Skills for Entrepreneurship Development in Pig Husbandry

Edition: 2022

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This e-book is a compilation of lecture notes obtained from the resource persons of the training programme "Skills for Entrepreneurship Development in Pig Husbandry" jointly organized by ICAR-National Research Centre on Pig, Guwahati & National Institute of Agricultural Extension Management, Hyderabad, India. This e-book is designed to educate extension professional from state animal husbandry and veterinary department, students, research scholars, farmers, entrepreneurs and academicians in animal husbandry and veterinary sector about the skills for entrepreneurship development in pig husbandry. Neither the publisher nor the contributors, authors and editors assume any liability for any damage or injury to persons or property from any use of methods, instructions, orideas contained in the e-book. No part of this publication may be reproduced or transmitted without prior permissionof the publisher/editors/authors. Publisher and editors do not give warranty for any error or omissions regarding the materials in this e-book.

Published for Dr. P. Chandra Shekara, Director General, National Institute of Agricultural Extension Management (MANAGE), Hyderabad, India by Dr. Srinivasacharyulu Attaluri, Program Officer, MANAGE and printed at MANAGE, Hyderabad as e-publication.

MESSAGE

National Institute of Agricultural Extension Management (MANAGE), Hyderabad is an autonomous organization under the Ministry of Agriculture & Farmers Welfare, Government of India. The policies of liberalization and globalization of the economy and the level of agricultural technology becoming more sophisticated and complex, calls for major initiatives towards reorientation and modernization of the agricultural extension system. Effective ways of managing the extension system needed to be evolved and extension organizations enabled to transform the existing set up through professional guidance and training of critical manpower. MANAGE is the response to this imperative need. Agricultural extension to be effective, demands sound technological knowledge to the extension functionaries and therefore MANAGE has focused on training program on technological aspect in collaboration with ICAR institutions and state agriculture/veterinary universities, having expertise and facilities to organize technical training program for extension functionaries of state department.

Animal husbandry and livestock sectors are critical for rural livelihood and economic development of the country. India possesses one of the largest livestock wealth in the world and a quarter of the agricultural gross domestic product is contributed by the livestock sector. Among the livestock species, pig finds an important place as it being reared by socio-economically weaker sections of the society. Pig as compared to other livestock species has a great potential to contribute to faster economic return to the farmers, because of certain inherent traits like high fecundity, better-feed conversion efficiency, early maturity and short generation interval. Pig farming also requires small investment on buildings and equipments. It has immense potential to ensure nutritional and economic security for the weaker sections of the society. Pork consumption being popular among select populations, improved pig husbandry programmes and pig-based integrated fish farming have significantly contributed in the poverty alleviation strategies of the Government.

It is a pleasure to note that, ICAR-National Research Centre on Pig, Guwahati is organizing a collaborative training program on “Skills for Entrepreneurship Development in Pig Husbandry” from 15-17 June, 2022 and coming up with a joint publication as e-book on “Skills for Entrepreneurship Development in Pig Husbandry” as immediate outcome of the training program.

I wish the program be very purposeful and meaningful to the participants and also the e-book will be useful for stakeholders across the country. I extend my best wishes for success of the program and also ICAR-National Research Centre on Pig, Guwahati, Assam many more glorious years in service of Indian agriculture and allied sector ultimately benefitting the farmers. I would like to compliment the efforts of Dr. Shahaji Phand, Centre Head-EAAS, MANAGE, Hyderabad and Dr. Vivek Kumar Gupta, Director, ICAR – NRC on Pig for this valuable publication

Dr. P. Chandra Shekara
Director General, MANAGE

FOREWORD

Pig is one of the most important livestock of the North Eastern Region that provides food livelihood security to tribal and weaker sections of the society. In India, the demand-supply gap of pork is about 50%, which provides immense scope for entrepreneurship development in piggery sector. In recent years, pig farming and value addition has attracted entrepreneurship and private investment indicating resurgence of piggery based agribusiness. There are opportunities for the small and marginal farmers to jointly form self help groups or farmer producer organizations for establishment of processing unit and development of branded products. Key priorities in the agribusiness promotion in piggery sector are the clean and safe pork production, value addition and brand development.

The ICAR-National Research Centre on Pig, Guwahati has a vision to bring in excellence in pig production, health and processing. The institute has been in the forefront to provide technological backstopping to different stakeholders in the piggery sector and to improve knowledge and skills. To promote piggery based entrepreneurship the institute has established a agribusiness incubator and has transferred technology to several startups. I am delighted that the NRC on Pig is organizing a online training programme on "Skills for Entrepreneurship Development in Pig Husbandry" sponsored by the National Institute of Agricultural Extension Management (MANAGE), Hyderabad for the extension officials of state/central animal husbandry departments, veterinarians, faculty of SAUs/KVKs/ICAR institutes, Research Scholars etc. during 15-17th June, 2022. The lectures of this online course are well designed to expose the participants to various aspects and opportunities of entrepreneurship development in piggery sector. I hope that the participants from different parts of the country would be immensely benefitted from this online course by interactions with the expert resource persons selected for this training. The compendium of lectures of this programme has been designed for providing comprehensive knowledge on the subject to the readers. I extend wishes to organizing team and participants for a successful learning experience.

(Vivek Kumar Gupta)
Director
ICAR-National Research Centre on Pig, Guwahati

PREFACE

This e-book is an outcome of collaborative online training program on "Skills for Entrepreneurship Development in Pig Husbandry" conducted from 15-17 June, 2022. This book will be highly useful to the grass root level extension functionaries, entrepreneurs in piggery sector, academicians and research scholars. In this book we covered different aspects of piggery based entrepreneurship development like Agri-Business Ecosystem in India, Entrepreneurship development in allied sectors of agriculture, Breeding management in commercial pig breeding farms, Entrepreneurship Development through Self-Help Groups (SHGs) and Farmer Producer Organizations (FPOs) in Piggery Sector, Artificial Insemination in Pigs, Feed formulation and setting up of large-scale pig feed production units, Value addition of pork and incubation support from ICARNRC on Pig, Agri-business units: Experiences from ICAR, Technology Commercialization and Transfer from Research Organizations, Bankable projects for pig farming, Innovations in agricultural extension and MANAGE initiatives, Entrepreneurship Models in Allied Sector.

We would like to express our sincere thanks to all the authors of the book chapters for their contributions within the stipulated time. We are thankful to the Director General, MANAGE and Director, ICAR-National Research Centre on Pig for their support and guidance. The financial aid provided by MANAGE, Hyderabad for this training program is duly acknowledged. We hope and believe that this e-book will help in promoting piggery based entrepreneurship in India.

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Dr. Shahaji Phand
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CONTENTS

Chapter 1

AGRIBUSINESS ECOSYSTEM IN INDIA

Mohan N H, Misha Madhavan M and V. K. Gupta
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India stands at the top position regarding the production of many agricultural products like pulses, jute, milk and the second position in the production of wheat, rice, vegetables, sugarcane, fruits, groundnut and cotton. India is also one of the leading producers of livestock, poultry, spices and plantation crops. Indian gross domestic product stands at 3.18 trillion US dollars and is projected to become 3.53 in 2022 (IMF report 2022). India is well known for its great ecosystem diversity and the climate in India varies from temperate alpine to humid and dry tropical in the northern and southern parts respectively. India holds only 2.4 percent of world's land area and still occupies four out of the 34 global biodiversity hotspots and home for 7-8% of all recorded species, including over 45,000 plant and 91,000 animal species (CBD 2014).

Indian agriculture is predominantly occupied with mixed crop-livestock farming systems. The livestock sector contributes about 30–40% of the farm income by providing employment. The share of gross value addition of agriculture and allied sector to total economy was 20.2% (PIB, 2021) with 138 million farm families, private faming is the largest enterprise, decrease in income, increase in cost of inputs and climate change are the main concerns of the farmers. In livestock sector, availability of superior germplasm, low productivity of animals, conservation of indigenous germplasm, the high cost of feed, disease outbreaks, the lack of proper market linkages, climate change, waste management are major challenges.

Agri-Business in India

Any business activities involving the transaction of agricultural products are known as agribusiness. Agribusiness sector consists of four different sub-sectors as given below.

- Inputs sector
- Production sector
- Processing sector
- Marketing and trade sector

In India, the agribusiness sector is emerging well through different entrepreneurship development programs. Reduced private investments in marketing infrastructure have been a

matter of concern, even though during the period between April 2000 and June 2021, the food processing industry in India has cumulatively attracted Foreign Direct Investment (FDI) equity inflow of about US$ 10.43 billion (IBEF, 2021). The direct marketing of agricultural products from farmers to consumers is one area for strengthening this sector. It holds very high employment potential and multiplier effect. Value addition to food production is only 7% (Grover et al, 2020). The improper cleaning, sorting, grading and packaging at the field level results in the postharvest losses of about 7 per cent of grains, 10 per cent of seed spices and 30 per cent of fruits and vegetables. It is estimated that Rs 50,000 crore is lost annually due to the poor marketing infrastructure and the inefficient system of marketing (Acharya 2006). A large number of farmers are shifting to high-value crops and farmers are facing huge risk of price and yield fluctuations.

The market value of agribusiness in India was estimated as 287 billion U.S. dollars in 2017 and is projected to reach 350 billion dollars in 2022. Acharya (2007) has calculated the value of agribusiness in India as 11.43 trillion. There are around 121 million operational land holdings in India as primary production units out of which about 63 per cent are of less than one hectare in size. The average land holding size was estimated as 0.4 hectare (Acharya, 2007). There exists a good opportunity in integrating these small production units. The agriculture and grocery market in India holds the world's sixth largest position and 70 per cent of the sale is contributed by the retail sector (Rastogi, 2017). In India, the market is dominated by the fresh food sector as most of the food processing units are in the unorganized sector. It is estimated that processed food segment constitutes less than 10%. The overall value addition is likely to increase to 35 per cent by 2025 compared to the present status of 8 per cent (IBEF 2011). The output of India's food processing sector is expected to reach USD 535 billion by 2025-26 and total export of processed food was valued at USD 4.121 billion in 2018-19.

Agribusiness Opportunities

India with a population of about 1.27 billion, and is expected to increase over years. Providing food for the population, along with possible export to other countries clearly provides a requirement and opportunities for extensive agribusiness in India. Advancement in food processing technology, information technology, e-commerce and government schemes to promote infrastructure and skill development, incubation, start-ups and farmer producer organisations are strengths for the agribusiness in India. There is a need for investment and some of the best available options for the investors are given below.

- Agricultural inputs- production of seed, input materials for horticulture and floriculture, fertiliser, organic pesticides, animal feed, mineral mixture, probiotics, microbial culture, fish seed, animal breeding, are some of the agricultural inputs where agribusiness opportunities are plenty.
- Agricultural production; production of staple food- rice, wheat, pulses, millets, vegetables, fish, milk (cattle, goat, buffalo, camel etc.), meat (poultry, pig, sheep, goat etc.), egg, flower, honey etc.
- Agro-processing- Value addition and production of diverse products based on agriculture, horticulture, livestock, fisheries, honey, floriculture produces and extensive opportunities exist in the agro-processing given relatively low level of value addition in agricultural produces. One emerging area to be specifically mentioned is the value addition in millets based products.
- Marketing and trade- Market and trading is a key activity in the agribusiness and extensive opportunities are available for collection, marketing, storage, especially cold storage, transportation present avenues for entrepreneurship.

It is relevant to mention a scheme of the Government of India such as Rashtriya Krishi Vikas Yojna - Remunerative Approaches for Agriculture and Allied Sector Rejuvenation (RKVY-RAFTAAR). This scheme support entrepreneurship in agriculture by providing incubation support for new innovations and ideas. The scheme supports infrastructure and assets creation, value addition linked production for integrated agriculture development, innovation and agri-entrepreneur development and provides flexi funds for projects in agriculture and allied sectors for innovative activities.

Startup India is another initiative of the Government of India with an action plan for promotion of entrepreneurship in India. This scheme provides funding support, incubation, incentives etc. for encouraging the entrepreneurs. Other initiatives include National Agriculture Market (eNAM), a pan-India electronic trading portal that links the existing Agricultural Produce Market Committee (APMC) mandis, to create a unified national market for agricultural commodities, "AgriStack" a unified platform to provide end-to-end services across the agriculture food value chain to farmers and Direct Benefit Transfer (DBT) Central Agri Portal, a unified central portal for agricultural schemes across the country.

Agriculture sector is and will remain central to India's economic development for the foreseeable future (Paroda 2018). Being the largest private enterprise that sustains 138 million

farm families, agriculture and allied sectors are one of the major contributors of GDP. Increase in population, market size, rising agricultural production over years, necessity of value addition, country with diverse agro-climatic zone, provides extensive opportunities for agribusiness in India.

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Chapter 2

ENTREPRENEURSHIP DEVELOPMENT IN ALLIED SECTORS OF AGRICULTURE

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Allied sectors of agriculture are considered to be the core of the Indian economy because of their high share in employment and livelihood creation. National Sample Survey Office's (NSSO) 70th round survey showed that more than one-fifth (23 per cent) of agricultural households with very small land size (less than 0.01 hectare) reported livestock as their principal source of income [1]. Farming households with some cattle head/livestock are better able to withstand distress due to extreme weather conditions. The allied sectors of agriculture are also an vital source of raw material and require for numerous industrial goods. The key agri-allied sectors are livestock, horticulture, fisheries and sericulture sector [2]. Majority of the farmers has accepted these allied sectors as subsidiary occupation; however these sectors are important source of income for small and marginal farmers in the country.

Entrepreneurial opportunities are emerging in various fields such as computers, electronics, medicine, agriculture, food technology, fashion designing etc. Allied sectors enterprises are also important activities which need an entrepreneurial role to boost up the production and productivity in India [3]. Entrepreneurship developments in allied sectors are the major apparatus for improvement and transformation of rural economy as these sectors assures regular employment and periodic returns round the year. There is a vast scope for entrepreneurship development in allied sectors of agriculture to ensure timely supply of critical items/services and resources for successful up-liftment of small and marginal farmers. Majority of the allied sectors of agriculture are followed as subsidiary occupation and relied up on family labour and involvement of women folk in several activities are very common. However, to harvest sustainable yields there is simple requirement of providing critical inputs at the right time and utilize better technological interventions.

