Technical Bulletin No 45

CELEBRATING 25 Years Silver Jubilee Publication

Rabbit *as an* Alternative source *of* Meat production

Samir Kumar Das, Eknath B Chakurkar,
and Narendra Pratap Singh

भाकृअनुप ICAR

ICAR RESEARCH COMPLEX FOR GOA
(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)
Old Goa - 403 402, Goa (India).

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डॉ. नरेंद्र प्रताप सिंह
निदेशक
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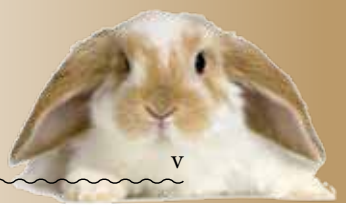
Director

Foreword

RABBIT, *a non-traditional livestock, appears as one of the most suitable means of producing high quality animal protein that could make significant contribution towards bridging the gap between local production and demand of animal protein in Goa. This is because of its attributes of affordable low cost management requirements, small body size, short generation interval, high fecundity, rapid growth rate, ability to utilize forage and agricultural by-products, and adaptability to a wide range of ecological environments. In many developing countries rabbits are reared purposely to achieve animal protein self-sufficiency for the household.*

The ICAR Research Complex for Goa has been functioning as an independent Institute since 1989 and mainly focus is around applied and strategic aspects in order to increase the agricultural production and productivity in Goa and the adjoining coastal region. The institute is mandated to address different issues such as resource conservation, watershed approach for soil conservation, conservation of biodiversity, integrated farming system approach incorporating horticulture, animal husbandry and fishery for maximum utilization of available resources, climate change impact and mitigation strategies for agriculture and allied sector, employment generation and livelihood improvement., value addition and post harvest processing, agro ecotourism for the coastal ecosystem.



Scientists of this institute have done commendable work on rabbit science and developed package of practices for rabbit production suitable to the coastal ecosystem. It is highly appreciable that the authors of this publication has taken lot of interest to release the publication "Rabbit as an alternative source of meat production" in due time to fulfill the mandate to make agriculture locally, nationally and globally competitive. I am confident that this publication on the occasion of silver jubilee of the institute will be of immense helpful to researcher, extension officials, students, livestock farmer and rabbit lovers.

(Narendra Pratap Singh)
Director

गोवा के लिए भा.कृ.अनु.प. का अनुसंधान परिसर, ओल्ड गोवा.
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Preface

RABBITS *belong to the order Lagomorpha, which has two families (Leporidae and Ochotonidae) that comprise 12 genera. The modern rabbit is Oryctolagus cuniculus, a descendant of the European wild rabbit. Rabbit is relatively a new introduction as farm animal in our country and more particularly in this region. The rabbit was introduced in India by Central Sheep and Wool Research Institute, Avikanagar, Rajasthan. As per basic animal husbandry statistics (2010) the rabbit population in India is 4,24,000.*

Rabbit rearing is gaining popularity for meat, fur skin and wool production besides as pet animal in our country and in this region also rapidly due to several reasons. It can be raised on roughage diet solely without affecting productive and reproductive performance. It indicates that it cannot compete with human beings for food grains like pig and bird. Its reproductive potentiality is very high i.e. rabbit can be bred around the year and gives at least four crops with five litters in each time, altogether 20 litters per doe per year. It is adaptable in wide range of climate and resistant to diseases. It can be marketed at 90 days of age. Rabbit meat is wholesome; tasty which is rich in protein, certain minerals and vitamins but low in fat and cholesterol. It fits very well in integrated farming system. In ICAR Research Complex for Goa, Ela, Goa also, lot of work was done on rabbit production and effort was made to develop package of practices and to popularize in the field as meat producing animal as well as pet animal.

Authors duly acknowledge Dr R N S Sundaram, Retired Principal Scientist and Head, Animal Science Section for introduction of rabbit unit at this institute. Authors also acknowledge Dr S B Barbuddhe, Principal Scientist (VPH) for disease diagnosis. Technical assistance provided by Mr B Dharampala, Retired Technical Officer, Mr Edward Cresta, Technical officer and Mr Datta Velip, Technician, Rabbit Research Farm is also duly acknowledged. Assistance provided by Mrs Maria Suxilia Dias, Skilled Supporting Staff was also acknowledged for daily maintenance work in rabbit farm.

We hope that this publication will be of immense helpful to all kind of users ie students, researchers, extension officials and above all rabbit farmers and rabbit owners for future planning and maintaining of rabbit as meat as well as pet animal.

Authors

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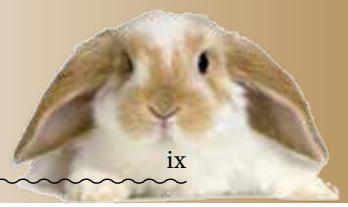


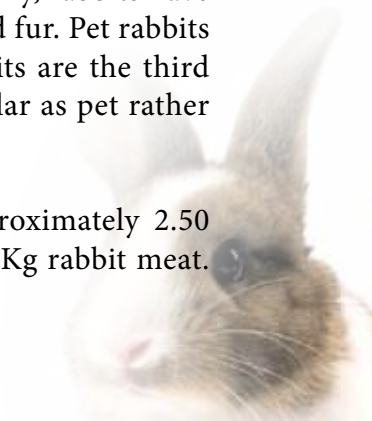
A. Introduction

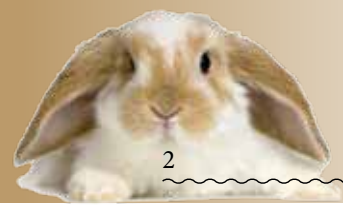
RABBIT is relatively a new introduction as farm animal in our country and more particularly in this region. However, rabbit rearing is gaining popularity for meat, fur skin and wool production besides as pet animal in our country and in this region also rapidly due to the following reasons:-

- It can be raised on roughage diet solely without affecting productive and reproductive performance. It indicates that it cannot compete with human beings for food grains like pig and bird.
- Its reproductive potentiality is very high i.e. rabbit can be bred around the year and gives at least four crops with five litters in each time, altogether 20 litters per doe per year.
- It is adaptable in wide range of climate and resistant to diseases.
- It can be marketed at 90 days of age.
- Rabbit meat is wholesome; tasty which is rich in protein, certain minerals and vitamins but low in fat and cholesterol.
- It fits very well in integrated farming system.

Rabbits belong to the order Lagomorpha, which has two families (Leporidae and Ochotonidae) that comprise 12 genera. The modern rabbit is *Oryctolagus cuniculus*, a descendant of the European wild rabbit. Male rabbits are bucks, females are does and babies are kits. Rabbits raised for meat are called fryers. The average life span of a domestic rabbit is 6 to 7 years. Rabbit is often confused with hare. Hares are usually longer than rabbit and have longer ears and hind legs. Young ones in hare are born with body hair and open eyes, whereas young rabbits born devoid of body hair and blind, generally eyes open after a week. Historically, rabbits have been used primarily for research and production of meat, wool and fur. Pet rabbits have become increasingly popular. In the United Kingdom, rabbits are the third most popular pet after cats and dogs. In Goa rabbit is more popular as pet rather than as meat animal.

Among the developed countries, France is producing approximately 2.50 lakhs ton of rabbit meat annually with per capita availability of 5 Kg rabbit meat.



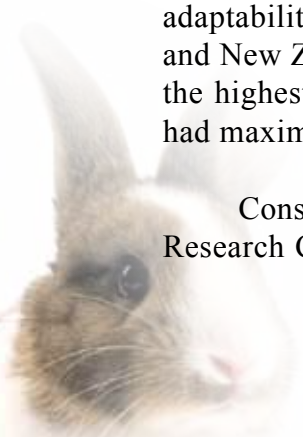


France UK and Germany are the biggest importer of rabbit meat. Among the Eastern European countries, Hungary is the biggest producer of rabbit meat and they normally export it to Italy. Among the Asian countries China is the biggest producer and exporter of rabbit meat. Korea and Japan are now also producing rabbit for meat production. Rabbit production received a major boost in Ghana as a result of a nationwide multimedia communication campaign backing the National Rabbit Project established in 1972 for the promotion of backyard rabbit breeding as a self-help means of increasing meat supplies at low cost (Osei *et al*, 2012).

INRA and FAO surveyed 64 developing countries to identify the potentialities of rabbit production in the developing countries. As per their report 70 % expressed possibilities, 22 % were skeptical about its social acceptance while the remaining 8 % were against it for religious and other reasons. Among the developing countries however, Ghana and Mozambique are utilizing rabbit as a source of meat. Rabbit has been found to play pivotal role, particularly in those developing countries that experience national meat shortage. India is also one of the developing countries who are facing meat shortage of 4.66 g / day against the recommended requirement of 87 g / day.

There is also very good demand of rabbit skin ie pelt in the world market. France produces about 70 million rabbit fur skins and 56 % of it is used for making different products like caps and jackets etc. Poland and Russia utilize all the pelts whatever they produce for making different products. Australia exports fur skin produced in their country. Main importer of raw skins is Korea and Phillipines who after processing export to developed countries like USA, Italy and Germany.

As per basic animal husbandry statistics (2010) the rabbit population in India is 4,24,000. It was reduced from 0.48 m in the year 2003 to 0.42 m in the year 2007. The rabbit was introduced in India by Central Sheep and Wool Research Institute, Avikanagar, Rajasthan and afterwards at its North Temperate Regional Station located at Garsa, HP. The programme was undertaken to study the performance of various meat and wool breeds of rabbit both at Avikanagar and Garsa. The study showed that Angora, New Zealand White and Soviet Chinchilla had much better adaptability and had maximum survival rate. The fur quality of Soviet Chinchilla and New Zealand White was the best. The rabbit project at Palampur showed that the highest combining ability was possessed by New Zealand White, which also had maximum growth rate.



