Handbook on Pig Farming and Pork Processing (Feeding Management, Breeding, Housing Management, Sausages, Bacon, Cooked Ham with Packaging) 2nd Revised Edition
<table>
<thead>
<tr>
<th>Code:</th>
<th>ENI902</th>
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<tbody>
<tr>
<td>Format:</td>
<td>Paperback</td>
</tr>
<tr>
<td>Indian Price:</td>
<td>1275</td>
</tr>
<tr>
<td>US Price:</td>
<td>125</td>
</tr>
<tr>
<td>Pages:</td>
<td>280</td>
</tr>
<tr>
<td>ISBN:</td>
<td>9789381039786</td>
</tr>
<tr>
<td>Publisher:</td>
<td>NIIR PROJECT CONSULTANCY SERVICES</td>
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Pig farming is the raising and breeding of pigs. Among the various livestock species, piggery is most potential source for meat production and pigs are more efficient feed converters after the broiler. Pig rearing has traditionally been in the main occupational axis of the socially backward down-trodden class of Indian population since time immemorial. But at present commercial pig farming has greatly changed social scenario of this business in India. Now everyone is conscious about the economic importance of pig farming.

Pig farming for meat production is one of the best and profitable business ideas for people. There are several highly meat producing pig breeds available and Initial requirements of small investment, quick returns and utilization of bristles and manure further increase the importance of this animal.

This handbook is designed for use by everyone engaged in the pork production. The book explains about how to raise and care for pigs, by choosing the right breed, how to house, feed and breed them, butchering process, manufacturing process of various pork products and sample plant layouts & process flow sheets with machinery details. Major contents of the book are behavior of pigs, feeding management, pig breeding, housing management, diseases, pork processing, sausages, bacon, cooked ham, chilling and freezing of meat, meat packaging.

It will be a standard reference book for professionals, food technologists, entrepreneurs, and others interested in startup of pig farming and pork production.

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INTRODUCTION
Pig is one of the most efficient feed converting animals among the domesticated livestock. It is the only litter bearing animal among meat producing livestock having the shortest generation interval and high feed conversion efficiency. Piggery farming has been recognized as one of the profitable venture among the rural masses. This venture has proved to be one of the most important livelihood options. Generally the pigs are reared for pork, considering the increasing trend of pork consumers; Piggery farming will certainly take a industrial form of livelihood in future.

Pigs are kept for the production of pork and bacon. Most breeds, if properly managed and fed are capable of producing either pork or bacon. Pig meat (pork) is a very important source of animal protein in human diets. In the areas where pigs are reared on tree range, they are most valued as a kind of “savings” to the farmer from where he can tap in times of cash shortage and emergency needs. Commercial production under semi-intensive conditions is becoming more popular because of its favorable rate of return on investments.

Commercial pig farming in India for meat production is one of the best and profitable business ideas for the Indian people. There are several highly meat producing pig breeds available around the globe. Some of those are very suitable for commercial meat production according to the weather and climate of India. A few years back, pig farming had a bad image in the society (only socially back warded down-trodden class Indian people used to raise pigs since the time immemorial and they were not respectable people). But at present the scenario has changed tremendously and commercial pig farming in India is no more restricted to lower class people.

Physical Characteristics of Pigs
Pigs are medium-sized mammals whose thick bodies weigh anywhere from 77 to 770 pounds (35 to 350 kilograms). Some domesticated, tamed, breeds weigh up to 990 pounds (450 kilograms). Pigs measure 34 to 83 inches (86 to 211 centimeters) in length and stand 21 to 43 inches (53 to 109 centimeters) high. The exception is the pygmy hog, which is the smallest species and never grows longer than 28 inches (71 centimeters).

The neck is short and the head is long and pointed. The snout is able to move separately from the head. The
eyes are small, the ears are long, and each foot has four toes. The two middle toes are flattened and have hooves. The upper canines, cone-shaped teeth on each side of the front of the mouth, are big and curve upward, protruding from the mouth. Skin color varies, depending on the species, from brown to near black. Some species have manes or tufts of hair. Others have warts on the face.