The benefits of entrepreneurship development in allied sectors of agriculture allows an individual to undertake different activities, which could lead to employment creation; to earn

periodically with satisfaction and flexibility; timely supply of critical inputs which an individual farmers would not be able to access easily; develop dynamic processes and enhance productivity. Entrepreneurship development in allied sectors of agriculture could serve as excellent mode for employment generation and transformation of rural economy.

Entrepreneurship

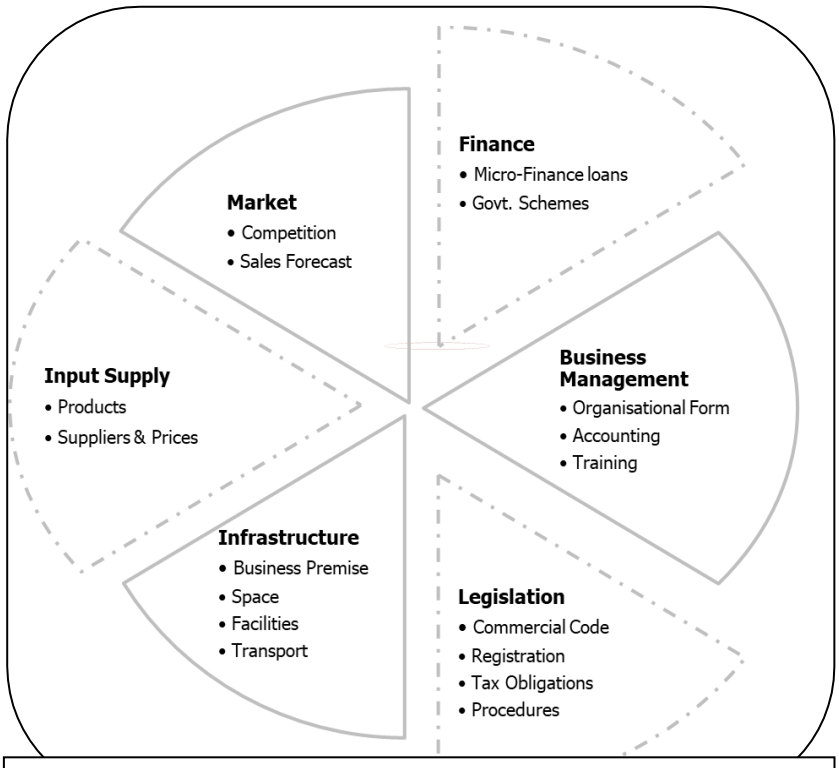
The word "Entrepreneurship" is derived from the French verb *entreprendre,* which means "to undertake" [3]. Entrepreneur refers to the individual and entrepreneurship defines the process. Engagement in entrepreneurship shifts people from being job seekers to job creators, which is critical to alleviate unemployment. An entrepreneur is a person who creates and develops a business idea and takes the risk of setting up an enterprise to produce a product or service which satisfies customer needs [4]. Both men and women can be successful entrepreneurs and here gender has nothing to do with. "*All entrepreneurs are business persons, but not all business persons are entrepreneurs",* this idiom summarizes about the differences between business and entrepreneurship. Entrepreneurship requires lot of creativity for converting ideas into action by mobilizing the resources in innovative ways to operate new venture/ old venture in a new way. One has to take enough risks in the beginning to emerge as successful ventures operator and to provide win-win situation locally for both farmer and the entrepreneur.

An entrepreneur should discover business opportunity to be able to supply improved or new goods and services that can provide opportunities for generate new growth-oriented enterprises. The process of identifying opportunities in the market place, arranging the resources required to pursue these opportunities and investing the resources to exploit the opportunities for long term gains. It involves wealth creation by bringing together resources in new ways to start and operate an enterprise successfully.The art of identifying viable business opportunities and mobilising resources to convert those opportunities into a successful enterprise through creativity, innovation, risk-taking and progressive imagination.

Qualities of an Entrepreneur

- Opportunity-Seeking
- Persevering
- Risk Taking
- Demanding Efficiency & Quality
- Time Management
- Information-Seeking
- Goal Setting
- Planning
- Persuasion & Networking
- Building Self-Confidence
- Listening to Others
- Leadership Quality

Entrepreneurship Development Programme (EDP) is designed to help an individual in strengthening his/her entrepreneurial motive and in acquiring skills and capabilities necessary for playing his/her entrepreneurial roles effectively. An entrepreneur should makes concerted efforts for the successful achievement of a goal and an entrepreneur should have lot of perseverance and not deterred by fears, risks or obstacles which could challenge the accomplishment of the final goal of benefiting the farmers. The best entrepreneur set his own objectives where there is modest risk of failure and takes calculated risks [4]. An entrepreneur does not only do things by himself, but also gets things done through others for example, networking of people with similar interests or concerns who interact and remain in informal contact for mutual assistance or support. Entrepreneurs also inspire, encourage others to carry out the given duties. The size of enterprise model should be in accordance with the requirement or as a matter of fact should be dependent on supply on demand.



Information Analysis in Entrepreneurship Development

Strategic Planning

Strategic planning for development of an enterprise is crucial as it determines whether the business could lead to profits in the future. An enterprise plan in allied sectors of agriculture could also avail bank loans based on certified bankable business models in the sector and complete DPR. An awareness on the subject and if possible, attending practical training in an authorized agency would be quite beneficial. The entrepreneur should also complement his/her strengths and weaknesses in coordination with government agencies with respect to his interest in allied sectors of agriculture for effective functioning.

Quality Management

The significance of quality management in entrepreneurship will replicate in the income of the enterprise. There would be forever demand for superiority products and proficient services in any sector and allied sectors of agriculture are not exception to this. The overall quality of products/services rendered by the entrepreneur would avoid the wastage; enhance productivity, ensuring cost-effective returns to the farmers. The entrepreneur would also be fulfilling his/her social responsibility, most likely to meet the standards set by the crop technology. The reputation of the enterprise would ensure no-competition in market and paves way for further growth and expanding to other activities.

Role of Extension Agencies in Entrepreneurship Development

Generally farmer looks at government agencies for his/her technical requirements till date. The staff crunch in the government agencies provides ample opportunities/scope for the entrepreneurship sector. An extension agent could influence the farmer's behaviour to adopt improved farming practices/technology for sustainable enterprise development. The extension agent should continuously update his/her awareness on latest technologies by attending refresher courses. Existing local and community institutions including self-help groups, micro-finance groups and NGOs etc. could be utilized effectively to facilitate technology adoption and diffusion.

Tips for Strengthening Entrepreneurial Skills

- ✓ Talk & meet successful entrepreneur(s)for enriched learning
- ✓ Get trained in a programme to study specific areas
- ✓ Read information to hone your entrepreneurial skills
- ✓ Find coordination agencies to complement your strengths &weaknesses
- ✓ Analyse the advantages &disadvantages of any situation or idea
- ✓ Keep motivated by suitable plans & innovations
- ✓ Develop the ability to understand the risksfaced
- ✓ Be open to the new ideas & stakeholders views
- ✓ Improve the ability to learn from mistakes
- ✓ Increase the commitment to work
- ✓ Understand that only quality products/services would bring success

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Chapter 3

BREEDING MANAGEMENT IN COMMERCIAL PIG BREEDING FARMS

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The success of efficient pig farming depends upon choice of good animal for breeding purpose to get improved animals in subsequent generation with higher productive and reproductive performances and subsequently better economic return. Most of the pig population in India is of local type with smaller body size and slow growth rate. This is due to unavailability of well developed, good performing pig breed. For pork industry as well as backyard rearing there is immediate need for development of superior swine germplasm by efficient breeding intervention.

A. Bases of Selection:

The choice of selection procedure should be such that it would give maximum response in terms of genetic gain. The pigs in a selection experiment can be chosen on following bases:

i) **Selection on the bases of individual performance /individual selection:** It is based on the principal "like begets like". The individual performances of the animals are considered for this type of selection. This base of selection gives encourageable results for highly heritable traits.

ii) **Selection on the bases of collateral relative/Family selection:** When the individual is judged on the basis of deviation from the average of its own family, the selection is known as with-in family selection. When own along with family performance, individual own performance is considered the selection scheme is known as between family selection.

iii) **Selection on the bases of progeny performance/progeny testing:** In this process animals are selected based on their progeny performance. The accuracy of progeny testing increases by increasing the number of progeny in the selection scheme. Low heritable traits are generally selected by progeny testing.

B. Important Economic Traits of pig for selection:

Selection of superior animals can be done by considering following points:

1. Body Conformation traits:

a. Boar Selection: Boars with 90kg body weight with length not less than 100 cm are prefer for breeding though relaxation can be given to the above traits for Indian breeds as per their

conformation. Generally animals with maximum weight at 6 months of age are preferred for breeding. The breeding boar must have well developed testes, stout body and wide apart strong legs, high vigor with active look and free from diseases and physical defect. Boar should not be used for breeding purpose until it attains 28-30weeks of age. Selection of boar should be done with utmost importance with maximum selection intensity.

b. Sow Selection: Selected gilts must have good breed characteristics of a breed. Females with wide apart legs, developed shoulder, arc back are preferred for breeding. The selected gilts must have six pairs of functional teats, prominent neck, thick and well-muscled ham, adequate depth and length of the body. Animals with history of good litter size and weight in pervious farrowing, superior temperament and mothering ability are preferred for breeding.

2. Essential Performance traits:

a. Litter size at birth and weaning: Out of total eggs released during ovulation period by a sow, about fifteen to twenty eggs may be fertilized and fetuses may be formed but many fetuses die. The litter size is most important economical traits for making pig farming profitable. However the control of this trait by genetics is limited due to its low heritable nature. High litter size at weaning indicates low embryonic mortality, high ovulation rate, good mothering ability and low preweaning mortality. The litter size at birth varies from 2 to 16 in Indian condition depending upon breed. Under average farming condition a moderately performing verity of pig breed gives eight to ten piglets per litter. The litter size at weaning should be seven to nine for optimum performance in Indian condition. Though breed specific target for the trait can be fixed before selection.

b. Litter weight at birth and weaning: Weight is one of the main criteria for selection. The selected animals must have better litter weight at birth and at the weaning as compared to non-selected population. The piglet number and wight at the time of weaning determines the profitability of pig farming system and it depends on the genetic makeup of sows. The weaning weight of piglets is influenced by milk production, mothering ability of the sow as well as management practices and feeding of piglets. The breeder must attempt for good health and low mortality in suckling pigs.

c. Pre and post weaning growth rate: Growth rate is one of the major factors for selection as animals with higher post weaning growth rate and feed conversion efficiency will results into better economic return. The post-weaning growth rate is highly heritable trait and thus selection based on these characters gives more genetic gain. Selected animals with higher growth rate must be separated to study the growth performance.

d. Feed conversion efficiency: This trait is highly positively correlated with growth rate. Feed efficiency of pig is the relative ability of a pig to convert feed into edible meat. The genetic variation between and within pig breeds exists that can be exploited to improve the trait by selecting breeding stock. Feed efficiency of a pig depends upon the genetic makeup of pig, sex, nature of the ration, management practices and environmental temperature. Generally an animal weighs 90-100 kg in 8-10 month of age with feed conversion efficiency 3.5 to 4.0. During breeding plan formulation, selection criteria can be fixed on the basis of performance of locally available germplasm.

e. Number of litters born/ year: Total number of litters per year is a good indicator of productivity of the farm. By reducing the weaning period of pig to 4-6 weeks, three litters can be achieved within two years of age.

f. Other reproductive traits: Age at first estrus, weight at first estrus, estrus cycle length, age at first service, age of 1^{st} fertile service, gestation period, age at 1^{st} farrowing, service period, inter-farrowing interval etc. are the other reproductive traits to be considered for selection. These traits can be fixed to the upper limited in the selected population than the non-selected animals.

3. Carcass traits:

a. Carcass length: It is the length of 1^{st} rib to aitch bone of the animal. A 90-100 kg pig should not have less than 75 cm carcass length.

b. Loin-eye cut: It is the length of *Longissimus dorsi* muscle of the animal. A transverse section of loin area (between 10^{th} and 11^{th} rib) is cut and muscle area is measured for this parameter. Normally a 90-100 kg pig must have 25.5 sq. cm of loin-eye cut area.

c. Back fat Thickness: It is the average of back fat of First and last rib and last lumber vertebra of animal. The ideal value of back fat thickness is 3.8 cm for a 90-100 kg animal.

d. Primal cut percentage: It is the percentage of loin, ham, shoulder and belly cut of the animal. The ideal population selected for breeding purpose must have of primal cut area more than 52.8 percent of total body weight.

4. Adaptive traits:

a. Pre and post weaning mortality: Mortality is an important factor for the profitability of a pig farm. Generally crushing, chilling, pneumonia and gastroenteritis are the main causes of pre and post weaning mortality. For proper monitoring of the farm mortality should be checked. Sometimes the preweaning mortality is caused by poor mothering ability of the sows. The sows with history of poor mothering ability should be avoided for further breeding.

5. Important genetic disorders:

Due to presence of certain lethal and semi-lethal genes the performance of the farm decreases. The animals with such type of genetically controlled disease should be avoided for breeding purpose. The important genetic disorders of swine are cryptorchidism (absence of one or both testes from the scrotum), hermaphroditism (presence of both male and female rudimentary sex organ), atresia-anai (absence of anus), hydrocephalus (fluid in brain), leg-less-ness and reproductive-organ-abnormality. Animals with history of such diseases in there pedigree should be avoided for further breeding. These types of genetically controlled disorders can be removed by selective breeding among the stock.

C. Methods of selection:

i) **Tandem Selection:** In tandem method of selection, selection is done for only one trait at a time. When desired improvement in one trait is achieved then other trait is taken in to consideration for selection. The main disadvantage of this method found in negatively correlated trait; which results to decrease in performance in correlated trait when other trait gives improved response.

ii) **Independent Culling Level:** By this method, a minimum criterion for all the traits is fixed and the individual which does not fulfill the minimum criteria for even a single trait is rejected while individuals which fulfill minimum criteria for all the traits are selectedThe main disadvantage of this method is that it does not permit to compensate the inferiority of one trait at the cost of other superior trait.

iii) **Selection Index or Total Score Method:** In this method of selection, individuals are selected on the basis of the total score by giving some economic value for the traits to be considered. The amount of score given to each trait depends upon its heritability, relative economic value, phenotypic and genetic correlations between traits. This is the most efficient method than other two methods. It allows superiority of some traits to make up for slight inferiority in other trait.