Considering the demand of meat and meat products in NEH region, ICAR Research Complex for NEH Region, Barapani introduced rabbit in that region in

the year 1988 as meat producing animal and afterwards studied extensively on different breeds and developed package of practices suitable to that region. It was popularized in all the seven states of NE Region and neighbouring states also. In Karnataka six rabbit breeding farms with 200-300 rabbits in each had been setup. The slaughtering age of rabbit in these farms was between 4 to 6 months within average weight of 3 kg. Kerala Agricultural University has setup the ICAR project for rabbit breeding in 1984. The commercial rearing in Kerala had been started within private and Government sector. In four districts of Kerala the scheme for rabbit development was being implemented. The districts were Trivandrum, Eduki, Quilon and Pathanamthitta. Rabbit farming in Andhra Pradesh is growing. Rabbits are mainly being used for meat in Kurnool, Hyderabad, Vijayawada and other parts of Andhra Pradesh. Rabbit farming is emerging as the main entrepreneurship in this region now a day. Low investments in rabbit farming attracted educated youth to come forward to start rabbitry in Hyderabad, Kurnool and other parts of Andhra Pradesh.

In ICAR Research Complex for Goa, Ela, Goa also, lot of work was done on rabbit production and effort was made to develop package of practices and to popularize in the field as meat producing animal as well as pet animal. Five breeds namely New Zealand White, Soviet Chinchilla, Gray Giant, Black Brown and indigenous breed of Goa are being maintained in the institute farm. Rabbits are being supplied to the interested farmer regularly both for breeding purpose as well as pet animal. Out of the five breeds New Zealand White and Soviet Chinchilla are the most heat tolerant and adaptable breeds in the agro climatic condition of Goa.

B. Breeds of Rabbit

AT present there are 38 breeds and 19 strains of domestic rabbits throughout the world recognized by American Rabbit Breeder Association (ARBA). Only 8 – 10 breeds of rabbits are available in India predominantly in Himachal Pradesh, Uttar Pradesh, Rajasthan, Goa, Kerala, Tamil Nadu, Andhra Pradesh, Karnataka, West Bengal, Meghalaya and Tripura.

New Zealand White

This is one of the best meat breed. It is medium sized and developed in USA. It had three varieties ie White, Black and Red. Adult buck and doe weighs 3.7 – 4.0 kg and 4.0 - 4.2 kg respectively.

Soviet Chinchilla

It has a compact, coby medium body and it is meat type. It has one variety ie gray. Adult buck and doe weighs 2.5 - 3.5 kg and 3.0 – 3.6 kg respectively.

Flemish Giant

It is the largest of the domestic breeds and has a well proportioned and balanced body. It is meat type breed. It is originated in UK. It has seven varieties ie Steel gray, Black gray, Sandy, Black, Blue, White and Fawn. Adult buck and doe weighs 5.0 kg and 5.4 kg respectively.

Satin

The Satin originated in the USA. It is meat breed. It has six varieties ie Black, Blue, Chocolate, Copper, Red Siamese and White. Adult buck and doe weighs 3.5 - 4.0 kg and 4.0 – 4.5 kg respectively.

Californian White

It is a meat type rabbit developed in California from Himalayan and Standard Chinchilla cross. F-1 male was crossed with NZW female to develop this. Adult buck and

doe weighs 3.6 - 4.5 and 3.9 - 4.8 kg respectively. The colour is all white with black, chocolate, blue or lilac nose, ears, feet and tail .

Rex

This is most valuable fur producing breed. It has seven varieties ie Black, Blue, Tan, Chocolate, Orange, Gray, Pale gray. Adult buck and doe weighs 3.2 and 3.6 kg respectively.

Himalayan

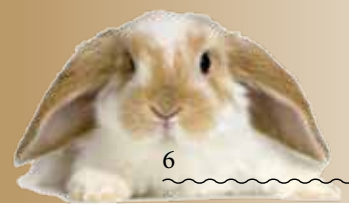
Originated in East and found in great number in China and Russia. It is a small fancy rabbit. It has two varieties, Albino with extremities black and blue. Adult buck and doe weighs 1.1 – 1.6 kg and 1.5 – 2.0 kg respectively.

British Angora

Developed in Angora town of Turkey. It is wool breed. It has much fine coat. It has two varieties ie White and coloured. Adult buck and doe weighs 2.4 - 3.4 kg and 2.5 – 3.6 kg respectively.

French Angora

It has longer and narrower head and a large body than British Angora. It is wool breed. It has two varieties ie White and coloured. Adult buck and doe weighs 3.0 and 3.2 kg respectively.



C. Housing Management of Rabbit

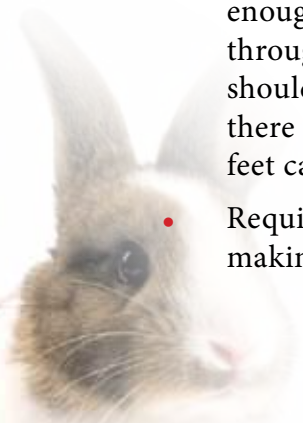
Location of Rabbit House

- Several factors may be considered before selecting a site for construction of rabbit house. A shaded and elevated area is preferred for easy drainage of unused water from rabbit farm. Shaded area is preferred to reduce the heat stress on the rabbit as it is very sensitive to high temperature.
- The area must be connected with town by road so that there would not be any problem to bring feed or sell products, but away from the town as location should be free from excessive moisture, smoke, fume, dust and other pollutants.
- There should be easy access of electricity and water.
- Area should be protected from predators ie dog, fox, cat etc. which are enemy of rabbit.

Types of Housing Systems

Indoor Cage System

- Cages are kept on wooden or concrete rack in a row in closed RCC house having asbestos or GI sheet roof. Cage size varies depending upon breed and age of rabbit. Wood is not a desirable material for cage making. Because rabbit chews and consumes it. Moreover it absorbs urine, water. So it is difficult to clean.
- The material normally used for making cage is galvanized wire mesh having thickness 12-14 gauze. The thickness of wire to be used for sides and top of the cage should be 16-18 gauze.
- Grid opening must be large enough to allow faeces to pass through. At the same time it should not be so large; otherwise there is chance of entangling the feet causing injury.
- Requirement of wire mesh for making floor for small size rabbit



should be 0.5 x 0.5 inch. For large size rabbit it may be 0.75 x 0.75 inch. But for side and top of the cage wire mesh should be 1.0 x 1.0 inch.

- Cage may be constructed square or rectangular. They may be made single or in a multiple of two or three.

Indoor Low cost Housing

- This house is of kachcha floor, thatch roof, bamboo wall. Roof may be made of coconut leaves, but to avoid entry of rain water turpolin/ plastic sheet may be applied on the top. As low cost and locally available materials are used, hence cost of housing is low. Racks are made of wood or bamboo and cages are of bamboo or galvanized wire mesh.

- The other advantage is that all the materials used are of bad conductor of heat. So this house is comfortable both during summer and winter. But durability is less; hence at an alternate year roofing material is to be replaced.
- In a study of Das and Sikka (2007), it was revealed that while rabbits maintained in indoor low cost housing and were fed 50 % green roughage and 50 % concentrate pellet feed performed best.

Indoor Floor System

- In this system like fowl an area of 300 ft2 (20 x 15 ft) is shaded with asbestos where wall is made of brick up to the height of 3.00 ft and above it wire net fencing is given up to the height of 6.00 ft.
- Animals are kept over clean dry litter made of saw dust. Feed and water are provided by feeder and waterer as usual.
- The main disadvantage of this system is that there is less control over feeding, breeding and management. So, more chance of occurring diseases.

Outdoor Hutch System

- It may be made of iron or wood with G I welded mesh floor and asbestos or GI sheet roof. There may be four or five compartments. If frame is made of iron, durability and cost of hutch increases in contrast to wooden frame.

- The dimension of hutch is generally 1.50 x 0.75 x 0.50 m and longitudinally it is partitioned into five compartments having a dimension of 0.75 x 0.30 x 0.50 m. So 3 weaners or 2 growers or 1 finisher or 1 adult may be kept.
- Hutches are kept in outdoor under tree shade. To reduce heat stress during dry summer paddy straw or thatch may be given over the roof to keep roof cold.

Outdoor Semi open Hutch System

- Here an area of 300 sq ft (20 x 15 ft) is covered by wire net in three sides and in rest side two or three hutches may be kept for night shelter of rabbit.
- The open area is kept for roaming and grazing to meet the need of at least 50 % dry matter requirement. The feeder and waterer are kept inside the hutch.
- Rabbits from post weaning period to age of marketing may be maintained. Breeding is not possible selectively and moreover there is chance of abortion in pregnant doe.
- If any rabbit is found sick it should be immediately separated to prevent transmission of disease.

Battery System of Housing

- In this system rabbits may be reared in two or three tiers like poultry. In each tier there may be three to four compartments. The main objective of this system is to manage rabbits in very limited space in town or city on the roof of the house.
- Structure may be made of galvanized iron, wood or bamboo with GI sheet roof and wooden floor. Side wall may be of wood. Here no grids are made in upper floor to avoid dropping of faeces from upper stair to lower stair.

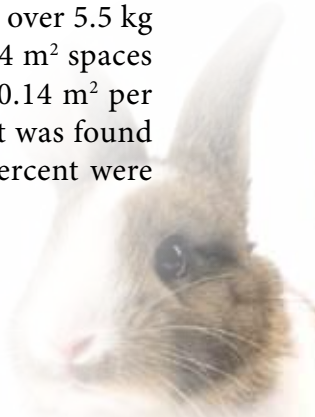
Group Size

- Rabbit may be maintained individually or in group of two or three. In individual rearing due to better feeding and management performance of rabbit is best but it is cost expensive.

- In group rearing productive performance is reduced. Moreover due to eating of fur from each other in this system quality of fur becomes poor. Sometimes fighting occur which renders rabbit injured, causing morbidity and mortality.
- So maximum two rabbits may be kept up to the age of marketing to reduce housing cost and to obtain optimum productivity

Floor Space Requirement

- To get optimum to maximum production, keeping housing cost as low as possible knowledge on floor space allowance is very important.
- Low floor space or high housing density has different disadvantages, a) more chance of diseases transmission particularly contagious diseases, b) reduces growth and wool yield.
- Different factors determine the floor space. The factors are as follows:-
- **Floor area:-** If total area of floor is more, less floor space per animal may be given. But if house is of small size, more space per animal is recommended.
- **Floor type:-** If floor is of wire netting excreta can be eliminated easily, so floor space per animal may be reduced. But on deep litter, when chance of contamination is there, more floor space per animal should be provided.
- **House type:-** If rabbits are maintained in open hutch system, less floor space may be given. But, rabbits maintained in indoor cage system require more space per animal.
- **Size of rabbit:-** With the advancement of age, body size is increased, so rabbit requires more space than in young age.
- **Climate:-** In temperate to sub temperate climate less floor space may be given. On the contrary, in hot dry region more floor space is required for optimum growth.
- **Ventilation:-** If there is provision of cross ventilation and adequate then less floor space per rabbit may be given.
- Harkness and Wagner (1989) suggested floor space requirement at different body weight. Up to 2 kg 0.04 m^2, 2 - 4 kg 0.28 m^2, 4 - 5 kg 0.37 m^2, over 5.5 kg 0.46 m^2 floor spaces is required. For doe with litter additional 0.14 m^2 spaces is required for litter. Mehta *et al* (1992) reported that an area of 0.14 m^2 per rabbit is sufficient in Soviet Chinchilla breed. Total gain in weight was found 900 from 9-15 weeks. Feed conversion efficiency and dressing percent were recorded as 5.95 and 50.2.