**Pig Breeds**

**1) Large White Yorkshire**

It is a large sized and most extensively used exotic pig breed in India. Their body is solid white colored with erect ears, dished face and snout of medium lengths. An adult boar (male pig) weights around 300 to 400 kg and an adult sow weights around 230 to 320 kg. Large White Yorkshire is an excellent pig breed for the purpose of cross breeding.

**Jangali Bandel/Wild Boar**

Jangali Bandel / Wild Boar Found in the wild throughout the country, for the commercial production to receive seed Rs 10,000 per piglet to be paid to the National Park and Wild Life Conservation Department of Nepal. 
Height ; 90 – 95 cm, Weight; 200 - 250 kg

**Banmpudke**

Banmpudke is the domesticated form of Jangali Bandel. Known as smallest domesticated breed of pig. 
Color varies red – brownish to black. Reached adultery at 187 days. Gestation period is 114 days with farrowing interval of 138 days. Average litter size is 4.7 and weaning size is 3.4 with birth weight 650 gm. Matured males average 20 and female 19 kg live weight. Resistance to several diseases and parasites.

**BEHAVIOUR OF PIGS**

Pigs are highly intelligent, curious animals who engage in complex tasks and form elaborate, cooperative social groups.

Their uncanny physiological and behavioral similarities to humans have given pigs a mysterious and often mythical quality that lends itself to folklore and fables.

Pigs were once considered wicked and dirty, but science has helped to shed light on the depths of their remarkable cognitive abilities and to extend a greater appreciation for these often maligned and misunderstood animals.

**Social Behaviour**

Social behaviour is highly developed in pigs. Within hours, newborn piglets begin to form social dominance relationships with littermates and eventually a stable hierarchy is formed. Fighting is therefore rare except when
closely matched mature males encounter each other during the breeding season. Aggression may occur during the autumn when food becomes concentrated in patches but it is usually regulated by the ‘submissive’ behaviour of lower ranking individuals. The early associations between piglets often persist into adulthood, particularly among females. It is believed that pigs can remember up to 30 other individuals, consistent with the finding that pigs are rarely observed to congregate in groups of over 20. The basic social unit consists of one to several females and their offspring with other loosely associated individuals. This organisation remains more or less stable until the beginning of the rutting season in October when the boars join the females. Mature males are relatively solitary but bachelor groups may form in the late summer. Sows usually give birth in spring though it is known that they can give birth practically all year round. In good feeding conditions, sows can give birth twice a year. In social groups, the breeding is often synchronised.

**Rooting Behaviour**

Rooting behaviour appears to be an important part of the behavioural repertoire, a rewarding experience and perhaps a behavioural need. The pigs’ natural inclination to root can also provide a useful cultivation and weeding tool. However, rooting can also lead to environmental damage. There are apparently no real differences between rotational and set-stocked systems with regard to levels of rooting, foraging and feeding behaviour. Keeping pigs on the right soil type and the use of rotational grazing is key to the exploitation of the former and minimising the impact of the latter. A system of integrating pigs into a crop rotation is described by Lund and Weary whereby a once a year farrowing herd is moved periodically within a crop rotation programme.

**Maternal Behaviour**

Maternal behaviour Young piglets are very active and are able to stand within a few minutes after birth. They sample the sow’s 14 teats before attaching to one with which they will remain for the rest of the nursing period. Newborn piglets also go up to the sow’s nose and sniff. This may be important for future mutual recognition. It is common for piglets to be born within a range of sizes and for the smaller ones to be born last. The larger, earlier born piglets attach themselves to the more productive anterior teats, which they then vigorously defend. This means that
the strongest piglets get the most food, significantly increasing their survival chances at the expense of the weakest.

**PIG BREEDING**

**Managing the Sows**

Sows that are to be kept for breeding should be selected and separated from the litter at about 3 months of age. They should not be allowed to get too fat because this will create fertility problems. They should get a little exercise to remain in good condition.