D. System of mating:

Inbreeding is avoided in pigs due to adverse effect of this type of breeding system in the performance of the animals. Out of different types of out breeding system, grading up and crossbreeding is generally adopted in swine breeding practice.

i) **Grading-up:** In this method, non-descript sows are mated with superior bores with high production potential of a well developed breed from generation after generation. After the 7^{th} generation of crossing the indigenous non-descript animal will have more than 99% exotic inheritance with superior performance. As most of the pig population of the country is non-descript type; this method of breeding will be highly beneficial for genetic

improvement of these animals. This method of breeding is also essential where high quality pure breeds cannot be maintained due to poor management and feeding conditions. One of the major limitations of this method is the adaption power of the superior breed to acclimatize in local climatic condition which may result to comparatively lesser performances of the progeny.

ii) **Selective Breeding:** This is a method of breeding where superior male and female animals with in a breed are selected and mated. This method is useful for increasing the performance of a well developed breed.

iii) **Crossbreeding:** This is the method of crossing between two well developed breed. This system of breeding is a recommended practice and widely accepted in commercial swine farming. Crossbreeding is used to exploit the heterosis which is the superiority of crossbred progeny over the mean performance of purebred parents. The crossbred progeny shows higher litter size and birth weight and weaning weight, greater resistance to environmental stress than exotic animals, better feed conversion efficiency, growth rate, high mothering ability and higher milk production**.** Commonly used crossbreeding system in swine industry are:

Two breed crosses: This is a system of mating in which purebred animals of two different breeds are used for crossing and the purity of the parent breeds is not altered.

Back cross and crisscross system: It is the mating of crossbred animals (F_1) to purebred animal of either parent breed. This cross is made to exploit maternal or paternal heterosis. The back crossing between crossbred female and purebred males shows 100% maternal heterosis. The offspring crossbred gilts are mated back to a boar of one or other of the two original breeds.

Three breed cross: In this system of cross breeding three breeds are rotationally used and males from each of the three breed are used in succession on cross bred females.

Four breed crosses or double two breed cross: This involves the crossing of crossbred females produced by crossing two breeds (A & B) with crossbred male produced from crossing another two breeds (C & D). Thus mating of two crossbreds (AB x CD) animals produce both maternal and paternal heterosis as well as individual heterosis.

E. Mating time and symptoms:

The duration of estrus cycle in pig is 21 days where as the duration of heat or estrus is 2-3 days. The sow can be bred round the year. During the estrus, the female shows frequent urination, less appetite, erection of ears, swelling and vulvar discharge and immovability when pressure is applied to back. The service should be done in 2nd half of the 1st day and 2nd day of

heat of 2nd or 3rd estrus cycles. The sow/gilt should be served twice at an interval of 10-12 hours. In Pigs, the average gestation period is 114 days and after farrowing sow may be ready to breed again after one month of weaning. The boar can be efficiently used for breeding up to age of 18 months whereas sows may be replaced after 4th farrowing. Two crops can be obtained at the 18 months of age.

F. Record Keeping:

Record keeping is of immense importance for efficient farm maintenance. Scientific management and handling of farm records helps to select the animals of higher genetic worth for further propagation in breed improvement programmes. Recording of animals in different aspects such as productive and reproductive performance, occurrence of disease, vaccination, feeding, breeding and disposal records of individual animal will helps in success of pig farming.

G. Culling:

One of the most important decisions in a pig farm operation is the selection of animals to retain as replacements and culling of rest of the stock. Deformed, infertile, low productive and other unwanted animal should be disposed off regularly.

H. General consideration for pig breeding:

1. Inbreeding should be avoided. As 10% increase in inbreeding cause one third less pig per litter furrowing and half less pig at weaning.
2. Crossbreeding with proper plan can be followed to get maximum heterosis. Crossbred animals have more potential for high milk production and thus maintaining maximum litter.
3. In case of hand mating the boar sow ratio should be 1:15, but in small hard or in case of non-availability of breeding boar the ratio can be increased upto 1:20.
4. First one or two heat of gilts shall be skipped for breeding the animals.
5. In hand mating, sow shall be preferably bred twice with 24 hours interval.
6. Proper health care and vaccination of animals can give better result for any breed improvement programme.
7. Breeding hard should be free from brucellosis and leptospirosis.
8. All the necessary pre and post weaning managemental practice can further increase the efficiency of breeding programe.

By following Proper breeding strategies and establishment of nucleus pig breeding farm in each district where pig plays a vital role for the upliftment of their economy can uplift the

socio-economic status of pig farmers. Distribution of superior boar at a subsidized rate to selected breeding farmers or establishment of artificial insemination centre with liquid /frozen pig semen within every cluster of 2-3 villages would help the farmers to solve the problem of unavailability of quality germplasm. Government has to identify breeder farmer in each village to establish multiplication/breeding farm. Attempt has to be taken to establish model pig village.

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Chapter 4

ENTREPRENEURSHIP DEVELOPMENT THROUGH SELF-HELP GROUPS AND FARMER PRODUCER ORGANIZATIONS IN PIGGERY SECTOR

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Entrepreneurship development plays a pivotal role in the growth and development of a country. Entrepreneurship in agriculture means the creation of new business ventures with an aim of profitability by using agricultural resources. The entrepreneurs bear certain characteristics like innovativeness, risk bearing ability, planning and goal setting, time management etc. Generally, the people with less education and exposure feel reluctant to start new ventures as they perceive low risk bearing ability for themselves. Here comes the importance of group-based entrepreneurship development. Group formation of small and marginal farmers, gives more confidence and strength to them rather than being individual. The profit-making ability of a group depends on their group cohesiveness and linkages with stakeholders involved in the sector. The new ventures in agriculture are allied sectors are gaining more attention nowadays. The government policy to promote agri-business supports agri-entrepreneurs by providing credit support and subsidies. As Indian farming is predominantly performed by small and marginal farmers, group formation is also encouraged through different government schemes for improving their bargaining power.

Piggery is one of the components in livestock farming which contributes 1.7 % of total livestock population in India. The rural areas of North Eastern Regions hold 40 % of the total pig population of the country. Pig farming is mainly practiced by the tribal communities in this region as an integrated part of their life. So, by promoting group-based entrepreneurship development in piggery sector, upliftment of rural poor can be achieved. For this, awareness creation on different entrepreneurial opportunities and government support should be done first by organizations. The officers who work in the grassroot level, should be aware about the process of group entrepreneurship development. By mobilizing the rural poor for group based entrepreneurship development, multiple goals like poverty reduction, employment generation, nutritional security and women empowerment can be achieved simultaneously. So, in this

chapter we discuss about entrepreneurship development through self-help groups (SHGs) and farmer producer organizations (FPOs) in piggery sector.

Self Help Groups (SHGs)

Self Help Group was conceptualized adhering to the principle "for the people, by the people and of the people". These groups are formed by the people from same socio-economic strata. They join voluntarily to become self-reliant. They solve their common problems through entrepreneurship. SHGs can exist with or without registration. The SHGs can be registered under societies registration act, partnership act or state cooperative act. The SHGs provide better financial security to its members through the availability of credit in emergency situations. The SHGs normally maintains records like minutes of the meetings, members list, attendance sheets, financial transactions, loan register, cashbook and general ledger. They have better access to credit from banks on group basis without any collateral securities. So, compared to individual attempt there is more scope of success and economic gain in ventures started by SHGs.

Characteristics of SHGs

- Informal and voluntary associations
- Ideal Size is 10-20 members
- Either contain men or women
- Members from same socio-economic strata
- Regular group meetings and proper record keepings
- Creation of common fund with shared contribution for urgent requirements and reciprocal support
- Collective decision making
- Code of conduct for the administration and management of the group
- Democratic mode of operation
- Self-reliance and sustainability

Farmer Producer Organizations (FPOs)

A farmer producer organization (FPO) is an organization formed and registered legally by the farmers. A FPO intends for sharing the profits among its members and it can take any legal form like a cooperative society, a producer company, or any other. FPOs are formed as organization of their own for ensuring better income. It helps the farmers to get benefits of

economies of scale by handling large volume of inputs and produce. FPOs improves the bargaining power of the farmers and avoid long chain of intermediaries. FPOs help the farmers by providing better business opportunities like value addition. FPOs help the farmers by providing better market information, access to better technologies, investments and markets.

Features of FPOs

- It is a legal entity and a registered body
- The farmers are shareholders
- Undertakes business activities using the primary produce
- Farmers get benefit of shared profit
- A part of the profit is used for business expansion
- The main intention of FPOs are the betterment of the member farmers

Different legal forms of FPOs

A FPO can take different legal forms under different acts as follows.

- Cooperative Societies Act/ Autonomous or Mutually Aided Cooperative Societies Act of the respective State
- Societies registered under Society Registration Act, 1860
- Section 25 Company of Indian Companies Act, 1956, as amended as Section 8 in 2013
- Producer Company under Section 581(C) of Indian Companies Act, 1956, as amended in 2013
- Multi-State Cooperative Society Act, 2002
- Public Trusts registered under Indian Trusts Act, 1882

Farmer Producer Companies

Farmer Producer Companies (FPC) are most accepted legal form of FPOs. FPCs are registered under the Indian Companies Act, 2013. This is a hybrid form of cooperative societies and private limited companies. It has a regulatory framework similar to private limited companies and accommodate the unique elements of cooperative business. An FPC can be formed by 10 or more producer farmers or 2 or more producer institutions or a combination of both. The members can involve in activities like production, processing, marketing etc. The share capital consists of equity shares which are not tradable but transferable. The voting rights are based on single vote for every member. A FPC should have a board of directors (minimum 5 directors and maximum 15). The members of the FPC elects the board of directors during annual general meeting. A full-time chief executive officer should be appointed by the board

(CEO). The FPCs are fully autonomous and government control is minimal limited to statutory requirements.

Registration Procedure of FPC

The farmers can come together for forming an FPC. Farmers have to undergo certain steps for registration process as given below.

- Apply for a Digital Signature Certificate (DSC): This certificate is an identity proof similar to pass port, driving license etc. which can be used for filing on-line documents.
- Apply for Director Identification Number (DIN): The DIN is a unique identification number assigned for all the directors of all the companies and maintained by Ministry of Company Affairs (MCA).
- Check for name availability and implement it
- File e- Memorandum of Association (MoA) and e- Articles of Association (AoA): The e-MoA documents all the activities planned for the company. It should include the activities planned for present and future in a very broad manner. The e-AoA includes the by-laws of the company. It specifies rules to be followed for appointing the director and for undertaking financial transactions. It defines how the activities to be undertaken in a company.
- Certificate of Commencement (CoC): This certificate is issued as a proof for the formation of the company. This is issued by the registrar of companies and date of commencement of the company is mentioned in this certificate

Producer Organization Promoting Institution (POPI)

The producer organization promoting institutions provide continuous trainings and hand holding support to the management and staff of producer organizations. A Government Department, an NGO, a Cooperative Society, a bank branch, or any other organization can become a POPI. The NABARD and SFAC supports POPIs by providing part of the recurring cost for promotion of producer organizations. The POPI ensures that the producer organizations become sustainable in its business and the capability of the staff is enhanced to run the business effectively even though the POPI support is withdrawn.

National Bank of Agricultural and Rural Development (**NABARD**)

NABARD is providing financial support to the existing FPOs. During 2011-12, NABARD created Producers Organization Development Fund (PODF) with initial corpus of Rs. 50 crores. This fund is created for improving the credit access and to meet the end-to-end credit requirements of the FPOs. NABKISAN Finance Ltd. is a subsidiary of NABARD created

for fulfilling the financial needs of FPOs by following a flexible approach based on life cycle needs. The grant fund of NABARD has been further enhanced during 2017-18 to provide need-based assistance to those FPOs which are financed by public sector banks, cooperative banks and regional rural banks. To promote new FPOs, a special initiative known as Producers' Organization Development and Upliftment Corpus (PRODUCE) fund was created in NABARD by the Government of India.

Small Farmers Agribusiness Consortium (SFAC)

SFAC provides mainly two types of support to the producer companies. A credit guarantee fund is operated by SFAC to mitigate the credit risks of financial institutions who provides credit support to FPCs without collateral. This helps the FPCs to get loans from financial institutions for their establishment and operating costs. The SFAC also provides Rs.10 lakh as matching equity fund to the FPCs to enhance their borrowing power.

Self Help Groups in the Piggery Sector

The self help groups of women in rural areas of Assam are working together by maintaining pig breeding farms. There is a good scope for starting small scale pork processing units also. The SHGs of women can make their on brand of pork products like pork pickle, pork momo, smoked pork, traditional sausage etc. with minimum investment. They can get credit support easily from financial institutions with subsidies under different government schemes like National Livestock Mission. Under the Deendayal Antyodaya Yojana-National Rural Livelihoods Mission (DAY-NRLM), the Self Help Groups can get hand holding support and access to skill development programmes.

Farmer Producer Companies in the Piggery Sector

As, the piggery sector is dominant with small scale pig farmers, the importance of FPCs in piggery sector is very high. The collective action of FPCs can help the farmers in purchasing the inputs at lower price and selling of their produce at higher price. The examples of FPCs in the piggery sector are Goreswar Piggery Producer Company Ltd. of about 500 pig farmers from Baksa district of Assam and SAAR pig producer company Ltd of 2500 women pig farmers from Dhemaji and Lakhimpur Districts of Assam.

The FPCs in piggery are mainly involved in activities like supply of feed to the member farmers at a reasonable rate, selling of pigs and piglets directly to the markets by avoiding the intermediaries, slaughtering of pigs at a common slaughter house, processing of pork in to value added pork products, branding and marketing of the pork products. The FPCs also

connects the farmers with the credit providers and government institutions who provide trainings.

Challenges faced by the FPOs in India

The FPOs are gaining lot of support from different government initiatives due to its successful implementation in many places in India. Eventhough, some FPOs are facing challenges in their way ahead due to the following reasons.