- Das et al (1996) tested three floor space allowances 0.27 m^2, 0.14 m^2 and 0.09 m^2 in case of Soviet Chinchilla rabbit. Highest growth rate (19.4 g / d) was found in 0.14 m^2 floor space but maximum FCR (5.42) was observed in 0.27 m^2. Floor space requirement for rabbit was standardized. Floor space is required for weaner 1.5 ft^2, for grower 2.0 ft^2, for finisher 2.5 ft^2, for adult 3.0 ft^2 and for nursing mother 4.5 ft^2.

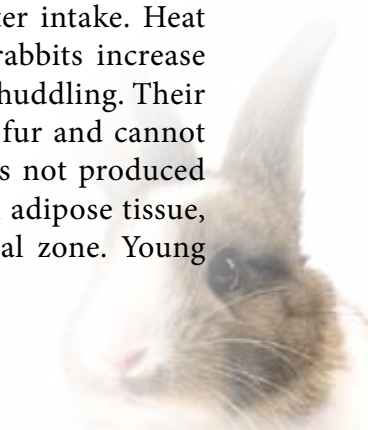
D. Environment Requirement for Rabbit Production

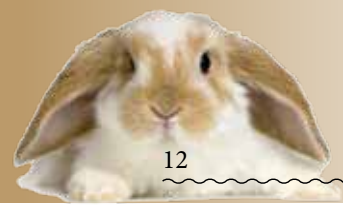
RABBITS are basically animals of temperate region. Hence, they prefer low temperature (10-25°C) rather than high temperature. Out of different environmental factors ambient temperature is the most important. Other environmental components are relative humidity, rainfall, wind velocity, light and solar radiation. Environments have significant effect on all productive and reproductive traits, so the knowledge of those is very essential for economic rabbit production.

Ambient temperature

Rabbit being homoeothermic animal maintains constant deep body temperature through thermo regulatory system located in the hypothalamus of brain by virtue of heat gain and heat loss. They use three devices to modify heat loss: general body position or change of posture, respiration and peripheral temperature especially ear temperature. Rabbit curls up to minimize the body surface area to reduce radiation loss and lowers ear temperature if ambient temperature is low (below 10° C). On the contrary if the temperature is high (above 25-30° C), the rabbit stretches out to increase the radiation and convection loss of heat from body surface and to step up their body temperature. The ear functions like car radiator. The efficiency of cooling system depends upon air speed around the animal. Sweat gland of rabbit is not functional so cutaneous evaporative loss of heat is very less, only from the external ear and foot pad (Lebas 1986, Harkness 1988).

Other ways of latent heat loss is by panting and by respiratory evaporation through the increase of respiration rate. Respiration rate may increase fourfold to 300 – 400 / m. If ambient temperature is above 35° C rabbit can no longer regulate their internal body temperature and heat prostration sets in. Rabbit also regulate heat loss and heat gain by increasing or decreasing feed and water intake. Heat regulation in newborn rabbits is somewhat different. Neonatal rabbits increase heat production during cold stress by fat catabolism, shivering and huddling. Their heat regulating system develops within two weeks. They have no fur and cannot correctly adjust their feed intake as they take doe's milk, which is not produced as per requirement. At birth young have good fat reserve ie brown adipose tissue, which helps to maintain body temperature within thermo-neutral zone. Young





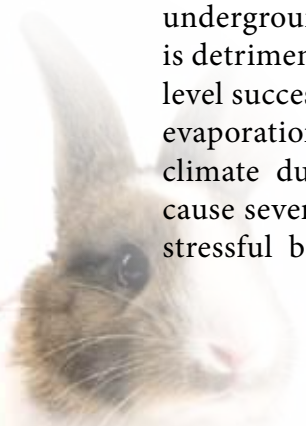
rabbit cannot curl up but the only way to reduce heat loss by conduction and convection is to hurdle together with the other young. When temperature is high, young rabbits again move apart to increase heat loss.

In rabbit during heat stress vasodilatation through sympathetic inhibition begins at 20 °C, increased evaporation occurs at 25 °C and panting begins at 35 °C and continues until the rectal temperature is above 104 °F. The average lethal rectal temperature is 109 °F. Rabbit panted, defecated, salivated and licked their forequarters at higher temperature (40 - 41 °C). In commercial rabbit when environment temperature exceeds 33 °C mortality due to heat stress occurs. Feed intake was decreased and water intake in rabbit was increased as temperature and humidity increased. It was reported that ambient temperature (32.2 °C) significantly ($P < 0.01$) reduced daily feed intake and rectal temperature by 0.5 ^{0} C significantly ($P < 0.01$). The average daily gain and average daily feed intake in low temperature (17 °C) and high temperature (32.2 °C) were 22.7 g, 11.4 g and 205 g, 133 g per day. It was reported that daily feed intake was significantly ($P < 0.01$) affected by ambient temperature. Feed intake decreased by 1.16 g per °C rise of temperature. Feed intake was highest at the temperature of 20 ° C. Heat stress not only reduced rabbit doe productivity but also growth performance of fattening rabbits (Simplicio *et al.*, 1988; Pla *et al.*, 1994; Chiericato *et al.*, 1995; Ayyat and Marai, 1997).

It was observed that change of air temperature had significant ($P < 0.05$) negative effect on average daily gain of all the breeds of rabbit. Average daily gain was reduced by 16.78 g in Gray Giant, 14.84 g in Black Brown, 12.50 g in Soviet Chinchilla and 6.51 g in New Zealand White rabbit per unit increase of air temperature respectively. So, it would be inferred that adverse effect of maximum temperature, minimum temperature and air temperature was most pronounced on Gray Giant and Black Brown rabbit indicating maximum adaptability of New Zealand White and Soviet Chinchilla rabbit (Das and Singh, 2012).

Relative humidity

Rabbits are very sensitive to very low humidity (below 55%) but not to very high humidity. This is due to the fact that rabbits expend much of their lives in underground burrows with a humidity level (100 %). Abrupt change in humidity is detrimental to health and production. French workers found 60 - 65 % humidity level successful. High humidity along with high temperature is stressful due to low evaporation heat loss resulted into discomforts followed by prostration. In tropical climate during rainy season high temperature along with high humidity can cause severe problems. High humidity along with very low temperature is equally stressful because water condenses on poorly insulated wall. So cold becomes



more penetrating, causing heat loss from the animal through convection and conduction. Digestive and respiratory disorders often follow. Low humidity at high temperature is also dangerous, because it not only upset the secretion of mucus but also enhances the chance of respiratory disorder. Hafez (1970) reported that feed and water intake decreased as humidity increased. Xu *et al* (1992) reported that daily feed intake was significantly reduced by 0.16 g with an increase of RH of 1 %. Feed intake was highest at a relative humidity of 52 %.

Ventilation

The rabbit house must have a certain minimum of ventilation to evacuate the harmful gases given off by the rabbit ie carbon dioxide and its excreta ie ammonia, hydrogen sulphide, methane etc and to renew the oxygen and get rid of the excess moisture and excess heat given off by the rabbits. Ventilation depends on climate, cage type and stocking density. Optimum air speed ie ventilation along with optimum temperature produces comfort. High air speed along with low temperature causes cold draught ie intestinal blockage. Low air speed along with high temperature causes respiratory distress. High air ammonia level ie 20-30 ppm weakens the rabbit's upper respiratory tract. To reduce this ammonia level ventilation must be increased in rabbit's house. It was reported that when New Zealand White rabbits were kept in three houses A, B, C having ventilation rate 2.27, 5.49, 11.54 cubic meter / hour / head ammonia level was 40.3 in A, 26.2 in B and 13.3 in C house, resulting in 34 %, 19 % and 1 % mortality in A, B and C houses.

Air circulation pattern (ventilation) is having a dominating influence on the air mixture, temperature and humidity gradients (Lokhorst *et al*., 1995) while both building orientation and amount of ventilating opening considerably affect the thermal comfort level of livestock micro-environment (Ogunjimi *et al*., 2007). During heat stress an animal in order to remain within its body temperature range ie in order to maintain thermo - neutrality must reduce its internal heat production, enhance its heat dissipation mechanism or combine both. In rabbit several investigators found that respiration rate increased under heat stress conditions (Habeeb *et al*., 1993; Marai *et al*., 1994; Marai *et al* 1996; Ogunjimi, 2007).

Lighting

Few studies have been made on the influence of light on rabbits and these are exclusively concern with the duration of lighting and seldom with intensity of light. Exposure of light for 8 hours out of 24 hours favours spermatogenesis and sexual activity in bucks. Conversely, exposure for 14 - 16 hours a day favour female sexual activity and fertilization. 24 hours light trial caused reproductive disturbances in

rabbit. It therefore seems best to limit the duration of light to 16 hours. Very young rabbit do not need extra light, but 15 - 16 hours per day is sufficient. 24 hours light may cause digestive disturbances or may disturb caecotrophic behaviour. A much weaker light may be used for young rabbits. For breeding, year round illumination of 15 - 17 hours / day @ 3 w / m^2 and for fattening, less than 12 hours / day @ 3 w / m^2 was recommended by different investigators.

E. General Management of Rabbit Production

MANAGEMENT involves all the plans and procedures necessary for the efficient and economic production of rabbits. It involves housing management, feeding management, breeding management, health management and general management. Here only general management procedures will be discussed.