Young sows are mature enough to conceive at about six months of age. They should not be served (mated) too early however as it is better to wait until they are fully grown. If they are well fed and healthy this will usually be at about eight or nine months. Mating too early will result in small litters, problems at birth, a loss of condition and poor growth of the sow.

Mating can only be successful during the sow’s period of heat (oestrus). Sexually mature, non-pregnant and non-lactating sows come on heat for two or three days about every three weeks. However if the boar is kept separate from the sows and gilts (young sows, not yet mated), as he should be, it may sometimes be difficult (but nevertheless essential) to recognise the heat.

**Recognising the Heat**

Twice a day (in the morning and in the evening), a check should be made of the sow’s oestrus condition. This should be done some time after feeding, preferably in the morning. Doubtful cases can be looked at again in the afternoon. Differences in breed and climatic variations in the tropics sometimes make it difficult to recognise oestrus. The first sign is a redness and swelling of the vulva, which is more obvious in gilts than in sows. Another sign is that other sows in the pen start to mount the sow on heat.

The clearest indication is the reaction of the sow to the boar. If a boar is brought alongside the sow’s pen, a sow on heat will advance towards the boar. They exhibit a typical ear display (especially noticeable in breeds with erect ears). If the sow does not react convincingly, then the boar should be let into the pen. The boar will nose the vulva and prod the sow in the belly and flank. If the sow accepts he will mount her. A good oestrus sow will stand rigid when mounted, with her back legs slightly apart (the so-called standing reflex).
Selecting the Boar

Selecting a boar is even more important than choosing your breeding sows. In choosing a breeding boar, the same factors should be taken into account as for the sows; this includes the presence of 12 nipples. Avoid choosing a boar too highly in-bred from your existing stock, as in-breeding will lead to reduced fertility, poor growth, and lower levels of disease resistance.

Feeding and Housing the Boar

Boars should be kept neither too lean nor too fat. They need plenty of exercise. In very hot conditions or when suffering from fever, they can remain infertile for a long time. A boar that is ill should be rested for 1 to 2 months and be replaced by another for this period.

Boars should be housed in individual pens, for if they are kept with non-pregnant sows it becomes impossible to tell whether and when he has served the sows, and whether or not they are in-pig. It is therefore important to separate the boar from them.

The Birth and Care of the New-Born Piglets

On average delivery will take place 115 days after conception (3 months, 3 weeks and 3 days). The sow will usually farrow during the night or evening. In the last 14 days of pregnancy the udder will increase in size. It feels firmer, and the nipples stand out more towards the end of the pregnancy. In gilts the udder begins to develop after two months of pregnancy.

Care of the New Born Piglets

A few minutes after the birth the umbilical cord may be pulled gently away or cut if necessary (to about 5 cm length). After birth, the navel of each piglet should be soaked in a cup of iodine solution to prevent inflammation and tetanus. Each piglet should be rubbed carefully, dry with a cloth.

Make sure the piglets are able to suck from the udder as soon as possible after birth. Their sucking will encourage the sow to let down her milk.

Problems Related to the Birth

Although there are normally very few complications at birth it is advisable to be at hand. If the whole process of delivery takes longer than 8 to 12 hours then there is something wrong. In particular the last piglets may be born in the membrane and will suffocate if they are not taken out. It is also true that sows do not pay much attention to their offspring until all the litter has been delivered. Piglets that waste no time in searching for milk may easily be...
crushed if the sow lies down again in the course of the farrowing. By being on hand to intervene in time this can be prevented.

**HOUSING MANAGEMENT**

This may still be an appropriate method for some farms, but today most farmers will need to fence in or otherwise confine their pigs in some way to prevent them from trespassing on others property. Pigs are crafty creatures, especially if they perceive food within reach, and they will go under, through, and over many barricades in search of a morsel. Careful site planning and materials selection will keep you and your pigs happy.

**Selection of Housing Location**

Avoid locating hog pens in any area where water pools or the ground becomes excessively muddy during rainy seasons. A slight slope will help drain away rain water and urine and keep your pigs more comfortable. In case of a large scale pig farm, the site selected needs also to be: well connected to roads throughout the year, suitable for manure disposal, connected to reliable water and electricity sources.

