms to counter either high or low ambient temperatures. For example, increased metabolic activities and greater conversion of feed to heat energy are used to counter low

ambient temperature. In contrast, increased respiration and blood circulation in skin counter high ambient temperature Agricultural products on the other hand have individual temperature and humidity requirements when held in storage, like animals, they also give off heat energy. See table below:

Table 1: Environmental Requirement of stored Products

Product	Temperature ^{0}C	Humidity %	Remarks
Milk room	10-30	90 max	Prevent freezing and condensation
Eggs	13	60-80	
Apples	-2 - +1	85-90	Controlled atmosphere desirable
Potatoes	10-16	85-90	First 7-10 days
	4	85-90	Fresh and Seed use
	7-12	85-90	As required by processing use
Grain	-	<14	
Hey	-	<20	

Source: Whitaker (1979)

A large proportion of automatically controlled ventilating fans are installed in well insulated buildings where the control of temperature and moisture are primary concerns. The proper selection and installation of ventilation equipment will provide the air volume required for uniform air mixing, moisture control and temperature levels

9.2 Fans and Blowers

Fans used to move air through buildings are classified as axial flow fans or centrifugal blowers. With the axial flow (propeller) type, the air is moved parallel with the fan shaft by two or more radially mounted blades. Centrifugal blowers discharge air at right angles to the squirrel cage shaft and blade assembly. The choice of a fan or blower depends on the stable pressure condition under which it must operate.

9.3 Poultry Housing Requirement

Changes in poultry housing in recent years have been rapid and dramatic. The transition from the old farm chicken coop with a few hundred birds to a modern, environmentally controlled cage house for thousands of birds represent one of the greatest advancement ever made in housing for an agricultural

enterprise. Automated equipment for feeding, watering, egg pickup, ventilating and manure removal has promoted egg production to one of the most efficient of farm operations.

9.31 Site selection and Building Design

Buildings for all phases of poultry production tend to produce considerable odour, hence, the site should be well down wind from living quarters. A well drained site is most desirable.

This is particularly true for the litter system as they may be partially below grade, foundation drains are essential to protect against wet manure problems

Temperature is the most important environmental factors in poultry housing. Young chicks need very warm surroundings to survive. Older chickens, both layers and broilers exhibit their best feed conversion efficiencies at 21 – 24^0C; however, production drops rapidly as temperature rise above 27^0C and temperatures above 38^0C may be lethal.

Humidity is important in two circumstances very low humidity tends to cause objectionably dusty conditions and high humidity combined with a very high temperature interferes with the birds natural cooling mechanism and contributes to high mortality.

9.32 Housing for Breeding Flock

Breeders are usually managed using the deep litter system in either window or environmentally controlled houses. Considerable supervision is required in feeding and disease control in order to produce high quality eggs for the hatcheries. Labour efficiency is improved with automatic feeders and waterers which are often located in lines along the outside wall or on either side of a center alley for convenient egg collection.

9.33 Housing for Laying Hens

Open houses utilizing cage system is protected with only a light reflective roof and roll-up curtains on the sides. In some cases, many lightly insulated, floor managed houses, often with open fronts, are being used. Although they after some protection from weather extremes, they do not provide either environmental conditions or the labour saving facilities for a modern and efficient laying enterprise.

A number of different cages and housing have been developed over the years; there are variation in equipment and design. Cage system may be classified by the number of levels of cages. Most of the early systems were flat deck, i.e. just one level of cages. The introduction of 2 –tier, stair – step cages greatly improved the accessibility to the birds. With the advent of controlled environment

housing, cage designs continued to be improved till 3 – and 4 – tier cage systems became popular and allowed increased bird density within a house.

9.34 Housing for Pullets Rearing and Broiler Production

Raising broilers and replacement pullets involves brooding and growing the chicks to either market age or point of – lay stage. Housing, equipment and management procedures during the first few weeks are similar. Most chicks for layer replacement or broiler production are started on the floor with either portable or centrally heated brooders.

As the chicks grow they are allowed to spread out to use a greater amount of floor area. Compared to the first week, 2 – 3 times the floor area will be required by the time they reach 7 – 8 weeks of age. Since heating and ventilating the entire building is insufficient at the start, "end room" blooding is recommended. One end of the house is closed off and used for the first 4 – 5 weeks and then the growing birds are allowed to spread out over the whole floor area.

Experience has shown that pullets grown on the floor can be put into either floor – or cage managed laying houses. However pullets grown in cages do not adapt well to floor – managed operations.