- Lack of sustainable vision and direction from board of directors and chief executive officer
- Poor skill in professional and operational management.
- No strategic business plans
- Lack of skilled human resource management
- Lack of legal, managerial and technical knowledge among directors and staff
- Poor capital investment and financial management
- Lack of unity among the group

The farmers should be aware about all the advantages of group based entrepreneurship. The groups like SHGs and FPOs help the farmers to get more benefits with the same efforts. The grassroot level extension officers can mobilize the farmers into groups for helping them. Agri-business is possible for the small and marginal farmers who joined their hands together.

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Chapter 5

FEED FORMULATION AND SETTING UP OF PIG FEED PRODUCTION UNITS

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In pig farming, feed cost alone represent more than 70-75 % of total cost of production. In intensive pig production, pig directly compete with human being for feeding, since conventional fattening is based on the feeding of cereals like maize, wheat, oats, barley etc along with other protein, mineral and vitamin supplement. Therefore, to develop a sustainable economic feeding programme for pigs, importance need to be given for selecting feed ingredients those are not compete with human being.

The primary objective of feed formulation is to provide the pigs with an acceptable ration that meets its nutritional requirements at different phases namely starter, grower and finisher, so as to yield optimum production at minimum cost. Flavour, colour, odour, texture and water stability are important characteristics related to acceptance and consumption. Better knowledge of preferences and feeding behaviour would greatly improve the choice of appropriate ingredients and feed preparation processes, as well as the methods of feed delivery.

To formulate a feed, one has the basic knowledge of requirement of crude protein, energy, specific amino acid, crude fiber at different stages of growth. One can use either metabolizable energy (ME) or digestible energy (DE) while formulating feed. The diet need to be supplemented with a vitamin premix, at levels in excess of the dietary requirement. Except energy, all others are determined on basis of laboratory testing of feed materials.

In order to formulate ration economically, knowledge on locally availability of feed ingredients is very important and ingredient composition of ration may alter depending upon the seasonal availability of ingredients.

Feed classification

Feeds can be classified as:

Plant Protein Products	Soy bean meal, canola meal, cottonseed meal, pea by-products, yeast products

Animal Protein Products	Meat and bone, animal by-product meal, blood meal, fish meal, poultry meal, hydrolyzed feather meal, milk and whey products
Processed Grain by-products	Wheat millrun, distillers dried grains, corn gluten meal, brewers dried grains,wheat middlings, bran products.
Molasses Products	Beet & cane molasses, molasses distillers dried solubles
Roughage Products	soybean hulls and millrun, cottonseed hulls, beet pulp
Forage Products	dehydrated alfalfa meal, ground alfalfa hay, ground grass
Non-protein Nitrogen Supplements	Amino acid specially lysine, methionine
Micro-organism source	Phytase enzyme, probiotics- Lactobacillus sp.
Fat and Oil Products	Animal source- tallow, fat; vegetable sources- refine oil

Other board classification of feeds are:

- Energy suppliers; e.g., Maize grain, wheat bran, rice bran, rice polish, broken rice, confectionary products, etc
- Protein suppliers; e.g., soybean meal, canola meal, ground nut cake, fish meal etc
- Medium-protein sources; e.g., brewers grains, distillers grains
- Fat sources; e.g., tallow, grease, oil, chocolate by-products
- Unconventional feeds: Tapioca tubers, colocasia, vegetable waste, azola, water hyacinth etc.

A basic analysis should include, at the very least, dry matter (DM), protein (CP), ether extract, crude fiber, calcium (Ca), phosphorus (P). Measuring pH is strongly recommended for alkaline or acidic feeds, such as potato waste or whey.

Ration classification for pigs:

While formulating ration for pigs, one has to follow feeding standard. One can use either NRC (National Research Council, USA), BIS (Bureau of Indian Standard), ICAR (Indian Council of Agricultural Research) etc feeding standard.

There are three classes of rations for pigs namely starter (0-60 days), grower (2-5 months) and finisher (> 5 months). Sustainability of pig production systems is depended upon augmenting nutrient efficiency at reasonable cost but without compromising the environmental integrity (FAO, 2006). Many studies have indicated that nutrient efficiency could be improved by better adjusting nutrient supply to individual requirements of the animals (Ferket et al., 2002; Pomar et al., 2014) at different stages of growth. Nutritional requirements change

dynamically over time (Table 1) and vary also among animals, even in age- or sex homogeneous populations (Pomar et al., 2003; Brossard et al., 2009).

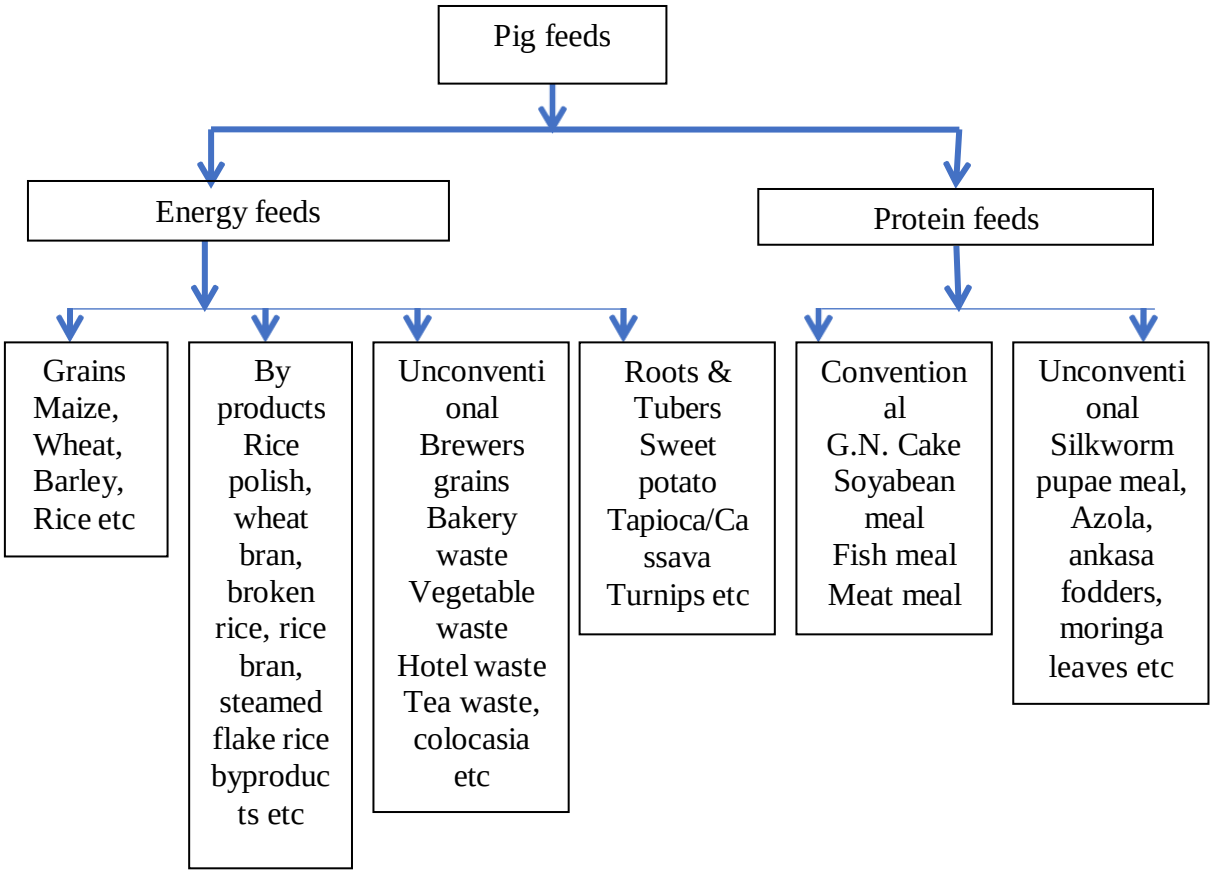


Table 1: Nutrients requirements for different categories of pig (BIS, 1986)

Parameters	Pig Starter	Pig Growing	Pig Finishing
Moisture, (%max)	11	11	11
C.P., (%min)	20	18	16
ME, Kcal/kg, min	3360	3170	3170
Fat, (%min)	2	2	2
C.F., (%max)	5	6	8
A.I.A, (%max)	4	4	4
Vitamin A, IU/kg	1700	1300	1300
Calcium, g/kg	6	6	6
Phosphorus, g/kg	6	4	5
Iron, mg/kg, min	100	90	80

Copper, mg/kg, min	8	6	6
Zinc, mg/kg, min	50	50	50
Niacin, mg/kg, min	17	14	10
Pantothenic acid, mg/kg	11	10	10
Riboflavin, mg/kg	3	2.4	2.2
Vitamin B_{12} activity, µg/kg	15	11	11
Vitamin A, IU/kg	1700	1300	1300
Vitamin D, IU/kg	190	180	130

The requirement of feeds differs at different stages of growth of pigs as shown in table 2.

Table 2: Daily feed requirement of different classes of pigs

Categories of pigs	Days	Weight (kg)	Feed requirement (kg)/day/pig	Aprox. growth (g/d)
Weaner pigs	56 – 120 days	0-15 kg	0.25 – 0.75	250-270
Grower pigs	121 – 180 days	15-35 kg	0.75 – 1.50	450-500
Finisher pigs	180 – 300 days	35-80 kg	1.50 – 2.50	500-550
Lactating Sow	3.0 – 4.0 kg of concentrate feed daily, additionally 200 g concentrate per piglet should be given to the sow.			
Pregnant gilt	2 kg mixed feed per day			
Breeding boars	3 kg concentrate feed per boar daily up to 18 months			
Mature boars	2.5 kg concentrate feed along with 3-4 kg succulent green fodder			

Creep feed

Creep feed is the first solid feed offered to the piglets at the age of 10-15 days. It is given to suckling piglets at an age of 10-15 days. It promotes development of digestive systems as well as secretion of digestive enzymes which encourage feed intake. The creep feed should

be highly palatable. It can be improved by sprinkling dry powdered milk on the feed to improve its smell. Part of palatability means the feed must be soft enough to chew by the animal eating it. This means the feed particles must be small enough to be picked up by the tongue and soft enough to be chewed without causing discomfort to the animal's mouth. The feeder should be of a design that allows easy access by the pig, stays relatively clean and can be locked to a mounting bracket inside the creep area. Any feeds contaminated with urine or feces should be replaced at the next feeding with a clean feed. The natural inclination of a pig is to root or look for feed from a flat floor surface. The creep feed that is supplied when the litters are still on the sow should be continued into the weaning process for at least 1-2 weeks. Examples of creep feeds are shown in Table 3.

Importance of Creep Feeding

- Creep feeding is very much essential to reduce the weaning age.
- It accustom the piglets to solid diet; it has proven that as creep feed intakes rise, post-weaning diarrhoea is reduced
- Feeding sow milk with creep feed the piglet performance at pre and post weaning leading to an overall improvement in net return
- On average, you should expect a total creep feed intake of 400-600g per piglet when weaning at 35 to 42 days of age, although all units are different.

Table 3: Composition (%) of Creep ration

Ingredients	Parts		
	I	II	III
Maize powder	47	35	30
Rice powder	0	15	20
Skim milk powder	10	10	10
Soyabean meal	6	6	6
Sesame oil cake	12	12	12
G.N. cake	15	15	15
Molasses	5	5	5
Mineral mixture	1.5	1.5	1.5
Salt	0.5	0.5	0.5
Total	100.0	100.0	100.0
Lysine, %	1.50	1.50	1.50
Methionine. %	0.01	0.01	0.01

Nutrition of weaned/starter pig

The primary objective for nutrition of weaned pigs is to optimize growth performance during the first few weeks after weaning. After first 24 hour after weaning, feed intake increases

linearly. Estimates of this rate of increase in feed intake range from 17 to 23 g/day for maize-soybean meal diets containing 3,200 kcal of DE/kg of feed. Usually piglets are weaned at 5-6 weeks of age should be provided with ration containing 21 % protein and 1.25 % total lysine along with other supplements like phytase enzyme (40g/quintal) and mineral mixture. An example of ingredient composition of starter ration is given in Table 4.

Nutrition of Grower and Finisher Pigs

Grower-Finisher diets are fed to pigs from 20 kg to market weight (approximately 80 kg). These diets are also phase fed and typically there are four phases. The first phase from 20 to 40 kg is a diet that is self-fed and contains approximately 1.15% total lysine (18 to 19% crude protein). The remaining phases are also all self-fed diets where the lysine (protein) concentration is reduced. In addition to reducing lysine content, the latter phases would also require less total protein, vitamins and minerals which help to reduce diet cost. The remaining phases would typically be as follows: 40 to 60 kg (0.95% total lysine; about 16% crude protein); 60 to 80 kg (0.85% total lysine; about 15% crude protein). Grower-Finisher diets are normally maize and soybean meal based with added vitamins, minerals, a fat source, and other potential feed additives. These diets are usually mixed on the farm but can be purchased commercially from feed companies. An example of ingredient composition of grower and finisher ration is given in Table 4.

Table 4. Different ration formulations for pigs

Ration I	Starter Ration (0-15 kg)	Grower Ration (15-35 kg)	Finisher Ration (35-80 kg)
Ingredients	Parts	Parts	Parts
Maize	60	64	60
Wheat bran	6.5	6.5	14.5
Soyabean meal	7	12	10
Ground Nut Cake	18	10	10
Fish meal	6	5	3
Mineral mixture	2	2	2
Salt	0.5	0.5	0.5
Total (kg)	100	100	100
Phytase Enzymes	40 g	40 g	40 g
Probiotics	0.25 g	0.25 g	0.25 g
Lysine, %	1.25	0.85-1.15	0.85-1.15
Crude Protein	20 %	18 %	16 %

Nutrition of breeding sows

Dry sows should be fed a maintenance diet containing 16 % protein and 3170 Kcal ME/kg diet. Daily requirement of diet is ranged from 1.5 to 2.0 kg. From the day of artificial insemination the daily dietary allowance should be reduced by 15-20 % of total requirement e.g. 1.28-1.7 kg/d as high feeding during first 21 days of service causes 10-15 % embryonic mortality.