**Fencing**

If you raise your pigs outdoors, fencing is a primary concern. Hog fences should be at least 32 inches high for smaller pigs and up to 60 inches high for larger pigs. Fencing can be constructed of many materials, including wood, hog or cattle panels, pipe, field fence, electric wire, and barbed wire. Each has advantages and disadvantages.

**Housing and Equipment**

Pig houses must be well constructed for maximum performance of the animals. For backyard operations houses can be constructed using locally available material such as bamboo, planks etc. Movable houses are constructed for pigs on range. For permanent pig houses the flooring must be concrete (neither too rough nor too smooth) to allow for easy cleaning and minimize occurrence of parasites and diseases. Pig houses should be provided with concrete feeders and water troughs though other materials such as automobile or truck tires cut in halves may be improvised as drinkers.

**The Sow and Sow Pen**

In an intensive pig production system, provision is made for five single sow pens per boar, because the sow has to stay there for five weeks and a sow/boar ratio of 1:20 has to be maintained. To manage enough contact between boar and sows, partitions are placed over the
slatted area between the adjoining boar and sow pens, because pigs tend to defecate while communicating with pigs in adjoining pens. Alternatively, the sow may be placed in a pen directly next to the boar right after she weaned her litter. For individual feeding.

**Farrowing Pens**
The most important considerations regarding housing during farrowing and the first seven to ten days thereafter, are to supply optimum temperatures to the sow and her litter and to limit deaths among the piglets through trampling or overlying. Sows should be placed in disinfected farrowing pens one week before farrowing to allow time for adjustment to the new surroundings. The sow or gilt is washed and treated for scabby skin, not less than two days before she farrows.

**Weaners and Weaner Housing**
For many years it was customary in South Africa to wean pigs at the age of 35 days, although there is the tendency to wean pigs at an earlier stage. This section focuses on housing for pigs weaned at 35 days, with two litters grouped together, all-in-all-out pens, housing for early weaned pigs and flat deck housing.

**DISEASES**
A disease outbreak in a piggery can have disastrous consequences: The management practices already described, if carefully followed, will minimize the occurrence of diseases. That prevention is better than cure is very relevant in the pig industry.

A clean, sanitary environment provides the best prevention for internal and external parasite which can be serious problems. Confinement prevents pigs from contaminated fields and dirty lots. Anthelmintics and other drugs, when properly used, aid in elimination of parasites. Antibiotics also protect pigs against disease proliferations and reduce disease outbreaks. They can also promote growth in pigs when given at recommended levels. For diseases that can be prevented through vaccination, a Veterinarian should be contacted to provide such services routinely.

A basic knowledge of the main diseases which may affect a pig herd is necessary so that a producer can diagnose the condition and implement control measures as quickly, as possible. Some of the common parasites and diseases that affect pigs are highlighted.

**INTERNAL PARASITES**
The internal parasites are more common to pigs on
free-range. An example is the round worm (*Ascaris Lumbricoides*) which causes lots of damage to pig herds. The round worm can grow up to 300mm long and 6mm thick in the small intestine. Heavy infestation leads to inherit in piglets, weakness and loss of weight. Worms are one of the most serious threats to pig keeping. There are more than 30 types affecting the intestines of pigs. The most important two are the intestinal roundworm and the tape worm.

**Tapeworm**
Tapeworms are flat and long ribbon like creatures which are common in all parts of the world. Tapeworms do not have a digestive system so they receive their food through their skin as they absorb our nutrients. They especially absorb folic acid and vitamin B-12. These parasites may cause what is referred to as “verminous intoxication” as they put out and leave dangerous waste products in our bodies. These tapeworms can roll themselves into a ball and can be felt on the right side of the abdomen under the liver.

**Lice**
These are blood suckers that also cause irritation of the skin. The hog louse is the largest louse species (6.4mm) commonly associated with domestic animals. It is found most frequently in the folds of skin behind the ears and between the legs. The blood-sucking activity of hog lice results in much irritation and discomfort to swine.