Handling / Controlling

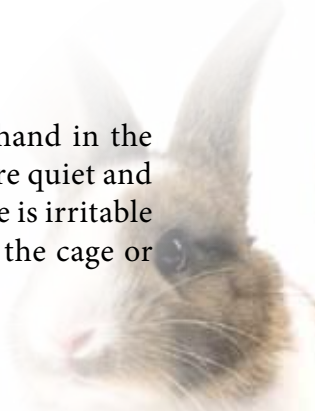
The object is day to day supervisions, identification, sexing, mating, providing treatment, keeping records and shifting from place to place etc. Use of proper method is essential to avoid injury to the rabbit and to the attendant. Method chosen should be used consistently, so that rabbit becomes accustomed with the system. Rabbits seldom bite but they can scratch, if not hold properly. When approaching to hold, one should proceed slowly and carefully, so that it is not frightened. Rabbits are lifted by grasping the skin over the shoulder, never by holding the ears, which irritate it. When it is controlled for a long time one hand should be put below the hindquarters or abdomen for additional support.

Management of nest box

Before one week of kindling, pregnant doe is brought into kindling cage. Immediately it starts plucking hair and preparing nest. If it is not sufficient, dry clean bedding material is supplied so that newly born kits do not get any injury or suffer from cold stress. Regular checking of moisture in nest material is needed to avoid mortality. If it is wet, it is to be replaced soon by dry one. When nest box material is replaced, it should be ensured that it is sufficient to cover kits. Castellini *et al.* (2003) reported that the litter weight of rabbit kits is significantly influenced by litter size at birth due to the fact that the relative share of milk per kit decreased as the litter size increased.

Care of litters

On the day after kindling inspect the litter. Quietly place your hand in the nest box and remove any deformed, undersized or dead young. If you are quiet and careful in making the inspection, the doe will not object too much. If she is irritable and nervous, place some tempting feed, such as a carrot or greens, in the cage or



hutch immediately before the inspection to distract her attention. Avoid disturbing the doe as much as possible just before and after kindling, since too much attention at this time may discourage the doe from settling down with her litter.

Weaning

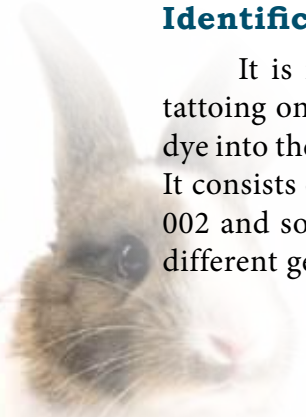
It is separation of young from the mother to make its habit on solid feed, generally practiced at the age of 4 to 6 weeks. If early weaning is practiced early mating of doe is possible. Creep feed is given to early-weaned kits. Post weaning management involves sexing, identification, deworming and drenching of ostocalcium to kits to avoid weaning stress. In a study of Das and Bujarbarua (2007), data on different productive and reproductive traits recorded from New Zealand White and Soviet Chinchilla breeds of rabbit for a period of four years were analyzed, while weaning of kits was practiced in three different ages ie at 30 days, 36 days and 42 days. Analysis of data revealed that weaning age had caused significant ($P < 0.05$) differences on litter weight at weaning, individual litter weight at weaning and non-significant ($P > 0.05$) effect on litter size at weaning, post - weaning average daily gain and mortality %. In respect of litter weight at weaning, individual litter weight at weaning, average daily gain and mortality, 42 days weaning was found to be best. In another study Das *et al* (2007) reported that parity and litter size at birth had highly significant ($P < 0.01$) effect on litter weight at weaning. Breed, season of weaning and litter size at weaning had non significant effect on litter weight at weaning. Ibrahim *et al.* (2003) reported a significant increase in preweaning mortality for kits born in large litter in New Zealand White breed of rabbit.

Sexing

It is needed for identification. In order to do this a very close examination is needed at the age of 4 -5 weeks. The fingers are placed before and behind the genitalia and with a little pressure inner surface of organ is exposed. In case of male the small penis protrudes slightly and in case of female opening is slit like and slopes towards the anus. After proper sexing in case of male tattoing mark is given on right ear and in case of female it is given on left ear.

Identification

It is required for keeping different records. The most common method is tattoing on the inner surface of ear. It involves impregnation of permanent ink or dye into the skin. Mark is given on right and left ear in male and female respectively. It consists of an alphabet indicating breed followed by digit in order, say N 001, N 002 and so on upto N 999. Here N stands New Zealand White. Within a breed if different generations are maintained, then P, 1 2, 3 may be given for parental, F-1,



F-2, F-3 generation and so on. Ear clipping and notching were used earlier, but both methods have disadvantage of tearing ear. Cage identification is also needed in case animal is misplaced. For this purpose a number plate dimension 5 x 4 inch, containing number of animal, breed, sex, age, date of mating and litter size at birth, date of kindling etc may be fitted on outer surface of cage.

Fostering

It means transfer of one or more nursing young from one female to another lactating female. This may be necessary if a nursing doe dies or fails to lactate normally or produce more offspring than she can fed properly. When fostering is practiced transfer should be made when the rabbits are as young as possible and they should be given to a doe that has the litter about the same age as those being transferred. It is generally being carried out within the age of 15 days old. If they are older, it is less likely that the foster mother will accept them.

Record Keeping

It helps for proper selection of animal for breeding, culling etc. It should be maintained regularly and systematically. For this purpose different registers may be kept for different objects e.g. breeding register, herd strength register, feed register, treatment register, post mortem register, growth register, sale proceed register.

Summer Management

a) As rabbit is sensitive to heat stress, hence during peak summer, they should be protected from direct sunlight either by providing shade, planting trees in and around the rabbit house.

b) Arrangement of cross ventilation.

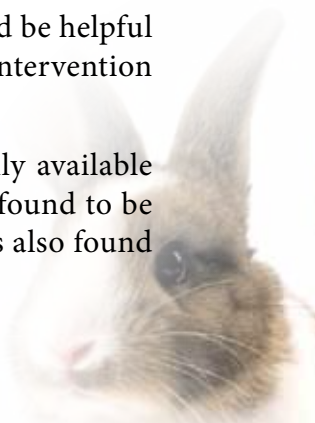
c) Provide sufficient clean drinking water.

d) Maintain rabbit individually.

e) If roof is made of GI sheet, it should be covered by thatch / straw to reduce heat load.

f) Arrangement of ceiling fan @ one fan / 15 m^2 of floor space would be helpful to reduce adverse impact of heat stress. It was also observed that intervention reduced the decline in growth around 40 %.

g) Arrangement of false ceiling by particle board or low cost locally available materials in addition to mechanical cooling by electric fans was found to be more beneficial to reduce adverse impact of climatic stress. It was also found



that intervention reduced the decline in growth around 49 %. Benefit was maximum in case of New Zealand White and Soviet Chinchilla rabbit.

h) Supplementation with Vitamin C @ 1 g / litre of water was reported to reduce heat stress and to improve productive and reproductive performances of rabbit (Yassein *et al*, 2008).

Winter Management

a) Arrangement of heating.
b) Arrangement of curtain / shed net to check entry of cold wind flow inside the house.
c) Provision of bedding material to kit's house.

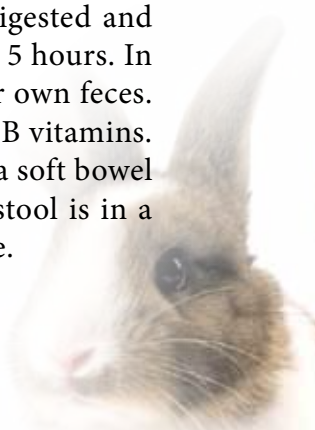
F. Feeding and Nutrition of Rabbit

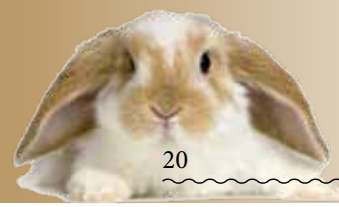
Rabbits are strict herbivores, which means that they eat vegetable, grass etc and they require a high-fiber diet for proper digestion. An optimum amount of high-quality grass, green fodder, vegetables, concentrate mash or pellet feed is an ideal diet for a rabbit. Water is the most important nutrient for rabbits and should be fresh and readily available.

Digestion

Rabbit kits nurse only one time a day and does stay with them only a few minutes a day. It has been postulated that once-daily nursing protects kits from predators. Doe produces very thick milk curd. After nursing, kits have fully distended stomachs full of thick milk curd, which slowly moves into the digestive tract.

Rabbits have continuously growing teeth. Rabbits have two pairs of upper incisors; the second pair is commonly called *peg teeth*. Rabbits are born with some permanent and some deciduous teeth and have all their permanent teeth by 3 to 5 weeks of age. Rabbits break down fiber by relying on the microflora of the hindgut. Rabbits selectively excrete fiber through their stool and re-ingest cecal contents in the form of cecotrophs. Rabbits cannot vomit because of a well-developed cardiac sphincter. A rabbit's stomach is used for storage and should never be empty. Twenty-four hours after eating a meal, a rabbit's stomach is usually still half full. If a rabbit has an empty stomach, a medical problem could exist. The small intestine of rabbits is the shortest of any species, making up only 12 % of the total gastrointestinal (GI) volume. The small intestine is the site of nutrient absorption, carbohydrate and fat digestion, fat emulsification and acid neutralization. The cecum is the largest organ in the abdominal cavity of rabbits. The cecum is coiled and thin walled, holding 40 % to 60 % of the ingesta. After moving into the cecum, fiber is digested and fermented. The GI transit time of fiber in rabbits is approximately 4 to 5 hours. In cecotrophy, which is commonly known as *coprophagy*, rabbits eat their own feces. Cecotrophy is required for rabbits to obtain certain nutrients - mostly B vitamins. Rabbits have two types of bowel movements: a normal hard pellet and a soft bowel movement that rabbits usually eat directly from their anus. The soft stool is in a grapelike cluster of small pellets surrounded by a gelatinous membrane.





Nutrient Requirements

Like all species, rabbits have nutrient requirements that can be met by consuming certain ingredients. A rabbit's basic nutrients are protein, carbohydrate, fat, vitamins, minerals, and water, which is the most important.