Nutrition of pregnant sows

2-3 weeks before breeding, ration allowance for sows should be increased gradually in order to get more ovulation which results in increase litter size at birth. This process is known as flushing. Gestation diets are typically formulated to contain 0.60% total lysine (12 to 13% crude protein). Gestation diets are limit fed (1.5-2.0 kg per head per day) to avoid obesity in the breeding herd. They normally contain higher levels of vitamins and minerals than swine grower-finisher diets in order to meet daily requirements under a limit feeding program. One should fed a mature bred sows a little more than maintenance during initial 90 days period of pregnancy. Due to rapid growth of foetus during last 20-25 days of pregnancy require extra nutrients and according extra nutrient need to be supplemented to enhance litter weight at birth and improvement of sow mil at farrowing. Others increase feed amounts as gestation progresses which is known as steaming up. The feed intake during pregnancy is depended upon energy concentration of diet, sow productivity, housing type and season. Fat added to sow diets during the final 7 to 10 days before farrowing may increase the survival of baby pigs shortly after farrowing. Feeding of high level of feed during early 3 months of pregnancy leads to death of few embryo especially in gilts.

Nutrition of Lactating Sows

The lactating diet should provide increased nutrients for milk production to prevent constipation and excessive weight losses. A sow must consume at least 4-5 kg of a standard lactation diet daily (14000-19000 kcal of metabolizable energy) to maintain adequate milk production and body condition. Sows with large litters (10 piglets or more) may require as much as 6-7 kg and peak intake may be over 8 kg per day.

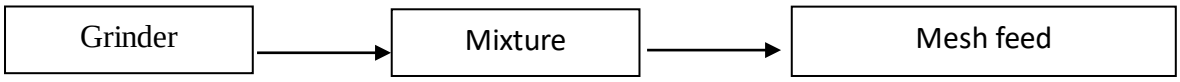
Nutrition of Boar

The boar nutrition should be managed in such a way that it maintains an optimum body weight and body condition along with optimum breeding performance. Boars that are used either for a natural or artificial mating program can be fed a grain-soybean meal diet similar to a gestation diet. Normal feeding amounts are 1.5-2.0 kg per head per day, but boars worked

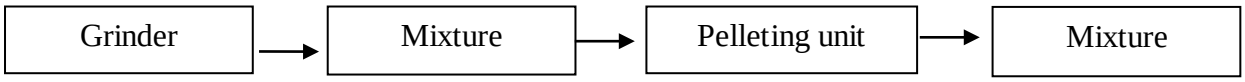
heavily should be fed 2.5-3.0 kg per head per day. Young boars (< 1 yr) may need more feed than older boars because they are still growing and developing. Feed intake may have to be increased when boars are used heavily to maintain body condition. Boar ration should contain about 16 % protein. Inadequate protein intakes reduce sperm concentration and total sperm count per ejaculate as well as libido and semen volume. Boar should be provided with 2-3 kg of green succulent fodders per day to keep the boar at good vigor.

Different component of pig feed plant

For mesh feed (only grinding and then mixing) formulation two component of feed plant is reqired- Grinder and Mixture unit. For formulating pelleted feed (cylindrical feed) for pigs three components are required- grinder, mixture and pelleting unit.



Component of mesh feed plant



Component of pellet feed plant

Proper planning is required for management of feeding of swine for economic production. Phase feeding in different stages of growth and production in pigs is required for efficient utilization of nutrients without causing any waste and environmental pollution. High nutritious diet is requite for pigs just before start of breeding in order to get large litter size and similarly such type of nutritious diets also required 2-3 weeks before expected date of farrowing in order to get uniform liter weight at the time of farrowing with optimum growth.

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Chapter 6

VALUE ADDITION TO PORK AND PROCESSING OF PORK PRODUCTS

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Value addition is an important avenue for efficient utilization of livestock resources with increased demand and higher returns. Higher growth in demand for meat, eggs and milk in developing countries would be a positive attribute for Indian livestock sector with increased trade opportunities. Value added products are further processed products with increasing convenience to the consumer. The growth of products industry assures the farmers a regular off take of their produce at reasonable prices and provides variety to consumer. It involves a larger component of labour where India is at advantage with nearly lowest labour cost in the world. Employment potential would be substantial.

Common processing technologies for preparation of value added meat products

Drying*:* The purpose of drying is to reduce the availability of moisture. It also reduces the water activity of the food products and thus, hinders the growth and multiplication microbes. Rehydration is required before consumption. Used mainly for military purposes. It is not a usual method for preparation of value added pork products.

Salting and curing*:* High concentration of salt expel out the water by osmosis, thus, microbial growth is restricted. Another purpose is colour and flavour retention. Main disadvantage is that halophilic bacteria may grow. Salting and curing is a part of processing of some of the value added pork products.

Smoking*:* Smokes contains formaldehyde, phenol, alcohol, cresol, aliphatic compounds, aldehyde and ketone which have bacteriostatic effect. Smoke is mainly effective against vegetative cells. It also coagulates the surface protein and blocks the entry of microorganisms. Liquid smoke is better. Certain carcinogenic and mutagenic substances like heterocyclic amines (HCA) and polycyclic aromatic hydrocarbon (PAHs). Smoking enhances the flavour and acceptability of the pork products.

Canning: It is a thermal processing method. Processed products are packed in hermitically sealed containers and then treated with heat (at least 121^0C). Cans are then cooled and stored. Can meats are ready to eat products.

Enrobing*:* Coating of meat products with edible materials in the form of batter using flours, whole egg and other cereal products is done to produce enrobed meat products. Enrobing imparts the product a crispy texture, increases eating quality.E.g. Pork cutlets, pork patties and nuggets etc.

Restructuring*:* It is a process where pre cut or comminuted meat is moulded into a shape resembling to a natural streak or intact cut. It is a good method of upgrading value of low quality meat. The pre cut meat pieces are tumbled or massaged and because of this process, protein exudes from the meat surface and thereafter high pressure is exerted to give a restructured new product.

Fermentation*:* Fermented meat products can be prepared by using lactic acid producing specific microflora like Lactobacillus, Micrococcus and Pediococcus etc. The bacterial cultures create such an environment that other spoilage and harmful microorganisms can not grow. Based on the moisture contents, three types of fermented pork products can be manufactured, E.g. Dry, semi-dry and moist. Extension of storage life, safety of foods and improvement of sensory properties are the benefits.

Heat processing (Cooking): Cooking must be done at an internal temperature of not below 65-70^{0}C. There are few changes taken place during cooking. There is coagulation and denaturation of protein, connective tissue (Collagen) conversion into gelatine, increasing of tenderness, and development of brown colour and textural changes of meat tissue. Generally meat and meat products are cooked by three methods.

- Dry heat cooking:- Dry heat cooking involves either broiling, roasting or frying. This method is suitable for pork of low connective tissue like pork shoulder, loin cured ham etc.
- Moist heat cooking:- This method is recommended for relatively tough cuts with large amount of connective tissue. Pressure cooking, simmering, stewing and braising are the example of moist heat cooking
- Microwave cooking:- It is a modern and rapid method. The heating results from the conversion of microwave energy to heat by friction from internal molecular rotation caused by the interaction of molecules with the rapidly fluctuating electromagnetic field. This method is many times faster than conventional method.

Categories of value added meat products

Value added products could be broadly classified based on processing, variety/ convenience and functions and are briefly discussed hereunder.

Comminuted pork products: Comminution is a process for meat particle size reduction and normally includes grinding, flaking, chopping, milling etc. Pork is well suited for comminuted meat products. The processing techniques for high quality pork patties, sausages, loaves, blocks, nuggets and rolls as well as restructured products are available. Incorporation of back fat in these products formulations could improve the juiciness and palatability of the finished products. Further, several low value by-products such as pork rind (skin), head meat, heart meat etc. could also incorporate into these products without much adverse effect on sensory attributes of the products.

Restructured pork products: Restructuring is a processing technique used for developing convenience meat products with texture in between intact steaks and comminuted products. Some of the modern processing techniques viz. flaking and vacuum tumbling can be used to improve the product yield, binding, texture and sensory attributes of the products.

Enrobed pork products: Enrobing is a technique for coating the meat products with edible materials to improve their cooking yield and provide better protection against oxidative and microbiological deterioration.

Cured and smoked pork products: Curing is one of the oldest methods of preservation technique for pork and pork products and per se it is the addition of salt, sugar and nitrite/nitrate to meat for the purpose of preservation, flavour enhancement or colour development. In the applied concentrations most curing agents are bacteriostatic or fungistatic and more detrimental to gram negative organisms. There are different methods of curing viz. dry curing (ingredients will be rubbed on the meat), pickle curing (ingredients will be dissolved in water and applied either by immersion or injection methods), cold curing (at low temperature) and hot curing (at higher temperature to accelerate the penetration of curing ingredients). The entire curing process may be divided into four different stages viz. curing, salt equilibration/maturation, ageing and smoking. Curing and smoking contributes attractive colour, unique flavour along with shelf life extension of meat products, which makes them popular among consumers.

Shelf stable pork products: Production of thermally processed pork products either in cans or retort pouches with extended shelf life at room temperature promotes distribution and

marketing. Simple technology was standardized for developing shelf stable pork sausages using hurdle technology.

Intermediate moisture pork products: Pork products with 15-50% moisture content with moderate juiciness and texture, inhibit growth of bacteria, moulds and yeast, water activity between 0.6 to 0.85, self stable at ambient temperature for a considerable length of time are known as intermediate moisture pork products. A mixture of sodium chloride, glycerin, lactic acid and antioxidants are used in the formulations.

Fermented pork products: Fermented pork products can be prepared by using lactic acid producing specific microflora like Lactobacillus, Micrococcus and Pediococcus etc. The bacterial cultures create such an environment that other spoilage and harmful microorganisms cannot grow. Based on the moisture contents, three types of fermented pork products can be manufactured e.g. dry, semi-dry and moist. Extension of storage life, safety of foods and improvement of sensory properties are the benefits.

Designer pork products: Pork can be effectively utilized to produce designer/ functional pork products. This is achieved by lowering fat, sodium and calories by incorporating fat replaces, fibers and natural antioxidants. A combination of hydrocolloid fat substitute, sodium alginate and carrageenan enhance the sensory attributes of low fat meat products. It is now tried to formulate designer pork products with bioactive peptides so as to use as disease preventing and health promoting food.

Clause 22 of the FSS Act, 2006 explains the definition of functional food as - (1) ―foods for special dietary uses or functional foods or nutraceuticals or health supplements means:

(a) foods which are specially processed or formulated to satisfy particular dietary requirements which exist because of a particular physical or physiological condition or specific diseases and disorders and which are presented as such, wherein the composition of these foodstuffs must differ significantly from the composition of ordinary foods of comparable nature, if such ordinary foods exist, and may contain one or more of the following ingredients, namely:- (i) plants or botanicals or their parts in the form of powder, concentrate or extract in water, ethyl alcohol or hydro alcoholic extract, single or in combination; (ii) minerals or vitamins or proteins or metals or their compounds or amino acids (in amounts not exceeding the Recommended Daily Allowance for Indians) or enzymes (within permissible limits); (iii)

substances from animal origin; (iv) a dietary substance for use by human beings to supplement the diet by increasing the total dietary intake;

Traditional pork products: Indigenous meat products are very popular because of their ease of preparation and unique sensory attributes, in particular flavour profiles. Considerable progress has been made in standardization of product profile and mechanization of traditional meat products. However, much has to be done to meet the increasing requirements of traditional food products particularly meat products. The demand for traditional meat products is bound to increase further in the coming years due to rapid urbanization and industrialization. The rich heritage of India contributes to wide range of traditional foods and has a role to play in health foods. Indigenous pork products are much popular in North-Eastern Region and are unique in their spicy flavour, simplicity and ease of preparation. With many processing methods and tools offered by contemporary food technology along with scientific packaging, the quality and shelf life of traditional pork products can be raised to world class standards.

Technical support to entrepreneurs/start-ups through 'Agri-Business Incubation' centre

ICAR has established Agri-business Incubation (ABI) centres in different ICAR institutes to nurture early stage innovative startups and entrepreneurs. ABI centres act as a platform for the speedy commercialization of the technologies and reinforcing of public private partnerships through an interfacing and networking mechanism between R&D institutes, industries and financial institutions, thereby contributing to knowledge based economy. Technology applications, skill development and developing the service sector that solves the problem of glut, unemployment, and waste management will definitely contribute to change the agriculture and allied sectors into an organized sector. ABI Centre is providing the possible technical support to the entrepreneurs to validate and upscale the technologies and encourage their reach to the end user for an attractive business proposition. It is also facilitating the innovator and the researchers to turn their ideas into commercial venture. Further, the ABI centre also extends support for starting, diversifying and up-scaling of commercial piggery/ allied services/pork processing/quality control sectors to the promising entrepreneurs. The centre focuses on incubation and business development programmes, including entrepreneurship skill development activities.

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Chapter 7

TECHNOLOGY COMMERCIALIZATION AND TRANSFER FROM RESEARCH ORGANIZATIONS

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To enhance the efficiency and augmentation of the industrial upliftment in the country there needs a constant urge to increase the output productivity by creating technology-oriented start-ups, entrepreneurship ecosystem, employment, and a new market through technology transfer and commercialization from research organizations. Conversely, technology transfer and commercialization from research organizations to entrepreneurship ecosystems are lower in a country like India as compared to western countries. Although the country has a large number of academic institutions and research organizations with a very good research and development ecosystem and made a significant contribution to science and technological up-gradation, the technology transfer and commercialization rate is still very low due to ineffective mechanisms, non-flexibility in IPRs regime and insignificant association of academic institutions and research functions with the entrepreneurs and industries. Commercialization and transfer support the life cycle of technology, from invention to commercialization in the market for end users' use. On the other hand, Intellectual property rights (IPR) are another important component in the research and development of innovations. The IPR assure the ownership of intellectual findings and the capacity to control them in line with inventors' mission and values. When technology is ready to commercialize, IPR acts as a powerful business tool to expand its spot on the market exclusivity over a new creation or development. So, the technology commercialization and transfer regime is not only an important instrument to attract partners or collaborators but also obtains return on research investment by the research organization through licensing deals. The IPR serves as a pivotal technology transfer tool and also acts as a technology managing tool for effective transfer and commercialization process. For successful technology transfer, it needs to create an innovation ecosystem within the research organization and universities to operate an interconnected network of governmental, industry and research organizations. This type of initiative enables critical factors like transfer structures, commercialization and market value. The resources and expertise collaborative process also help in achieving the targeted goal of innovation for overall economic development in the system.