**Symptoms**
- Itching
- Skin may show red spots or bite wounds.
- Thick skin and rough hair coat.
- Anaemia in severe cases especially in piglets.

**Prevention**
- General cleanliness.
- Treat piglets before putting them in fattening house.
- Fatteners don’t need to be treated.
- Treat gilts before first service.
- Treat boars twice a year.
- Treat new stock on arrival and seven days later. Piglets below three weeks should not be treated.

**PORK PROCESSING**

**Stunning**
The animal should be killed as quickly and humanely as possible. In most slaughter plants, hogs are immobilized either by electrical stunning or carbon dioxide gas suffocation. On the farm a hog can be stunned by...
striking it one sharp blow with a mechanical stunner or by shooting it in the forehead midway between and slightly above the eyes. The first attempt should be successful. Improperly placed bullets could cause the animal much pain and injure helpers or other livestock. Animals that become excited during stunning will not bleed as well as those less excited. As always the case whenever using firearms, exercise all appropriate safety precautions. The animal can be scalded by several methods. The easiest method is to have two barrels, one for heating the water and one for use as a scalding vat. Fifty-five gallon barrels will be large enough for most hogs. The scalding barrel can be buried in the ground at a slight angle; thus movement of the hog in and out of the barrel is easier. Be sure the angle of the barrel is not too flat or the barrel will not hold enough water to cover the carcass. Another method for scalding is to have a scalding vat or a barrel under which a fire can be built. This method requires more construction, and the temperature of the water is difficult to control. Slow scald is usually best. Scalding water temperatures between 140° and 140°F are optimal. At these optimal temperatures, 3 to 6 minutes of scalding are required to loosen the hair and scurf (layer of accumulated oil, dirt, and the outer layer of cells on the skin). In the fall when the winter hair is beginning to grow, the hair of most hogs is difficult to remove. Higher water temperatures (146° to 150° F) or longer submersion times are usually required for scalding during this “hard-hair” season. About 1/4 cup of rosin, lime or some other alkaline material added to the scald water to aid in scurf removal results in a whiter skin. On the farm, regulation of water temperature is difficult. Add boiling water to the scalding barrel, then add cool water to adjust to the proper temperature. Begin with the scalding water at 155° to 160° F because it cools rapidly. At these high temperatures, the carcass must be kept in motion and pulled from the barrel several times.

**Skinning Method**

The skinning procedure used for pork carcass is similar to that used for beef carcasses. Skinning requires less equipment and can be done faster than scalding and scraping. We have commonly believed that the skin was needed on hams and bacon to assure proper curing; however, this belief is not necessarily correct. A poor skinning job can lower the quality of the belly for bacon. After stunning and bleeding the animal, move the carcass to the location of the hoisting equipment. Place the
carcass on a sheet of plywood, a concrete slab, or straw. Wash the blood and dirt from the carcass. Turn the carcass on its back and hold it in place with blocks placed on each side.

**Evisceration**

Losen the anus by cutting around it, deep into the pelvic canal. Pull outward and cut any remaining attachments; be careful not to cut into the large intestine. When the anus is loosened, tie it with a piece of string to avoid contaminating the carcass.

**Splitting and Head Removal**

Wash the inside of the carcass before splitting. With the saw, begin splitting from the inside between the hams. Keep the split as near the center of the backbone as possible, and saw through the tail region to a point midway through the loin. Move around to the back and continue sawing through the shoulder and neck to the base of the head. If the split gets off center, continue sawing through to the next vertebra and then realine the saw. Remove the head at the atlas joint (the joint closest to the head). This joint should be exposed if the carcass is properly split. After cutting through the joint cut downward along the jaw bone, leaving the jowls attached to the carcass. If desired, remove the tongue, wash it thoroughly, and place it with the liver and heart.