Protein

The crude protein requirement for rabbits is 12 % to 18 % dry matter (DM). The protein requirements of rabbits vary with life stage. Gestation and lactation require 18 % DM protein, growth requires 15 % to 16 % DM protein, and maintenance requires 13 % DM protein.

Carbohydrate and Fiber

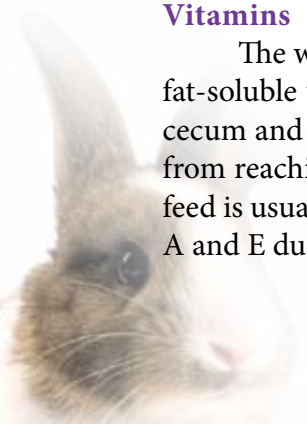
Carbohydrate is a major source of energy for rabbits. Most of the carbohydrate requirement for rabbits is in the form of fiber. Non digestible fiber is not fermented in the cecum, whereas digestible fiber is fermented by passing though the cecum. Nondigestible fiber is important for dental health because it helps wear rabbits' teeth. Non digestible fiber also helps stimulate gut motility. Fermentable fiber helps rabbits digest cecotrophs as well as prevents colonization of the cecum by pathogenic bacteria, helping to prevent bacterial overgrowth and decreasing the likelihood of enteritis. Volatile fatty acids (i.e., propionate, butyrate, acetate) are produced by bacteria in the cecum, absorbed into the bloodstream and used as energy. To produce volatile fatty acids, rabbits require crude fiber of at least 12 % to 16 % DM, depending on life stage: 12 % DM for lactation, 14 % DM for gestation, and 15 % to 16 % DM for growth and maintenance. Low-fiber diets can decrease GI motility, possibly leading to retention of food and hair and to formation of hairballs. Rabbits cannot vomit hairballs therefore; blockages can be life-threatening.

Fat

Rabbits use fat for energy and to absorb fat-soluble vitamins. Most foods contain 2 % to 5 % DM fat, which rabbits can get from a vegetable diet. Rabbits do not need fat added to their feed. Fat can increase palatability, but an excess amount can increase the risk of obesity, hepatic lipidosis and atherosclerosis in the aorta.

Vitamins

The water-soluble vitamins comprise the vitamin B complex and vitamin C. The fat-soluble vitamins are A, D, E and K. B vitamins are synthesized by bacteria in the cecum and colon and are absorbed by eating cecotrophs. Obesity can prevent a rabbit from reaching its anus to eat its cecotrophs, resulting in a vitamin deficiency. Pelleted feed is usually fortified with vitamins and minerals. To prevent destruction of vitamins A and E due to oxidization, rabbit feed should be fed within 90 days of milling.



Minerals

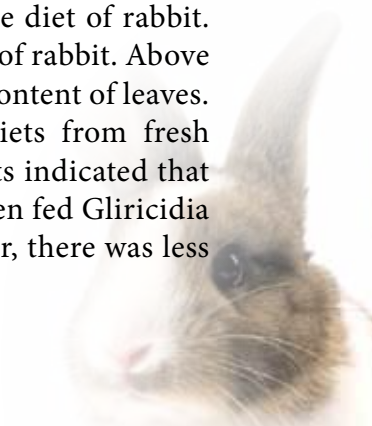
Rabbits absorb all the calcium in their diet; the kidneys excrete excess calcium as calcium carbonate in the urine, which appears milky as a result. Excess calcium carbonate can cause crystals and uroliths to form in the kidneys, ureters and bladder. Therefore, rabbits require a calcium level limited to 0.5 % to 1 % DM. Deficiencies in phosphorus, calcium or vitamin D can result in rickets, which causes a crooked, unnaturally arched back and enlarged joints in young rabbits. These deficiencies in adult rabbits may cause bone demineralization, increasing the risk of a broken back. Commercial rabbit feed would be supplemented with mineral and vitamins.

Water

Water is the most important nutrient for rabbits and should be clean, fresh and readily available. Water should be available round the clock particularly to a lactating doe. Rabbits consume water approximately 10 % of their body weight per day. Always keep water pots clean and remove sediments daily. Water pots should be cleaned thoroughly every week. Use of properly designed automatic watering equipment can also be made.

Feeding

Rabbits are very selective in their feeding behaviour and in the wild will select specific plant parts. They generally select leaves rather than stems, young plant materials rather than old and green rather than dry materials, resulting in a diet that is higher in protein and digestible energy and lower in fiber than the total plant material available. They are much more sensitive to slight changes in the feed than other livestock. Sometimes they will refuse to accept a new diet and will starve rather than accept the new feed for several days (McNitt *et al.*, 2000). The European Rabbit Society listed acceptable vegetables and fruits ie cabbage, broccoli, carrots, strawberries, papaya and pineapple. Vegetables, fruits and grass hay lose nutrients during storage, so, they should be fresh when fed to rabbits. Different grasses such as para grass, congocignal grass, guinea grass may be provided to the rabbits. Leaves of different fodder trees ie Mulberry (*Morus alba*), Subabol (*Leucaena*), Gliricidia (*Gliricidia sepium*) may be used for feeding rabbits. Mulberry leaves may be supplemented up to a level of 40 % in the diet of rabbit. *Leucaena* may be provided in the range of the 10 to 30% in the diet of rabbit. Above 30 % was reported to cause reduction in growth due to mimosine content of leaves. Onwudike (1995) studied two different foliage supplemental diets from fresh Giricidia and Leucaena added *ad-libitum* to a pelleted feed. Results indicated that there was a significant difference in growth rates of the rabbits when fed Gliricidia compared to Leucaena versus the feeding of pellets alone. However, there was less

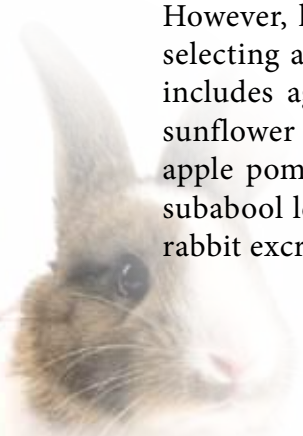


feed consumed for Gliricidia than for Leucaena, which might have been due to Gliricidia being less palatable than Leucaena. Feed conversion of the rabbits was improved 3.07 when fed Gliricidia compared to 3.91 with a Leucaena diet.

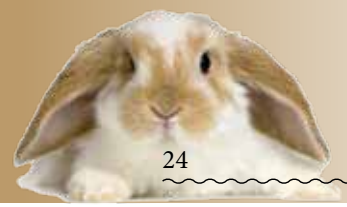
Pellets should be stored at or below 22.2 °C and for not more than 3 months past their milling date when they are fed. When a new feed is introduced, it should be gradually transitioned into the diet over a period of 5 to 7 days. To do this, owners should feed three-fourths of the original food and one-fourth of the new diet for 2 days, then half of the original diet and half of the new diet for 2 days, and then one-fourth of the original diet and three-fourths of the new diet for 2 days. After these 6 transition days, the new diet can be fed without the original diet. Concentrate feed may be prepared by mixing maize crust - 50 %, rice bran - 20 % , soya cake – 28 %, vitamin and mineral mixture – 1.5 % and common salt – 0.5 %. Feed requirement for different classes of rabbits was standardized as such ie weaner – 50 g, grower – 75 g, finisher-100 g, adult – 125 g and nursing mother 200 g.

Das *et al* (2003) in a study found growth rate of around 12 g / day in grower to finisher exotic broiler rabbit fed 50 % congosignal grass replacing 50 % concentrate feed. The mortality was found to be 6.73 % and mostly due to coccidiosis. Das *et al* (2004) reported in another study around 11 and 13 g / day ADG on 50 % congosignal grass and 50 % rice bean fodder in finisher Meghalaya Local rabbit. In a study of Das and Bardoloi (2008) different breeds of rabbits were maintained solely on different roughages such as grass, fodder, vegetables grown throughout the year in the terraces of farm. Congo signal grass, Rice bean fodder in summer season; Congosignal grass, Rice bean fodder, Guinea grass, Soybean leave, Sweet potato stem and leaves in rainy season, Oat fodder, Carrot root and leaves, Radish root and leaves, Beet pulp and leaves, cabbage were fed to rabbits in winter season. Average daily gain was found to be 17.15, 16.11, 17.40, 17.97 g / day in New Zealand White, Soviet Chinchilla, Indigenous local and Cross bred rabbits respectively with an average value of 17.06 g / day.

Rabbit being omnivorous in nature, can thrive on wide variety of unconventional feed stuff without any adverse effect thus lowering feed cost. However, level of incorporation and toxic principles are to be considered before selecting any unconventional feed in the diet of rabbit. Unconventional feedstuff includes agricultural crop residue eg cow pea hulm, peanut hulm; oil cake eg sunflower cake, neem seed meal, cottonseed meal ; fruit industry byproduct eg apple pomace, citrus pulp; forest by product eg mulberry leaves, tapioca leaves, subabool leaf; aquatic plant eg azolla; animal organic waste eg poultry droppings, rabbit excreta (Das and Khagaria, 2004).



In a study it was revealed that probiotic supplementation had significant ($P < 0.05$) effect on final live weight, average daily gain and FCR in Soviet Chinchilla, on average daily gain in Local breed only. In case of New Zealand White breed effect was non significant in all traits. Probiotic supplementation had no significant ($P > 0.05$) effect on average daily dry matter intake in any of the breed. It was found that final live weight, average daily gain and feed conversion ratio were improved in treated group i.e. probiotic supplemented group (Das *et al*, 2006).



G. Reproduction of Rabbit

Selection of Breeding Stock:

The selection of breeding buck and doe is very much important aspect of breeding since good progeny is expected from good buck and doe. One has to consider the breeding stock in terms of fertility, maternal instinct, milk yield, growth rate, fecundity and viability.

(a) Buck : The male rabbit is known as buck. A buck develops its breeding capabilities at the age of 8 months. An ideal buck should continue to maintain its reproductive ability at least for 3 years. A young buck may be allowed to mate one doe at an interval of 3 to 4 days. But, from 12 months of age onwards it may mate 4 - 6 does in 7 days. A buck beyond 6 years of age should be culled since semen quality declines. In order to keep the buck healthy additional protein, vitamin and minerals are to be supplemented in diet. Two breeding bucks should not be kept in same place as they will fight each other and cause injury.