Technology transfer and commercialization

The transfer and commercialization of any technology from any research organization needs a collaborative step. The collaboration between the scientist and entrepreneurs allows scientific invention, information and intellectual property to flow from inventors to market, through research organizations and other academic institutions for successful public and private uses. The main aim of such collaboration is to transform the scientific outcomes or innovation from the research organization into new products and services that not only benefit the entrepreneur but also benefit the whole society. Moreover, technology transfer is very closely related to the transfer of knowledge to benefit society as a whole.

Limitations of Research Organizations

There are many limitations of research organizations which directly hampered increasing technology transfer and commercialization process. But through an effective policy framework the technology transfer and commercialization process can be increased and implemented through the collaborative research with industries, augment the trust for entrepreneurs to buy home-grown technology, the proper economic value of technology or innovation by appropriate estimation, maintaining a coherent association between entrepreneur and research organizations, developing technology as per the need and aspiration of entrepreneurs, adopting formal intellectual property policy, implementation of risk incentive policies by research organizations, involving in technology commercialization process and development, improving maintaining collaborative ecosystem to increase the technology transfer and commercialization. Above mentions factors are very critical for research organizations and inventors to improve and successful implementation process of technology transfer and commercialization. There should be always favourable policy implementation strategies in respect of collaborative research with entrepreneurs and research organizations. This kind of favourable environment increases the confidence and conviction of entrepreneurs in research organizations to commercialize innovative technology. Another important factor that has a greater impact on technology transfer and commercialization is proper valuation of the technology, which has not only increased the incentive to research organizations to commercialize the intellectual property to the entrepreneurs but also it would escalate the alliance of research organizations with entrepreneurs in the long run.

Affecting Factors of Technology Transfer and Commercialization

The crucial contributor to enhancing technology transfer and commercialization from research organizations is made by different forms of IP prevailed in the country. These factors

directly act on technology transfer from research institutes to industrial applications and one entrepreneur to the other in manufacturing the country. The technology transfer and commercialization process can be either technology-push or demand-pull (Jun & Ji, 2016) depending on the requirement of technology in the market. Demand-oriented parameters for conveying technology relays upon the demand or need of a specific technology. Technology transfer and commercialization is a daring approach for a scientific person in a research institution due to reasons like an evaluation of the economic feasibility of technology or novelty, the settlement on the period of licensing, mutual agreements among the technology formulators and its users, etc. (Kumar et al., 2015). The IP law prescribed the legal term and conditions for further use of a technology or invention through the protection of technology that increases the possibility of commercialization many folds. The key determinants of technology transfer and commercialization from research organizations are namely activities and expenditure of research and development projects, funding, skilled staff, scientists, technology aspirants, negotiating power of research institutions, technology learning and commercialization capability. The entire process of technology transfer and commercialization includes an array of factors such as law and policies, licensing pattern, commercialization design, communication, the technological aptitude of firms, human resources, technology localization, technical qualities, and collaboration among the entrepreneurs and industries (Singh and Kumar, 2022; Feng et al., 2010; Singh and Singh, 2020; Singhai et. al., 2021). Another important factor for successfully increasing technology transfer and commercialization from research organizations is making a viable and constant communication among the stakeholders.

Lab to Land Approach

In 1979 ICAR launched The Lab to Land Programme (LLP), whose major objective was to enhance the financial condition of the small and marginal farmers and landless agricultural labourers, particularly scheduled castes and scheduled tribes, and by transfer of improved technology innovated by the research organization and agricultural universities. But the accelerated propagation of pioneering technologies necessitates their efficient transfer, to stakeholders whether in the public or private segment. Even though such institutional mechanisms for technology management and transfer have been established it is to be recognized that these activities call for professional guidance and a very diverse kind of expertise. In this context, Agrinnovate India Limited (AgIn) a registered Company owned by the Government of India in DARE has been established to encourage the development and

spread of R&D products through IPR protection, commercialization and forging partnerships both in the country and overseas for the benefit of the public.

Validation of technologies

Technologies formulated by the scientists/inventors in the laboratories require scaling up for their commercialization. The industrial use of technologies requires standardization, validation, production and quality control under expert supervision. The technologies need to be evaluated and validated with 100% reproducibility accuracy before it is released to the market.

Evaluation by IP management committee at institute level

India being an affiliate of the World Trade Organization (WTO) complies with the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement), which requires that member countries provide for intellectual property rights (IPR) in one form or the other in all fields of technology along with agriculture. The transfer of IPR-enabled agricultural technologies through commercial channels gains greater weightage. A prominent IP management regime helps to develop an in-built incentive for scientists/ inventors to engage in knowledge divulging thus leading to greater professional recognition. Through the process of licensing fees and royalties, a fraction of the monetary profits flows to the researchers. The ICAR organization promotes greater creativity in the research system, by sharing monetary incentives with its employees and institutions. This likely generates further innovations thus resulting in faster technological advancement.

Technology IP protection

IPR is protected by ICAR as per the Indian laws, rules and regulations in conformity with the international agreements to which India is a signatory. It advances the transfer of its IPR-enabled technologies, including finished processes, products, creations/works and other know-how, through commercial and public routes to the stakeholders. Systematic management of its IPR regime will promote a commercial ethos in public sector research helping to transform agriculture from a predominantly subsistence mode to a globally competitive one. The technological derivations developed by the scientists/ inventors could be secluded by patents, or any other form of exclusive IP rights such as copyright, trade mark, design, etc.

Technology Valuation

The committee governing the techno-commercial agency and /or committee for developing standard terms decides the licence fee, royalty and market price of its IPR-enabled technologies either on a fixed basis, through negotiations with the licensee, or using an open

bidding procedure, whichever is suitable. The following points together with expert opinion and judgment viewpoint are considered in determining the price/licence fee-

1. Cost of IPR protection and maintenance.
2. Cost of production and handling.
3. Other institutional costs as appropriate.

Generating Entrepreneurship

Entrepreneurship involving scientific technology can lead to the setting up of new enterprises by individuals or corporations thus exploiting technological innovation. It can be achieved by the commercialization of promising technological discoveries by the means of advertisement, display mode, sensitization programs etc.

Commercialization of technologies

An efficient way of transfer of technologies includes commercialization of technologies and other know-how, through public-private partnerships. Expansion in the rate of embracing of technologies by the producers will create an increase in productivity, production, farmers' profits and employment generation. The following factors are prerequisites for the process of technology transfer through commercialization, such as (i) national priorities relating to food security, (ii) sustainable use of natural resources, (iii) enhancing the incomes of small and marginal farmers, and (iv) entrepreneurship and employment generation.

Technologies developed by ICAR-NRC on pig

Technology for creating wealth from waste (vegetable waste/banana waste-based pig feed)

In pig farming, the cost of the feed represents more than 75 % of the total production cost. Moreover, there is a huge deficit of pig feed in the NE region. However, to reduce the cost of pig feeding locally available materials like vegetable waste etc. can be used to formulate pig feed, which otherwise gets wasted and causes environmental pollution. This innovation can reduce the feeding cost, improve the production performance and increase the profit.

Technology for creating wealth from waste (vermicompost production from pig dung)

The solid waste of pigs mainly pig dung can be converted to valuable fertilizer *i.e.* vermicompost which otherwise goes waste and causes environmental pollution through foul odour emission. This pollution can be reduced by converting the waste to vermicompost. It can be used in the kitchen garden, flower garden and other horticultural gardens for the production of organic agricultural products. From 100 adult pigs, one can get 20-25 tonnes of pig dung annually which causes pollution. This innovation can reduce environmental pollution, increase agricultural productivity and increase the profit of farmers.

Technology for economic feed formulations for pigs using locally available feed ingredients

Feed procurement accounts for 65%-75% of the total costs of swine production. As such, the kind of feed provided largely determines the profitability of a piggery farm. Maize and soybean meal are the chief supply of energy and protein respectively in swine ration. Alternative feeds can also be used to provide energy or protein in the swine ration. There are many recognized alternatives to feed sources in pigs that meet nutritional demand while reducing the price of the ration. Brewer's rice by-products, bakery waste, azola, moringa leaves, silkworm pupa meal, tapioca tubers, colocasia, steamed flake rice products, water hyacinth etc. are such alternative pig feeds available in large quantities in Assam and other NE states. This by-product can be used to replace either energy or protein feed ingredients at various percentages to formulate economic rations for pigs without affecting nutrient utilization. Feeding costs are greatly reduced by employing such technologies.

Technology for Development of chelated trace mineral mixture (PIGMIN) to improve pig production

Consuming insufficient quantity of trace minerals can lead to reduced feed ingestion, lower reproductive efficiency, inferior immunity, slower growth and poorer feed conversion in pigs. The technology for the development of chelated trace mineral mixture (PIGMIN) can improve reproductive performance, herd health and growth performances in pigs.

Technology for tapioca tubers-based pig feed

In pig farming, cost of feed represents more than 75 % of the total production cost. Moreover, there is a huge deficit of pig feed in the NE region. However, to reduce the cost of pig feeding locally available materials like tapioca tubers can be used to formulate pig feed, which is very perishable and get fungal contamination within 2-3 days in the open environment after harvesting.

Technology for processing restructured pork products.

Comminution of pork results in emulsification and the pork tissue becomes very soft. Comminute pork products could only offer the taste and flavour of the pork to the consumers but not the texture or chewiness of intact meat. Restructuring technology provides ample scope for imparting chewiness in pork products apart from taste and flavour. Thus, consumers will get all the characteristics of pork in the restructured pork products. Accordingly, the technologies for processing Restructured ham slices, Restructured pork salami, Restructured pork nuggets and Restructured pork bites with good consumer acceptance were developed at the R&D pork processing plant. The technology has also been

developed to process these products with different flavours and tastes to provide variety to the consumers.

Technology for processing enrobed pork products

Pork products processed using comminution or restructuring technology lack the crispiness. Enrobing technology provides ample scope for imparting crispiness in pork products apart from taste and flavour. Thus, consumers will get better eating quality parameters. Accordingly, the technologies for processing Enrobed pork nuggets and Enrobed pork bites with good consumer acceptance were developed at the R&D pork processing plant. The technology has also been developed to process these products with different flavours and tastes to provide variety to the consumers.

Technology for processing shelf-stable pork products using retort technology

Pork products processed using emulsion, restructured or enrobed need a cold chain for their marketing and storage, which adds to the cost of the product. Also, provision for a continuous supply of electricity in many parts of the country is still a dream. Retort processing technology offers the scope for processing pork products which are shelf-stable at room temperature, thereby permitting the marketing of the products without a cold chain. Accordingly, technology has been developed for processing Pork curry with bamboo shoot and pork vindaloo.

Technology for the cost-effective rural pig slaughterhouse

Pigs are often slaughtered in a very inhumane way in most rural parts of the country. This results not only in imparting stress to the animal but also retard the quality and stability of pork. Technology for the construction of cost-effective (say Rs. 6-8 lakh) pig slaughterhouses in rural areas have been developed. The technology offers provisions for electrical stunning, bleeding and cleaning operations in a raised platform, treatment of effluents etc. as per FSSAI requirements.

Individual identification of pig by auricular venation pattern

Auricular vein pattern was identified as a trait for individual identification of pig. The image of the ear for vein pattern was processed for segmentation followed by generation of the auricular-vein tree. Those vein trees were used for generating a template database for the recognition of pigs. More than 90% of matching was achieved.

Individual identification of goat by iris image

Iris's image of the goat can be used as a unique trait for the identification of individual animals. After critical statistical analysis of the repeated sample, it was found that matching

of any image with a pre-stored database was more than 70 per cent for the same individual whereas the matching percentage decreased to less than 55 for different individuals.

A Portable Free Standing Small-Animal Restraining Tool/ Pig Restraining Tool

To restore small animals, restraining tools are essential for easy handling of all animals during the conduction of different veterinary procedures. A tool was developed to restore the small animals. The present invention relates in general to restraining tools and harnesses for animals and in particular to a portable small-animal restraining tool which is free-standing, cost-effective and easy to handle. The tool is intended for handling small animals like sheep, goats, dogs etc.

Technology for hygienic transport of meat for local distribution

Currently, meat is sold in open markets without any cold chain facilities in most of the country. In most cases, the meat gets spoiled by the time it reaches the consumers. A container for hygienic transport of meat for local distribution has been designed and developed. The container can be fitted onto the carrier of a bicycle or a bike as applicable. The patent has been granted for this technology [Patent no. 296345].

Pig breeding technologies including farm data collection

Scientific pig breeding can increase the farmers' income to double that of the conventional method. To achieve the target for profitable pig breeding, technologies for the following aspects were standardized for the farmer's field.

- Methods of Selection of pig
- Boar selection
- Avoiding inbreeding
- Data recording

NRCP-Nucleic acid-based diagnosis of porcine reproductive and respiratory syndrome (PRRS) virus infection in pigs

Porcine Reproductive and Respiratory Syndrome is a newly emerged exotic disease of pigs in our country. The disease is the root cause of huge economic loss to the pig industry and affects the socio-economic condition of the farmers, mainly in the north-eastern region of India. The diagnostics available for the disease are in very initial stages and we do not have any diagnostic techniques for this particular disease. Presently, no fully validated PCR has international acceptability. No specific and sensitive diagnostics (both for antigen and antibody) for PRRSV in India. Currently, we are importing the ELISA kits for the diagnosis of the PRRS infection in pigs. These kits are very costly and have a limited number of

applications. The NRCP-Nucleic acid-based diagnosis of porcine reproductive and respiratory syndrome (PRRS) virus infection in pigs is useful for routine screening of PRRS infection in pigs. The test developed here can simultaneously detect three antigenic (N, M and ORF5) genes of the PRRS virus in a single PCR reaction. Thus the test is extremely specific for PRRS infection in pigs. Further, the test is earmarked with its *rapidity* (can be completed within 5-6 hours), *user-friendliness* (as it is easy to perform), *economical* (because it does not need expensive types of equipment and reagents) and highly s*pecific*

Multiplex PCR kit for rapid detection of prevalent pathotypes of Escherichia coli from diarrhoeic piglets

Diarrhoea in pigs is a serious prevailing problem as it causes extensive economic loss in the pig industry, especially targeting suckling and weaned piglets. Enteric colibacillosis is very common and the most important cause of enteric disease in pigs. Diarrhoea in piglets is caused by different pathotypes of E.coli such as Enterotoxigenix E. coli (ETEC), attaching and effacing E.coli and sometimes by Shigatoxin producing E.coli. The multiplex PCR Kit is a ready-to-use kit developed for the detection of prevalent pathotypes of Escherichia coli from diarrhoeic piglets.