**SAUSAGES**

Cooked Sausages is an ideal meat product. It can be made by many different formulations and in any forms. All edible parts of the carcass can be used in an efficient way, thus making it possible to utilize its entire nutritional capacity. It is ready-to-eat food that can be eaten cold or heated, as a part of a meal or on its own.

**Sausage Types**

Sausage can be simply defined as a product manufactured from ground or chopped meat; combined with salt, spices and other ingredients; and shaped in some manner, usually by means of various sizes and types casings. The origin of sausage-type products precedes recorded history. Over the centuries, sausage making has been refined and developed into an art strongly tied to various ethnic groups. Today scientific principles are employed to improve production procedures, product quality and product safety. By altering raw materials (including spices and composition), processing procedures, spice and other nonmeat ingredient usage and level, casing size and type,
smoking and cooking procedures, a wide variety of sausages can be produced. Classification of all sausages into specific categories is very difficult, since any given sausage may be produced in a number of different ways. Extreme caution must be used when adding nitrite to the sausage batter since overdoses of this ingredient can be toxic to humans. As little as 3-7 grams of nitrite can be very toxic and lethal to humans. Because of the safety concern in using nitrite, it is not readily available in pure (100%) form. In addition, since straight sodium nitrite is added at a very low level (1/4 ounce per 100 pounds of meat) it would be difficult to accurately weigh out the desired amount on commonly available scales. Therefore, for safety and accuracy, salt blends already containing nitrite at the proper level are best used by home sausage makers when the recipe calls for nitrite or nitrate addition. Morton’s “Tender Quick Salt” (contains 0.5% nitrate, 0.5% nitrite and 99.0% salt) is an example of such a blend, containing a very small amount of nitrite and nitrate. It is available in many grocery stores. When this blend is used as the salt source for products which call for nitrite or nitrate, these curing ingredients will automatically be added to the batter at a safe and proper level.

**Casings**

Home sausage makers often inquire about where they can buy sausage casings. Usually a small supply of natural and synthetic casings can be purchased from local meat processors, who use these casings in the manufacture of their own line of sausages. Most casings used in sausage making are natural, collagen or synthetic. Natural casings are from the G.I. tract of animals. Most fresh bratwurst are in pork casings. Natural casing wiener and some breakfast sausages are in lamb casings. Ring bolognas are typically in beef casings. Natural casings always have a natural “curve” to them and a very desirable “snap”.

**BACON**

Originally developed as a method of preserving pork before the widespread use of refrigeration, bacon remains a popular product in its own right. Its production varies from country to country but typically involves the treatment of boneless pork cuts with curing salt, usually added as a brine. As practiced in North America, bacon is produced from boneless pork belly that is not smoked, sliced thinly, and vacuum packed, while in Ireland and the United Kingdom, the most popular bacon is made from cured pork loins. In continental Europe, bacon lardons
(cubes) are used mainly as a cooking ingredient. Salt (sodium chloride) and nitrite are essential for curing, although nitrates (sodium or potassium) are still used in some brines. Both major ingredients, salt and nitrite, are multifunctional. Salt acts as a preservative by lowering water activity, gives bacon its characteristic salty flavor, and increases the water-holding capacity of meat by solubilizing myofibrillar protein and increasing the myofibrillar lattice spacing. Although nitrite chemistry is relatively complex, the basic functions of nitrite are well known. It (1) acts as a preservative, (2) promotes the formation of the cured meat color, (3) contributes to cured meat flavor, and (4) acts as an antioxidant.

**Injection of Pork Sides**

Whole sides, usually bone-in and rind-on, were injected with a brine containing salt, nitrate, and nitrite. Injection was carried out manually, using a single needle. The brine was introduced at multiple points (25-30) along the carcass in order to obtain a reasonably uniform distribution.

**Pig Production and Slaughter**

Most bacon is made from pigs, of various genetics, reared in intensive indoor systems and fed a commercial concentrated diet. The pigs have a fast growth rate and are slaughtered at 90-110 kg when they are 5 to 6 months old. Such pigs are relatively lean, the average backfat thickness of UK pigs being about 11 mm. Bacon from organically produced pigs—reared less intensively and using organic feed—inevitably commands a premium price.