(b) Doe : The female rabbit is known as doe. A doe becomes capable to reproduce based on breed, nutritional status and seasons. The smaller breeds attain sexual maturity earlier than larger breeds. A small breed may accept mating at 6 months of age whereas the larger breed may accept mating at 7 months of age. A doe can be used for breeding up to the age of 3 years and culling should be made afterwards.

Reproduction:

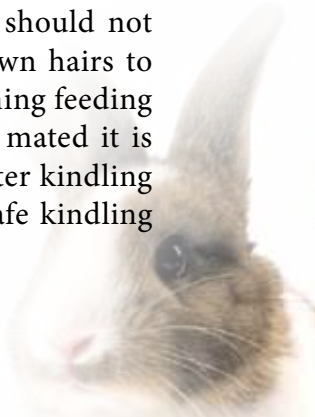
(a) Ovulation: The rabbit belongs to a group of mammals which do not ovulate spontaneously. There is no oestrus cycle. Ovulation requires stimulus of mating and thus induced in nature. Sexual stimulation with copulation or in response to exogenous, gonadotropins, ovulation takes place. Generally it takes place at 10 hours following mating. It is thought that does may remain in constant heat throughout the year or in breeding season. But, it is known that follicles develop and regress in cycles of 15-16 days. There is a lack period when the doe may lose interest for the buck. Ovulation can also be induced through mechanical stimulation of vagina.

(b) Mating: A doe whether is in heat condition or not is difficult to recognize outwardly. But, does may show some manifestations like restlessness, nervousness, rubbing of head and chin on the side of the cage or other objects. The vulva becomes swollen and purple in colour. But, acceptability of the does to the bucks or does reaction to bucks should be taken as a criteria for heat. Therefore, detection of heat through buck should be made before allowing for copulation. The approximate age of first mating is around 6 months of age. During mating females are brought to the male's cage and after successful mating females are brought back to its own cage. If reverse is done female refuses mating. In case of new rabbit attendant should lift backside of female rabbit and hold the male accordingly. Early morning and early evening are the most conducive time for mating. A receptive doe will lift her tail and allow mating. Males vary greatly in their sexual drive. A buck may be slow in performing the service to a strange cage. After successful mating the buck usually produces a typical cry and falls down to one side of the doe.

One mating is usually sufficient. Consecutive two days mating with the same male assures conception. In an experiment of Das and Yadav (2007), it was found that if double mating is practiced in rabbit, farmers will be more benefited in terms of litter size at birth, litter size at weaning, litter weight at birth, lesser services per conception and number of live born kits / doe / year.

It is a good practice to mate several does on the same day for practicing fostering. If two breeding animals are kept together they should be separated at least 15 days before mating to avoid pseudo pregnancy. If a female does not allow, in that case keeper should wait for 3 to 4 days or assist in mating by holding the female. In a commercial rabbit farmers would like to have five or six litters per doe per year. This is possible only by weaning the litter at five weeks of age and mating the doe immediately following weaning.

(c) Pregnancy: The gestation (pregnancy) period in rabbit ranges from 28 - 32 days (approximately 30 days). The nest box is to be kept within the cage to facilitate the doe for preparing bedding for the new born. The nest is to be provided at least 5 - 6 days before parturition. The nest box should contain nesting materials like straw, grass, wood savings etc. Saw dust should not be used as bedding material. A doe may pullout some of her own hairs to make nest for litters. Adequate measures should be taken concerning feeding and management during pregnancy period. Once the female is mated it is desirable to know whether she has conceived or not to reduce inter kindling period. If positive, proper care and management be given for safe kindling and obtaining higher litter size.



Quantity of feed should be increased for 10 to 15 days of pregnancy. In a study Das (2006) revealed that prepertum feed supplementation ie in addition to roughage, concentrate feed was supplied to adult rabbits during last stage of pregnancy, had significant ($P< 0.05$) effect on individual litter weight at weaning only. Litter size at birth was non-significantly ($P > 0.05$) higher in the group where concentrate feed were fed to adult rabbits upto the weaning of kits. The average litter size at birth was 6.01. However individual litter weight at weaning was significantly ($P < 0.05$) lower in concentrate supplemented group. Moreover it was also found that lesser service is required per conception in the rabbits fed concentrate mash feed in addition to green roughage. Conception rate was non-significantly higher in concentrate supplemented group than that in sole roughage feeding group with an average value of 71.37 %. Plenty of fresh water should be provided. Environmental stresses should be avoided as far as possible. Balanced nutrition containing 16 % CP, 12 % CF, 6 % mineral and vitamin should be given. If negative, doe is rebred with another male preferably.

Pregnancy can be detected by following methods

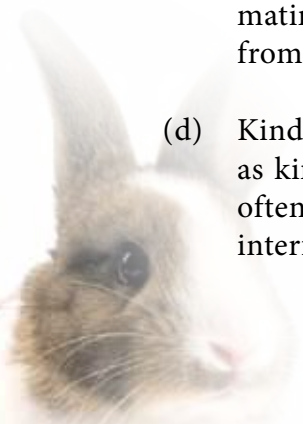
(a) Through palpation of abdomen by which embryos can be felt by hand. This is best done at about two weeks after mating. Palpation involves careful feeling of abdomen. For this the doe is placed over a table in relaxed position. The thumb and forefinger should be used to feel the embryos by moving the hand gently backward and forward. The embryos are easily felt as distinct ball evenly spaced on each side. Considerable experience is required for accuracy.

(b) Placing the buck near the doe for mating. A buck may not mate the pregnant one.

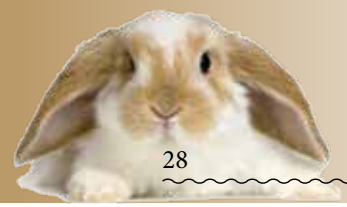
(c) Careful observing of uterine swelling may be detected. Uterus may swell up to 12 mm at 9 days after mating. It may reach 20 mm at 13 days. Only experienced person may be able to predict.

(d) Changes in body weight - There are significant change in body weight from mating up to 30 days. Average gain of around 300 - 400 gm has been suggested from mating to 30 days in large sized rabbit.

(d) Kindling (Parturition): Process of giving birth of new baby of rabbit is known as kindling. It is a natural physiological phenomenon. The parturition very often takes place at late night or early morning. It may not require any interference by the keeper. The process usually completes within 7 - 30 m.



Sometime all the litters may not be born on succession. Some may born after several hours or a day. Following parturition the does used to lick the young and may eat the placenta. The baby rabbits will try to suckle the mother. If the number of litter is eight, all may be able to suckle since doe has eight teats. The baby rabbits those will be unable to suckle may turn weak and susceptible to diseases. Many of them may even die prematurely. The does should not be disturbed during this time and be fed ad lilbitum. Adequate food and water should be provided so that optimum amount of milk is available to the baby rabbits. Rabbit used to nurse her young usually at night or early morning only for once. 6 - 12 baby kits may be born from a single kindling.



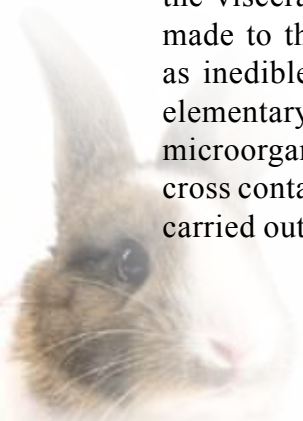
H. Slaughtering of rabbit, Carcass traits and Carcass composition

Rabbit is introduced in India in the last decade as an alternative source of meat production. Rabbit meat is wholesome; tasty with appreciable juiciness and tenderness. It contains highest amount of protein and least amount of fat and cholesterol. The low cholesterol level of rabbit meat leads to an increase in its consumption by human beings (Elamin, 2013). Thus people have great fascination for consumption of rabbit meat. Moreover people of this region are non-vegetarian and they don't have any social prejudice regarding consumption of rabbit meat. Even rabbit has very high dressing percent ranging from 60 - 65 %. The heritability of different carcass traits is medium to high. So, the carcass traits might be considered for selection and breeding of rabbit.

Slaughtering and dressing of rabbit is done by dislocation of the neck followed by bleeding. The rabbit is held firmly by the rear leg and head stretching it to full length. The head is then bent backwards with a hard sharp pull to dislocate the neck. After the dislocation the head is severed to allow complete bleeding by hanging the rabbit upside down. The forefeet are then removed.

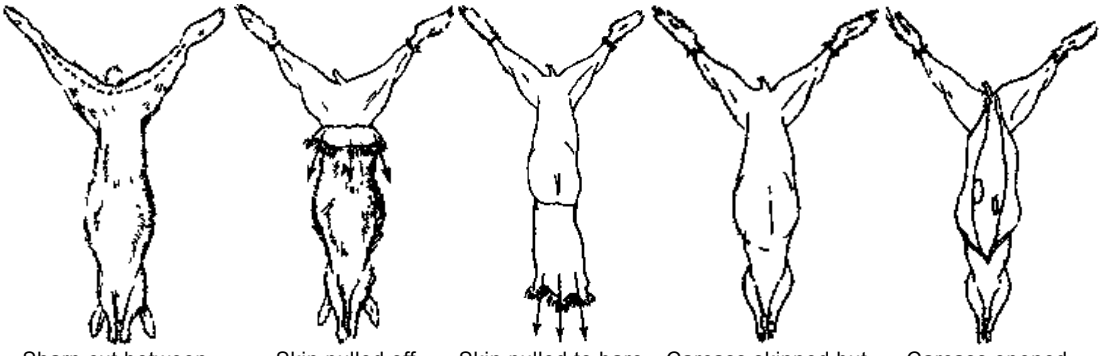
The next is to cut the skin around the hock joints of the legs and then to cut between these points across the lower part of the body. The tail is cut away and the skin is then free to be pulled down and forward over the body. This operation should be done with care to avoid mutilation, knife marks, grease (which oxidizes and burns the skin) or bloodstains. All these defects reduce the value of the pelt, especially when the coat is originally of good quality. The skin thus removed is sundried immediately to prevent its spoilage and proceed thereafter.