Multiplex PCR kit for rapid detection of Methicillin-resistant Staphylococcus aureus (MRSA) from biological samples

Staphylococcus aureus is one of the most infectious pathogens affecting both humans and animals. Methicillin-resistant *Staphylococcus aureus* (MRSA) has become an emerging problem in hospitals (healthcare-associated MRSA), the community (community-associated MRSA) and livestock operations (livestock-associated MRSA). These bacteria are contagious to humans having a close association with MRSA-colonized animals. Livestock species, particularly pigs can act as reservoirs for LA-MRSA. The multiplex PCR Kit is a ready-to-use kit developed for the detection of Methicillin-resistant Staphylococci at the first attempt.

Rapid detection of virulence-associated genes of Pasteurella multocida in pigs using Multiplex PCR kit

According to the World Animal Health Organization (OIE), Pasteurellosis is a high-alarming disease affecting livestock. Among the Pasteurella species, *P. multocida* is the common organism causing chronic as well as acute infections in pigs, leading to significant morbidity, manifested as Pasteurellosis, pneumonia, atrophy rhinitis, hemorrhagic septicemia (HS) and mortality. In swine, *P. multocida* is most common and the lung is the

targeted organ of this infectious process. The multiplex PCR Kit is a ready-to-use kit developed for the detection of Pasteurella multocida at the first attempt.

LAMP (Loop-mediated isothermal amplification) Assay kit for detection of Porcine Circovirus Type – 2 (PCV-2)

Porcine circovirus type 2 (PCV-2) is a viral pathogen of global concern having great economic value in pig farming. It is responsible for ravaging post-weaning multisystemic wasting syndrome (PMWS) and many other disease syndromes generally regarded as Porcine circovirus-associated diseases (PCVAD). LAMP is a sensitive, easy and time-efficient assay for the detection of Porcine Circovirus Type 2 (PCV-2) infections in the field.

LAMP (Loop-mediated isothermal amplification) Assay kit for detection of Porcine Parvovirus (PPV)

Porcine Parvovirus (PPV) is a viral disease affecting embryonic and foetal loss and is a major concern for the death and mummification of affected foetal pigs. The disease targets pregnant sow or gilt where the virus infects and destroys both embryos and foetuses. It is primarily responsible for the Stillbirths Mummification Embryonic Death and Infertility (SMEDI) syndrome. Presently, there is no vaccine for PPV available in India, contributing to one of the major problems of reproductive failure in pigs. LAMP is a sensitive, easy and time-efficient assay for the detection of Porcine Parvovirus (PPV) infection in the field.

Multiplex PCR kit for simultaneous detection of Porcine Circovirus -2 (PCV-2), Porcine Parvovirus (PPV) and Classical Swine Fever Virus (CSFV)

Along with PCV-2 and PPV, Classical swine fever (CSF) is considered one of the major endemic viral diseases of pigs throughout India. Classical swine fever (CSF) is caused by CSF virus (CSFV) and can be the concern of enormous morbidity and mortality events in the affected swine. The disease can spread in acute, chronic, or prenatal forms. The multiplex PCR Kit is a ready-to-use kit that consists of multiple primer sets within a single PCR mixture. It can target multiple sequences in one go and hence multiple results can be obtained in a single test. This is a rapid test kit that enables success in the first attempt.

Nucleo ^{FAST} Viral DNA Isolation Kit

Nucleo FAST Viral DNA isolation kit technology can be useful for the quick extraction of viral DNA from animal post-mortem samples. The developed NucleoFast Viral DNA isolation kit has the following distinguishing features when compared to existing methodologies

Simplicity: The buffer can be easily prepared without any technical difficulties

Cost-effectiveness: The estimated cost per sample is INR 10-15/-only

Short handling time: The total time required for DNA extraction is only 5-6 minutes

Multiplex $^{\text{CSF, JE \& PRRS}}$ assay Kit

To detect CSF, JE, and PRRS in porcine samples, a specific set of oligonucleotide primers was designed and combined in a multiplex arrangement. To demonstrate the accuracy of the developed multiplex PCR assay, 413 swine post-mortem tissue samples were tested. Each of the CSFV, JEV, and PRRSV target genes was amplified with the help of the designed primers, but no other pig viral genes were detected. The detection limit of the assay was 102-103 copies/µl of viral nucleic acid. The presence of viral DNA of PRRSV, CSFV, and JEV is indicated by the detection of 144 bp, 171 bp, and 283 bp fragments in agarose gel electrophoresis, respectively. Cost-effective: Since no expensive equipment is required; No containment facilities are required; Can be performed in any laboratory; simultaneously tests for the presence of all three RNA viruses

High producing crossbred pig (Rani) for breeder farmer

The success of pig farming depends upon the accessibility of superior germplasm in multiplier farms which can unfailingly provide its replacement stock. Considering the insufficient number of high performing improved pig germplasm, a breeding programme was introduced at the ICAR-NRC on Pig, Rani, by using Ghungroo as the indigenous germplasm and Hampshire as exotic to develop a suitable crossbred variety for multipliers of the NE and its neighbouring states. This success led to the development of the crossbred pig named “Rani”, based on its locality name. The Rani breed has higher litter size/weight at birth and weaning, promising growth rate, better adaptability and body condition of sow remaining excellent up to fifth farrowing.

Crossbred pig (Asha) for fattening farmer

Recently, there has been an enthusiastic involvement of youth and entrepreneurs in the piggery sector. Such kind of participation will not only mitigate the demand-supply gap in pig husbandry but also increase the opportunity for employment generation among the rural youths. The introduction of finisher products in the piggery sector requires the abundance of improved germplasm with a maximum growth rate, thus ensuring better economic returns. Presently, Duroc sires are mostly utilized as the Terminal/Paternal sire in a terminal crossbreeding program. To achieve the objective of the development of high-producing crossbred pig, a breeding programme was launched at the ICAR-NRC on Pig, Rani, and Guwahati to use Duroc as a terminal sire for crossing with Rani sows, a crossbred of Hampshire and Ghungroo. The proposed crossbreeding program with rigorous selection resulted in the development of

“Asha”, a crossbred variety with 25% Ghungroo, 25% Hampshire and 50% Duroc inheritance. The developed variety has a promising growth rate and is adaptable to local climatic conditions.

Artificial Insemination in Pigs

Artificial Insemination in pigs is a scientific process, which involves the collection of semen from a healthy trained boar and undergoes the course of testing, processing, packaging/storing and finally inseminated into a receptive female at the occurrence of heat.

Previously, the technique was designed to improve the genetic conditions of animals and resolve their sanitary problems. However, a considerable enhancement in both productive and economical aspects was further introspected, making a possible acceleration in the diffusion of the desirable characteristics of the reproducers with high genetic value. Artificial Insemination in pigs can reduce the cost of keeping males, and feeding males, cause genetic improvement and overcomes the size of male and female. AI is a convenient technique broadly welcomed at the farmers' level.

Pig husbandry is one of the most lucrative professions in India and plays an instrumental stand in providing sustainable employment to the small marginal farmers of different regions. The unemployment problem is a burning social concern in India adversely affecting its economy. This has made pig breeding very profitable with upcoming many entrepreneurs in the country. ICAR acting as the governing body of public research organizations about agriculture and pig farming leads a pivotal role in entrepreneurship generation and technology advancement.

For the enhancement of technology commercialization and transfer process from research organizations factors like a collaborative ecosystem between entrepreneurs with research, organizations need to be properly established. Research organizations should set up a unit for technology transfer and commercialization at the organization level. Academic institutions and universities should build up the syllabus as per the basic prerequisite of the manufacturing division. There should be a regulatory guideline for uniform and effective intellectual property rights execution. There should be a condition for all scientists and faculties to develop a minimum of one innovation or technology from a project funded for research and development. This kind of initiative will be very much obliged for technology transfer and commercialization in a research organization. Research organizations should take organise capacity-building and outreach programmes for the entrepreneurs or start-ups to understand the needs and requirements. There is an urgent need for and implementation of strict IP laws to nullify the replication rate of technology. Also, scientists and innovators need to be sensitised about IP law and its advantages to reduce the replication rate of new inventions. The IP

regulatory body should grant patents or other forms of IPRs within the minimum frame. Also, IPRs-linked programmes should be commenced by the research consortium at the higher academic levels. Although there is an impeccable progression in IPRs and technology transformation and commercialization in the last decade due to the precise operation of IPRs, S&T and other policies, there is an insistent need to increase the collaborative networking between entrepreneurs and research organizations for expansion in this arena. Moreover, the facilitation of incentives for the innovators and autonomy of scientists in research management is a requirement to speed up technology transfer and its commercialization.

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Chapter 8

ARTIFICIAL INSEMINATION IN PIG

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Pig farming is popular among rural residents, particularly among India's tribal populations. More than 40% of the nation's total pig population lives in the North-Eastern Region, which has the highest concentration of pigs. The North Eastern region has tremendous potential for pig farming to provide food security and a means of subsistence for the economically disadvantaged parts of society. Due to the quicker financial returns, pig farming is currently attracting a growing number of young entrepreneurs to start their own businesses. The fact that technically capable and skilled individuals are being attracted to this farming is encouraging for the nation. According to the 20th livestock census, there are 9.06 million pigs in the country, and their number is now declining. India's pig population is dropping as a result of the enormous disparity between supply and demand for pork, particularly in North East India. Another obstacle to increasing the population of pigs is a lack of sufficient outstanding males for breeding. A village typically raises only a few male pigs, making it impossible to serve an estrus female at the appropriate time. Missing one oestrous cycle in female pigs results in a management cost loss of about Rs. 2000. Since the extended and stored boar semen can be made available at any time at any place, widespread artificial insemination of pigs using the boar semen is the only way to solve the issue. The method may be applied at a farmer's doorstep and aims to lower the expense of maintaining and feeding male animals, improve genetics, and get around the size difference between males and females.

In Western and developing nations, artificial insemination (AI) is mostly used for breeding pigs. Due to the lack of semen dosages available nationwide, artificial insemination in pigs has not been widely practised in India. The method is still only applicable in locations that are close to certain research stations or veterinary institutions. This is a result of issues with storing boar spermatozoa for an extended period of time at low temperatures like 5°C or in a frozen form at -196°C. The artificial insemination (AI) approach might be useful for supplying farmers' doorsteps with improved pig genetics and for expediting the proliferation of elite germplasm. Boar spermatozoa have the highest level of sensitivity to cold shock among domestic animal spermatozoa, which may compromise their ability to produce

the high-quality frozen sperm required for effective artificial insemination. Boar spermatozoa lose fertility as storage duration increases during liquid preservation. Boar spermatozoa experience a variety of changes during storage, including decreased viability, motility, and permeability. Artificial insemination in pigs using frozen-thawed semen is limited to less than 1 per cent of the total insemination in pigs done worldwide. In the past 15 years, the use of stored semen for pig AI has increased by around threefold. The estimated 19 million inseminations performed annually around the world use more than 99 per cent of semen that has been extended in a liquid state, used that day or held at 15-20°C for up to seven days after collection with little impact on fertility. Eighty-five per cent of inseminations take place on the same day of collection or the day after.

The procedure of artificial insemination involves the collection of live sperm from trained boars, evaluated, processed, and introduced into the female (gilt/sow) reproductive system with the aid of AI catheters under hygienic conditions in order to produce viable offspring. In contrast to cattle and buffalo, artificial insemination in pigs is relatively simple.

Advantages of Artificial Insemination in Pig

- Making the most of the genetic potential of the greatest boars with a large number of sows. In addition, reproductive performance is better in AI than that attained through natural mating and AI also facilitates genetic progress easier.
- Keeping male/boar for natural service is an expensive endeavour. Additionally, the market value of that male becomes very low after a certain age of roughly more than 3–4 years since the boar meat emits a foul scent that is not tolerated by meat consumers. These pigs end up being a burden for the farmers. By lowering the expense of maintaining males and boars, A.I. offers a very good answer for these animals.
- It gives young people a way to work for themselves as inseminators and make money.
- Artificial insemination can produce the fastest genetic progress. Since polytocous species suffer from inbreeding depression, which affects reproduction, productivity, carcass characteristics, and feed conversion efficiency and causes economic loss, the AI technology can be used to solve this problem.
- Using a large sized boar from an exotic breed of pigs, the finishing weight and production performances of native pigs (small size) can be improved in a shorter amount of time.
- Large-scale crossbreeding is feasible for synthetic breed development programmes.

- Using superior quality boar semen, AI can be performed remotely.
- Importing semen and using that semen for artificial insemination can reduce the expense of importing live animals.
- Sexually transmitted illnesses can be avoided.
- A.I. overcomes the gender-specific size inequalities.
- As record keeping for production and pedigree sheets improves, it becomes easier to maintain the dam and sire lineages.
- For marginal and small farmers, A.I. is a very economical technique of reproduction since it avoids the expense of maintaining and feeding a breeding boar.
- It reduces management expenses when used with synchronisation techniques for inducing estrus or heat, allowing a group or number of sows to breed at a predetermined time and resulting in more synchronous farrowing.
- Under the AI programme, evaluation of sperm. enables early investigation of low fertile boars.

Training of Boar

It is necessary to train the boar to collect semen on the dummy. The most important aspect of AI programme is said to be the training of the boars. The number of boars that are successfully trained to mount a dummy sow varies depending on factors including age, breed temperament, season, the trainer's patience and skill, etc. However, the age of the boar is the most crucial element. However, it is best to begin training of boar when they are between 7-8 months old. Within one to ten days, the majority of boars may be trained to mount a dummy sow. A boar that has never interacted sexually with a female is typically simpler to train than one that has mated. The dummy sow's height needs to be accurate. Handling the boar during training for semen collection requires patience. Always handle a boar quietly and patiently when teaching him to mount a dummy sow. Mistreated boars in the collection area are unlikely to respond to the dummy. It is crucial to make a pleasurable experience for the boar to associate the collection area and procedure. Boars who are in discomfort will be very difficult to collect semen. In its own pen, the boar needs to be aroused and exposed to the dummy each day for three to four days. After putting the dummy in the boar's pen, stimulate the animal by massaging his prepuce and scrotum. The boar should be collected daily for one week after it has been trained well on the dummy, then once or twice per week for the following

month. The boar under training should be introduced to the dummy sow as soon as the semen has been collected from a trained boar. Boar training may take three to four weeks.