**COOKED HAM**

The processing of cooked ham involves the use of brine that is either injected or infused through soaking, followed by the application of thermal treatment. The final quality depends on both the raw materials and the processing. The most outstanding factors are the type of meat cut, the type and amounts of ingredients, the injected volume of brine, the rate and extent of tumbling, and the cooking time and temperature. The goal is to obtain a product with high sensory quality that is microbiologically safe, usually based on minimum temperature-time treatments. The best-quality products are generally produced with a low-brine injection level and no addition of polyphosphates. In general, the more water is injected into the ham, the poorer is the quality, since water retention is facilitated by some compounds like polyphosphates and starches. The consumption of cooked ham is relatively high, since
it is a very popular meat product. For instance, it may account for as much as 26% of the delicatessen products sold in Europe, with France, Spain, and Italy being major consumers. There are different manufacturing technologies for the production of cooked ham, depending on the raw materials and the processing conditions.

**Types of Products**

There is a broad range of types of cooked ham, which generally are classified depending on different characteristics. In general, cooked hams can be classified according to the raw material used for the processing, the composition of brine ingredients (like the use of polyphosphates, starches, and carrageenan), the technological yield (from 85% to higher than 110%), and finally, the ham presentation (boneless, bone-in, pieces, whole legs, and so on).

The manufacture of cooked ham has been evolving in order to solve different problems such as the increased proportion of exudative meats or the reduction of the salt content and processing time. The intensive selection for leaner pigs in response to consumer demands resulted in an increased proportion of exudative pork meat. The protein of this meat exhibited poor texture, lower waterholding capacity, and poor cooked cured color. In order to improve the functionality of these meats, several binders have been used, including starch, carrageenan, and soy proteins.

**MEAT PACKAGING**

Meat has long been considered a highly desirable and nutritious food. Unfortunately it is also highly perishable because it provides the nutrients needed to support the growth of many types of micro-organisms. Fresh meat requires presence of oxygen for maintaining color for consumer appeal. Packaging fresh meat is carried out to avoid contamination, delay spoilage, permit some enzymatic activity to improve tenderness, reduce weight loss, and where applicable, to ensure an oxymyoglobin or cherry-red colour in red meats at retail or customer level. It has a shorter shelf life. Cured meats degrade in presence of oxygen. Two decisions are important while selecting packaging material i.e. shape or form and material. Selection of packaging material would depend on product factors such as color, stability, storage conditions, microbial condition, preservatives and degree of processing. Processed products require more sophisticated and extensive packaging because they will be stored at
higher temperatures for longer periods than refrigerated products.

**Single-Layer Films**

One common use of single-layer films is the wrapping of meat pieces, processed meat products, bone-in or boneless meat cuts or even entire carcasses. These films are usually self-adhesive, i.e. they cling together - "cling film" - in the overlapping areas. Hence they provide good protection from external contamination and to some extent from evaporation, but no protection from oxygen, as they are not hermetically closed or sealed packages. Foils with good self-adhesive properties are PE, PA, PVC and PP.

Another important utilization for single-layer films is in freezer storage. For meat blocks, meat cuts or smaller portions of meat or meat products, single-layer films are stretched tightly around the meat surface before freezing. The tight film prevents evaporation losses, which occur during freezer storage of unpacked products. The film is in tight contact with the products surface, in order to avoid evaporation, ice formation and freezer burn at non contact spots. Suitable cold resistant films for freezer storage are PA or PE.

**Multi-Layer Films**

Practically all the other films used for meat packaging are designed as strong oxygen and water-vapour barriers. In order to fully achieve these requirements, films with good barrier properties for oxygen and water vapour respectively are combined.

Layer A: Outside layer (mechanically strong, gas barrier to oxygen).

Layer B: Middle layer (barrier to oxygen).

Layer C: Inside layer = sealant layer (capable of being melted and welded under pressure to the sealant layer of the opposite sheet of the bag/pouch, serves also as barrier to water vapour).