After the head, forefeet and skin are removed the carcass is opened to remove the viscera. A cut is made on the lower part of the abdomen and straight cut is made to the chest cavity. The elementary tract and lungs are normally removed as inedible offal. Extreme care has to be taken to ensure that no portion of the elementary tract is cut or punctured as the contents of these organs contain lot of microorganisms that can contaminate the clean carcass. In order to prevent such cross contamination it is advisable that the area where deskining and evisceration is carried out be compartmentalized from the areas where the relatively clean carcass



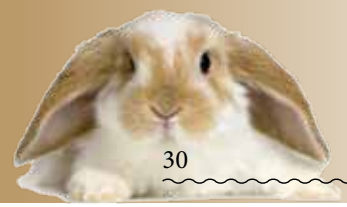
is handled. Liver, kidney and heart may remain with the carcass or conversely may be removed and disposed off separately as the pluck which is the edible portion of the offal. The carcass thus remaining is then cut into requisite pieces. Normally for commercial purposes the rabbit carcass are cut into six major portions.

Different steps of deskining a rabbit was shown below :-



It is reported that different factors such as age at slaughter, weight at slaughter, breed and sex had influence on different carcass traits (Salroo *et al*, 1989; Roiron *et al*, 1992; Parigibini *et al*, 1992; Deb and Gaur, 1996). In a study of Das and Bardoloi (2008), it was revealed that slaughter weight, slaughter age, breed and sex had highly significant ($P < 0.01$) effect on carcass weight of rabbit. However, slaughter age, breed and sex had highly significant ($P < 0.01$) effect on dressed meat weight. It was also found that only preslaughter weight had significant ($P < 0.05$) effect on dressing %. The overall carcass weight was 854.37 g. The overall dressed meat weight was 910.15 g. The overall value of inedible offal weight was 679.37 g. The overall value of dressing percent was recorded to be 54 .84 %.

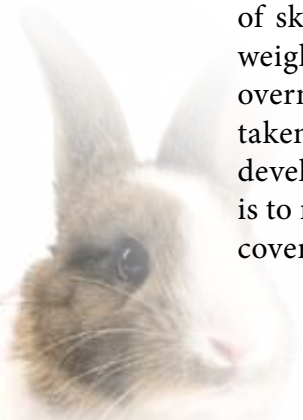
Comparative study on carcass traits between two breeds of rabbit revealed that preslaughter weight, carcass weight and dressed meat weight were higher in New Zealand White, breed of rabbit but edible part weight and dressing percent were higher in Soviet Chinchilla breed. Based on information collected from 80 consumers, it was found that 43.75 % consumers reported flavour of meat as good, 46.25 % consumers reported juiciness of meat as medium and 50.00 % farmers reported tenderness of rabbit meat as medium. Consumption pattern of meat revealed that 52.50 % people took rabbit meat once per week and 37.50 % reported that they took rabbit meat @ 100-200 g / week. Chemical composition of rabbit meat was determined also during carcass study. It revealed that rabbit meat contained crude protein (CP) 20.00 % and crude fat (EE) 5.40 % (Das and Bujarbarua, 2005).



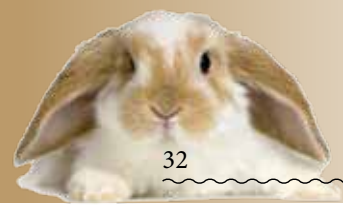
I. Processing of Rabit Fur Skin

At the time of slaughter besides meat an important by product fur skin is available from rabbit. Farmers usually throw this skin due to lack of proper processing technique. The commercial value of rabbit skins has long been recognized. In USA more than 100 million rabbit skins are processed annually for making fur garments, hats, hand gloves etc. Therefore, if some products would be prepared from processed skin, farmers would earn besides selling meat as well as shelf life of skin would increase. Hence an effort was made to standardize the technique. Qualitative study was done for 259 rabbit skins. It was found that length, breath and thickness of Soviet Chinchilla rabbit was higher than that from New Zealand White rabbit. Even the margin from rabbit enterprise was enhanced due to processing of fur skin and selling it regularly besides meat and manure. The processing cost appeared to be high. However, if skin processing is done in large scale cost of processing would be reduced. Around 325 fur skins of rabbit were processed by chrome tanning method. However, it was standardized for rabbit skin to make the products. It was standardized and processed by going through following steps (Das and Yadav, 2007).

- **Washing :-** It was done to make skin free from dust, blood etc. If meat was adhered, it was removed by knife.
- **Soaking :-** It was done to make skin soft and swelled for better penetration of chemical during next step.
- **Pickling :-** To make skin soft , this operation was continued for a period of three days. Everyday pH was maintained 2.8 to 3.0. 1st day skin was treated with 8 - 10 % sodium chloride, 2nd day with 1 % formic acid and 3rd day with 1-2 % alum on the basis of skin weight.
- **Tanning :-** The object was to get strength, thermal stability and fullness of skin. 8 – 10 % basic chromium sulphate was taken on the basis of skin weight, made a paste and applied on the flesh side of the wet skin. It was left overnight and then checked whether it penetrated or not. A piece of skin was taken to see inside whether blue colour developed or not. If the colour did not develop, it indicated that chemical did not penetrate the skin, so the process is to repeat. Then tanned skin was kept in tub containing water sufficiently to cover the skin.



- **Basification:-** The object was to fix the chromium sulphate. 1 % solution of sodium bicarbonate was prepared and was added in the earlier tub in 5 to 6 installments. During this time pH was maintained 3.8 to 4.0. During adding chemical one has to stir the water of tub continuously.
- **Fat liquoring:-** It was done to achieve softness of the skin. 4 - 5 % synthetic, 4 - 5 % semi synthetic and 4 -5 % fish oil based fat liquor on the basis of skin weight was taken for this operation. The operation was continued for half day. Before adding fat liquor, it was emulsified by pouring measured quantity of fat liquor in 250 - 500 ml luke warm water (60 ^{o}C). During adding emulsified fat liquor, the water in the tub was stirred continuously.
- **Retanning:-** This was done by synthetic tanning agent i.e. basynton DI 2 - 3 % on the basis of the skin weight. The object was to give skin strength and thermal stability. The step was continued for half day.
- **Neutralization:-** This was done by 1% sodium bicarbonate or 1% formic acid, pH during this operation should be 5.2 - 5.5. This was ascertained by taking section of skin and measuring pH by pH paper. Chemical was added to the water of tub slowly. The object was to fix the retanning agent. The operation was continued for 2 – 3 hours.
- **Cleaning:-** If there was any oil, stain, dirt on fur side of skin it was cleaned by soaked cotton with rectified spirit.
- **Drying:-** Then the skin was dried in shade, in hanging condition for two days.
- **Pressing:-** After drying the skin perfectly 5 - 6 skins were tagged one above another and heavy weight was put over it to make the skin uniform as far as possible.
- **Rubbing:–** Then skin was rubbed over a hard object, preferably wooden piece for few minutes to make the skin uniform.
- **Preserving: -** Afterwards skin was tagged, keeping either fur side or flesh side one above the other in dry place.



J. Diseases and Health Management of Rabbit

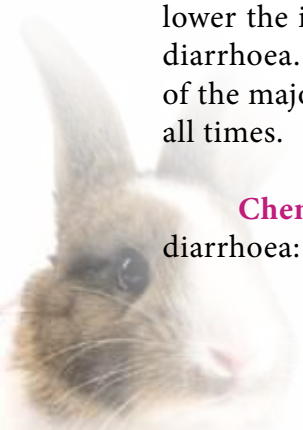
Digestive Disorder (Enteritis)

The symptomatology of rabbit enteritis is relatively simple and constant and rarely permits an etiological diagnosis of the disease. The first signs are decrease in feed intake and growth. Next, diarrhoea appears, sometimes preceded by complete constipation or production of soft pellets which are not eaten. Diarrhoea is moderate, consisting of a small quantity of fairly liquid faeces which soil the animal's hindquarters. Death can occur at this stage, sometimes even before the appearance of diarrhoea. Skin dehydration also appears at this time. Two or three days later the acute phase of the illness starts. It involves an almost total stop in both solid and liquid intake, extensive diarrhoea and high mortality; grinding of the teeth is a symptom of severe intestinal pain.

A post-mortem examination shows lesions, usually atypical. During the acute phase the intestinal contents are very liquid, sometimes discoloured. The caecum often fills with gas and contains little food matter. The intestine is sometimes congested or bruised. The walls of the caecum are most striking, congested and streaked with red, like brush strokes.

It has been seen that different factors can cause outbreaks of diarrhoea. Rabbits seem to react negatively to: transport, especially during the postweaning period; the presence of unusual visitors (people or animals); and sounds not identifiable by the animal and lasting for hours or days, such as work in progress near the rabbitry.

Feeding is unquestionably a prime factor in the occurrence of diarrhoea. Not enough crude fibre, too much protein and meal which has been too finely ground are all unfavourable. Also to be remembered the fact that the rabbit regulates its intake according to the energy in the feed. Too much energy in the feed can lower the intake too far and vice versa. Feed changes are all too often blamed for diarrhoea. Improper watering is very common in farm rabbitries. It is probably one of the major causes of mucoid enteritis. Rabbits must have clean water available at all times.



Chemical agents: Administration of some antibiotics invariably provokes diarrhoea: ampicillin, lyncomycin and clyndamycin. Antibiotics should always be

used very sparingly with rabbits, especially penicillin. It also seems that drinking-water with a high nitrate content causes the chronic diarrhoea observed in some areas.

Mouldy feed: (pellets, domestic waste, bread, vegetable peels) can very quickly cause diarrhoea even in a healthy rabbit.

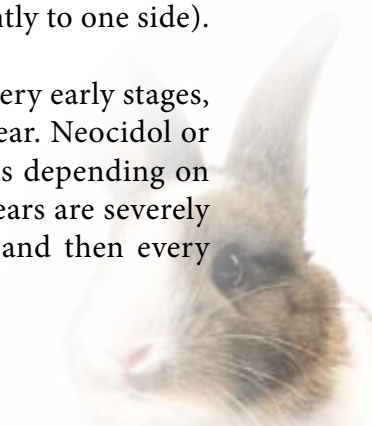
Viruses and bacteria: There has been little work on enteropathogenic rabbit viruses but they are known to exist. It is very likely, however, that as with most other animal species the condition of the animal itself is a decisive factor in the occurrence of viral diarrhoea. Salmonella are rarely isolated in sick rabbits but this is not true of *Corynebacteria, Clostridium, Pasteurella* and especially, *Escherichia coli.* Apart from some *Clostridium* species and a few serotypes of *E. coli,* healthy rabbits carrying these bacteria do not contract the relevant disease. *E. coli* occur systematically in very large numbers in rabbits with diarrhoea or even with coccidiosis. The most pathogenic among them *(Clostridium,* certain serotypes of *E. coli)* can, above a certain pollution threshold in the rabbitry, be the direct cause of diarrhea.

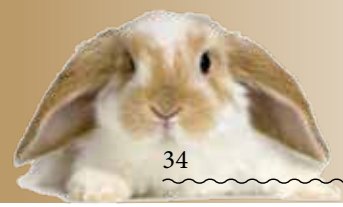
All the major parasite families are found in rabbits: trematodes (flukes), cestodes (tapeworms), nematodes (intestinal worms) and protozoa (coccidia). Coccidia are the major specific agents of diarrhoea in the rabbit. Coccidia are protozoa, the most primitive phylum of the animal kingdom. They are sporozoa, i.e. parasites with no cilia and no flagella, which reproduce both sexually and asexually. A large number of families are represented. The Eimeriidae family is typified by the independent development of male and female gametes. Most of clinical signs are not specific to intestinal coccidiosis. The main symptoms are: diarrhoea, weight loss, low intake of feed and water and death.

Ear canker

Ear canker is very common. It is a parasitic disease caused by a mite *(Psoroptes* or *Chorioptes)* and frequently complicated by bacterial infection. The symptoms are external otitis and yellow or brown scabs in the ear canal. The middle ear may then be affected, causing wryneck (the rabbit's head is held constantly to one side).

Treatment can be effective if the disease is diagnosed in the very early stages, that is, as soon as small yellow-brown deposits are noticed in the ear. Neocidol or Butox may be applied locally in the ear for three to four occasions depending on the condition. Prevention involves culling rabbits whose external ears are severely affected, and treating all other rabbits for several days running and then every





fortnight. Throughout the treatment the straw litter must be changed frequently as the parasites can stay alive in the litter for a long time. Ivermectin is the drug of choice; two 200 mg injections per kilogram of live weight twice daily provides a spectacular cure.

Skin mange

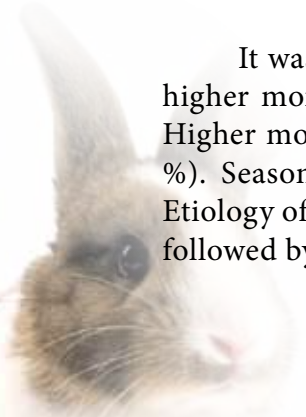
Skin mange, a parasitic disease caused by a mite *(Psoroptes* or *Chorioptes).* Tip of the nostril, abdominal area, extremities are generally affected. Clinical symptoms are loss of hair followed by wound, if it is a aggravated by bacterial infestation and not treated in the initial stage. Neocidol or Butox may be applied locally for three to four occasions depending on the condition.

Aflatoxicosis

It is a fungal disease caused due to intake of mouldy feed contaminated with *Aspergilus flavus*. Such fungus forms mycotoxin ie aflatoxin in the feed. It causes mortality as high as 35 %. It does not respond to any treatment. The clinical symptoms are loss of appetite, dull and depressed, distended abdomen, when rabbit is shaken distinct gurgling sound is audible similar to shaking of coconut. There is no sign of diarrhea or high rise of temperature. Even in case of pregnant rabbit abortion may occur. So as a precautionary measure immediately the feed is to be replaced by fresh feed. Feed should not store for a long period, particularly in high humidity and high rainfall area. More vegetables, grass and fodder may be given. Treatment consists of broad spectrum antibiotic parenteraly to the sick animals for three to five days and antibiotic powder may be mixed with water or feed and fed to the good animals for three to five days. Multivitamin may be mixed with feed and liver extract may be mixed with water and fed to all the rabbits for a week.

Around 374 data on different mortality cases recorded from New Zealand White and Soviet Chinchilla breed of rabbit in three seasons i e summer, rainy and winter over a period of four years in Rabbit Research Farm under Animal Production Division of the institute were analyzed statistically (Das, 2012). Rabbits were housed in indoor cage system and 50 % mash feeding and 50 % roughage feeding was practiced.

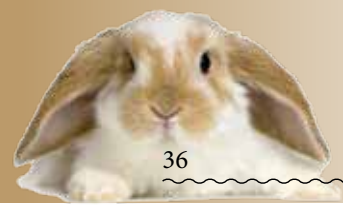
It was found that highest mortality was in first generation crops. Breed wise higher mortality was observed in New Zealand White breed of rabbit (22.12%). Higher mortality was observed in female (20.48 %) and in finisher rabbits (21.49 %). Season wise highest mortality was recorded in summer season (17.90 %). Etiology of disease indicated that highest mortality was due to coccidiosis (5.62 %) followed by deficiency disorder (5.50 %).



Control and prevention:

The best control for any disease is good husbandry techniques and culling of rabbits with clinical disease. Management measures should be aimed at controlling the clinical disease expression. The rabbitry must have good ventilation, low ammonia levels and low temperature and humidity to decrease incidence of this disease. So it would be concluded that

- Regular cleaning of shed, feeder and waterer is very essential to avoid digestive disorders.
- Practically rabbit does not suffer from any major disease, hence no vaccination is needed.
- They suffer from coccidiosis. Hence regular deworming is needed by anticoccidial medicine like sulmet etc. at least four times a year.
- To avoid ricket problem one course of ostocalcium is needed after weaning.
- In case of mite infestation neocidol or butox should be applied three to four times locally.
- To avoid aflatoxicosis mold infested feed should be discarded and necessary treatment should be given immediately as per instruction of veterinarian.



K. Economics of Rabbit Production

Following assumptions were made for calculation of economics: -

1. Eight female and two male rabbits of Soviet Chinchilla / New Zealand White breed of 6 months age group was taken and economics was calculated for a year.
2. Four crops per year and five litters per birth were considered
3. Mortality was considered as 10 %.
4. Conception rate was considered as 80 %.
5. Age of selling rabbit was considered at 90-100 days
6. Interest of loan was considered 5 % and it was considered that money for fixed cost was given by bank.
7. Family labour was put, so no labour cost was included
8. Cost of feed was Rs 20 per Kg. 50 % dry matter was supplied through kitchen garden produce and household offal, as rabbit is herbivorous and more particularly omnivorous
9. Purchasing price of each animal is Rs. 200 /-
10. Selling price of each rabbit is Rs.220 /-
11. Cost of ordinary cage and kindling cage is 400 and 600 each respectively.
12. Dimension of thatch house 20 ft x 15 ft = 300 sq ft. Rate of construction is considered to be Rs 50 per sq ft.

A. Fixed Cost

1.	Animal	10 x 200	= Rs. 2,000.00
2.	House	300 x 50	= Rs 15,000.00
3.	Ordinary Cage	50 x 400	= Rs 20,000.00
4.	Kindling cage	10 x 600	= Rs 6,000.00
5.	Waterer and feeder	250 x 10	= Rs 2,500.00
	Total		= Rs 45,500.00

B. Recurring Cost

1.	Cost of feed	10 x 100 g x 365 d x 20/-	= Rs 7,300.00
		125 x 60 g x 100 d x 20/-	= Rs 15,000.00
2.	Cost of Medicine	136 x 10/-	= Rs 1,360.00
3.	Interest of loan	Rs 45,500 x 10 %	= Rs 4,550.00
	Total		= Rs 28,210.00

C. Income from Sale

1.	Sale of rabbit	
	4 crops x 7 does x 5 litters = 140 - 14= 126 x 220/-	= Rs 27,720.00
2.	Sale of manure	
	(125 x 50 g x 90 d) + (10 x 100 g x 365 d) = 9.28 Qt x 500 /-	= Rs 4,640.00
	Total	= Rs 32,360.00

1.	Net Income / 10 rabbits / year	= Rs 4,150.00
2.	Net Income / rabbit / year	= Rs 415.00
3.	Net Income / rabbit / month	= Rs 34.58

NB If income is done solely from selling of dressed meat, economics will be different. For this economics following assumptions are made

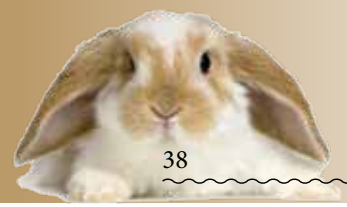
i) Meat available at the age of 90 days is 1.0 kg per rabbit which will be sold @ 200/- per kg.

ii) Raw fur skin will be sold @ Rs 30/- per piece.

1.	Sale of rabbit meat 126 x 1.0 kg x 200/-		= Rs 25,200.00
2.	Sale of furskin	126 x 30/-	= Rs 3,780.00
3.	Sale of manure		= Rs 4,640.00
	Total		= Rs 33,620.00

1.	Net Income / 10 rabbits /year	= Rs 5,410.00
2.	Net Income / rabbit / year	= Rs 541.00
3.	Net Income / rabbit / month	= Rs 45.08

NB. Afterwards breeding stock, 60 cages, feeders, waterers and hutch will remain with the farmer.



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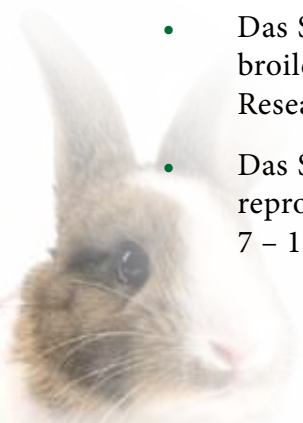

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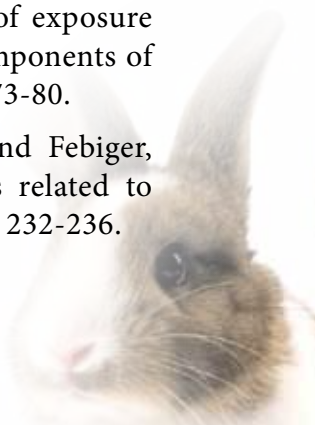

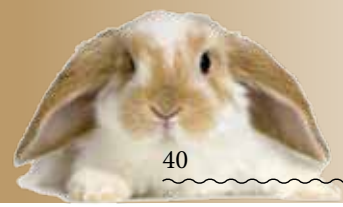

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