Semen collection and handling of semen

The gloved hand method is the most effective way to collect boar semen. The penis should be held with warm fingers, first lightly and then firmly, when it is partially extended. The first and second ridges of the spiral part of the penis need to be firmly pressed. Applying pressure to the spiral region of the penis triggers ejaculation. The little finger should be placed such that it is close to the penis's tip. The penis should be left to naturally extend as the boar thrusts without being pulled. When a clear, watery ejaculate has been produced, the penis should be placed in the collection container. The boar will stop thrusting when fully extended, assume a hard, "locked-on" position, and begin ejaculating. The grip shouldn't be relaxed during ejaculation because doing so will cause the ejaculation to stop and the boar to restart thrusting. It takes five to ten minutes to ejaculate and typically produces 200 to 500 ml of semen.

Storage of semen

Because boar sperm is susceptible to cold shock, it is imperative to store sperm samples between 15 and 20°C, because a more drastic decrease in storage temperature may seriously jeopardise the survival of seminal dosages. The amount of time sperm samples can be stored, however, is limited by storage at 15-20°C, since cell metabolism is not sufficiently slowed down and microbial contamination cannot be controlled as it could at lower temperatures, such as 5°C and in a frozen form at -196°C. Antibiotics are essential to keep bacterial growth under control because of this.

Depending on how long they will be stored, refrigeration extenders are divided into two groups. Short-term extenders can keep sperm viable for up to three days and long-term extenders that can keep sperm viable for more than four days. The use of a short-term extender, which is less expensive and may be highly efficient in retaining sperm quality, will be the most rational option in some situations as 85 per cent of the AIs carried out using extended semen is performed during the first two days after semen collection.

Heat Detection

The most crucial task in a farm for the successful implementation of the Al programme is accurate heat detection. In many instances, once a day is sufficient, but heat detection needs to be done twice every day at the same time in a methodical manner. When weight is put on the loin, the sow or gilt becomes rigid and immobile, if she reaches "standing

heat". The technique for accurately identifying female pigs in estrus that involves applying pressure to the pig's loin or back is known as the "Back Pressure Test". If a boar is present, a greater proportion of females will react to the "back pressure test." Therefore, using a pig that has been vasectomized or left intact is an essential component of a routine heat detection programme. Finding standing heat is essential because it tells us when to inseminate the animal. For monitoring and precise detection of heat, keeping thorough records of the female pig's reproductive events is beneficial.

Signs of Heat (estrus)

Early heat

The gilt/sow is restless and easily disturbed during this time, which lasts for about a day before she stands for mating.

Signs of early heat:

- Swollen and red vulva (more typical in gilts but not consistently in sows)
- Climb on gates and walls
- Produce a watery discharge from the vulva
- Emit a high -pitched whine
- Mount other females but do not stand themselves

Period of Heat

The sow is getting ready to stand for mating around this time.

Signs of heat:

• Normal vulva (swelling and reddening subsides)
• Stands with tail upright and flicking up and down
• Reduced appetite (less interest in feed)
• Repeated grunts or growls for a long time.
• Display pricked ears
• Displays a standing reflex
• Stands with arched back
• Glazed eyes
• Tacky discharge from the vulva
• Be attracted to stockperson
• The majority of sows and gilts exhibit increased interest in boars.
• Stand rigid if mounted by another female
• Respond positively to the "back pressure test" when the boar is present.

Reddening and Swelling of the Vulva:

Red and swollen vulva are typically more noticeable in gilts than in sows. The swelling of the vulva is possibly the most readily apparent physical symptom that an animal is entering the heat cycle. Many animals experience vulva swelling and reddening 2 to 5 days prior to breeding. Some animals show little or no swelling. Reddening and swelling of the vulva peak and begin to subside 24 to 36 hours prior to the animal reaching standing heat.

Discharge of Sticky Mucous:

Most sows and gilts release mucus from the vulva as standing heat approaches. The mucus starts out clear, smooth, and oily but changes to cloudy and sticky during standing heat. Put on a latex glove and use your thumb to wipe the interior of the vulva to see how thick the mucus is. Draw the thumb and pointer finger apart gradually by pressing them together. The mucus is sticky if it forms a thread between the thumb and pointer when they are pulled apart. Another indication that the animal is exuding sticky mucous is straw or bedding stuck to the vulva. An engorged clitoris and sticky mucous are physical indicators that a female is in standing heat, or that standing heat is only a few days away.

Roaring:

When sows and gilts achieve standing heat, they may "growl" or "roar." A sow or gilt that emits deep growls should be checked straight away for standing heat.

Back pressure Test for confirmation of Standing Heat:

Following the observation of signs of heat, the sow or gilt should be checked for standing heat every morning and evening. After the animal has finished eating is the optimum time to accomplish this. Use both hands to press down on the animal's loin or sit on the loin to check for standing heat. When in standing heat, a female will remain motionless and rigid and often "push back" by slightly arching her back when pressure is placed on the loin. This is an automatic reaction that causes her to brace herself to support the weight of the boar. Allowing sows and gilts to come nose to nose with a mature boar that is in a nearby pen results in a considerably stronger response from them to loin pressure. Allow contact with the boar only during heat detection, since sows and gilts that have constant exposure to a boar may not react to loin pressure even when they are in standing heat. "Ear popping" is the classical indication of standing heat, in which the female holds her ears upright when pressure is applied on her loin. Breeds with floppy ears, like the Duroc, can only lift their ears partially or twitch them. The animal is in standing heat if its ears are popping.

Back Pressure Test

Techniques of Artificial Insemination in Pig

Different types of catheters used for A.I.

Liquid boar semen dose

Performing of A.I. in an estrus female pig

Estrous cycle, estrus and ovulation

Sows and gilts that are not lactating or pregnant frequently exhibit standing heat or estrus throughout the year. The period of time between the beginning of one estrus and the beginning of the next is known as the estrous cycle, and it typically lasts 21 days. The cycle might last anywhere between 18 and 24 days. Sows typically won't return to heat again until the litter has been weaned because lactation or the nursing stimulation inhibits the oestrous cycle.

Estrus or heat lasts for about two to three days in pigs. It varies, though, and can last as little as 12 hours in gilts to as long as 60 hours or more in sows. It is advised that a female get at least two matings during estrus because the exact moment when estrus begins is rarely understood. This makes sure that sperm are available at the right time, in relation to ovulation, for fertilisation to take place. Two services as compared to one may result in a 10% increase in conception rate and litter size.

Female reproductive system and AI

AI is less time-consuming and simpler to complete in pigs since their reproductive systems are more conducive to it than those of cattle or sheep. The vulva, which is the part of the female reproductive system that is visible, may be red and swollen before or during standing heat. The vulva leads to the vagina, which tapers into the cervix. . Numerous ridges on the cervix serve as a barrier to stop bacteria, dirt, and other foreign objects from entering the uterus. The cervix swells during estrus, making it possible to "lock" the AI spirette or catheter into it. Spiral shaped insemination rods with plastic tips are referred to as "spirettes" and insemination pipettes with foam tips as "catheters". This initiates uterine contraction and prevents some semen backflow, which is necessary for sperm transportation through the uterus to the oviduct, where fertilisation occurs. During ovulation, the ovary releases the eggs (oocytes), which then enter the oviduct and reach the site of fertilisation.

Time of Artificial Insemination

The single most crucial factor impacting fertilisation rate and Al's overall success is the timing of insemination. To reach the site of fertilisation and to develop the capacity to bind and penetrate an egg, the inseminated spermatozoa need time in the female reproductive tract (capacitation). The sperm will attempt to fertilise an egg as they reach the site of fertilization (between 30 minutes and 8 hours after deposition). Sperm will adhere to the surface of the female oviduct if no eggs are present and wait until ovulation takes place and hormones signal

their release from the surface of the female tract. The window for fertilising the egg after ovulation is roughly 8 to 12 hours.

After copulation, spermatozoa can be found in the oviducts of naturally mated sows for at least 24 hours, whereas the viable life of frozen and subsequently thawed spermatozoa in the oviducts is only 8 to 10 hours. The eggs or ova remain viable inside the oviduct for less than 6 hours. As embryos from aged eggs tend to die more easily, it is ideal for the eggs to be fertilised as soon as possible after being shed. The best chances of conception come from inseminations using fresh or refrigerated semen around 12 hours before ovulation. After this point, defective embryos or embryos that survive do not develop into a foetus at farrowing, even if fertilisation of the egg does take place. Poorer litter sizes and lower farrowing rates will result from insemination occurring either too early (24 hours before ovulation) or too late (after ovulation) in the sow/gilts.

In general, gilts should be bred 12 hours after detection of standing heat, and again 12 hours after the first insemination. Sows should be bred 24 hours after detection of standing heat, and again 12 hours later. These insemination regimens, nevertheless, are effective for the majority of animals; yet, some may require timing adjustments due to unusually short or prolonged heat periods. The timing of insemination must therefore be optimised on a farm using an Al strategy.

Table: Right time of Insemination for Single vs Double Inseminations

Type of Female	**Single insemination**	**Double Insemination**	
		1st Insemination	2nd Insemination
Gilt	24h after detection of standing heat	12h after detection of standing heat	12h after 1st Insemination
Sow	24h after detection of standing heat	24h after detection of standing heat	12h after 1st Insemination

Method of AI in Pig

The preparation of a semen dosage involves combining 20 ml of semen with 60 ml of extender. With the aid of an insemination catheter, the resulting 80 ml pack of semen dosage containing 2 to 3 billion spermatozoa is transferred to the deep cervix of an estrus sow or gilt at the time of insemination. The tip of the AI catheter is lubricated with a non-spermicidal

jelly, inserted into a sow's vulvar lips after being properly cleaned with antiseptic. The catheter is inserted into the genital tract until resistance is felt, at which point it is turned counter clockwise. Semen is allowed to flow naturally in the genital tract after attaching a semen packet to the catheter. Starting the process may need a light squeeze, but once it has begun, the semen should be allowed to be taken by uterine contractions. At least 3 minutes are needed for this process. Gilts frequently take longer to inseminate than sows because of the variability in the intensity of uterine contractions. The semen will overflow out of the vulva if it is deposited too quickly. Semen that spills out onto the ground is obviously wasted. Semen backflow in a negligible proportion is anticipated. Stop the insemination, if there is a large amount of backflow. Either the semen is being deposited too quickly or the spirette is not adequately placed into the cervix, which results in excessive backflow. This could be fixed by turning the spirette a quarter turn. Reposition the spirette by a quarter turn or slightly move the catheter back and forth to restart semen flow if it stops. Cut a tiny hole in the semen bottle as well, if a vacuum buildup has caused the flow to cease. Reposition the spirette if there is significant resistance to the flow of semen because the tip may be pressed up against a cervical fold. To prevent the spread of sickness or infection from one female to another, a fresh spirette or catheter should be used for each insemination. Keep the female pig in a quiet area for 20 to 30 minutes. At this point, stress may still prevent fertilisation and semen transit. The catheter is rotated clockwise and dragged outside to be removed from the genital tract after the semen has been deposited.

Procedure of Artificial Insemination (A.I.)

Step1:

- Identify the female pig in standing heat.
- Use a gentle paper towel to wipe off the vulva.
- Apply a little amount of sterile, water-soluble, non-bactericidal lubricant to the catheter tip.
- While positioned on the left side of the estrus female, widen her vulval lips with your left hand before inserting the catheter around three to four inches.
- Shift your position such that you are behind the female.
- Hold the catheter with the tip pointed upwards at a 20 to 30 degree angle. Push the tip a little bit forward and backwards until it is about 4 to 6 inches forward. (It will prevent entering the urethral [bladder] opening)

Step 2:

- Place the catheter in a more horizontal position and advance it slowly until resistance is felt. That should be enough to show that the tip is at the cervical opening.
- As the catheter is inserted into the cervix, turn it slowly counter clockwise. Get a firm lock; which is indicated when the catheter feels tight and will spring back about a quarter turn. Don't push it too hard.

Step 3:

- Attach the bottle or tube to the catheter's shaft and hold it upright. By gently pressing the bottle or tube, start the flow of semen. Semen flow may be improved by the catheter being moved gently and alternately.
- Apply pressure on the female's back and rub her flank and underline. Be patient; some females will "take" the semen with little to no pressure being given to the bottle or tube, whereas others may need to apply alternate pressure. Give each female a minimum of 3 minutes. Some take longer than others. NEVER RUSH.
- When finished, remove the catheter by gently rotating it in a clockwise direction. Dispose of the catheter and the semen bottle properly. DO NOT REUSE. Record and rate the mating.

Post Artificial Insemination Measures

A successful AI programme requires meticulous record keeping. Record the boar that was used, the dates and times of the inseminations, the 21-day check-back date, and the due date. Note down information that can help you make improvements, if necessary, on subsequent inseminations

Post Insemination Advice to Farmers:

1. Request that the animal is under observation for the ensuing 12–24 hours.

2. Call for a repeat AI if the signs of heat continue even after 18–24 hours; otherwise, check for heat symptoms after 18–21 days and also after 36–42 days.

3. After two to three months from the date of insemination, contact an AI technician for a pregnancy diagnostic if the animal does not repeat heat at intervals of 18 to 21 days for two consecutive times.

4. if necessary. keep the animal's body cool by keeping it in the shed and sprinkling it with water.

5. After three consecutive AIs, if an animal still isn't pregnant, the farmer should be advised to get the animal examined by a veterinarian and follow his advice.

Post insemination follow-up:

1. After about 21 days, check on each and every animal that was inseminated to see if it was repeated.

2. Follow up on every inseminated animal for a pregnancy diagnosis after two to three months, note the date and result in the format provided, and send it to the area office every month.

3. Check the results of the pregnancy diagnosis against the date of insemination, and if necessary, ask the farmer about the post-insemination events to learn whether the animal remained in heat for a long time or came into heat again. If so, how many days later? And whether the farmer scheduled a natural service for the same or a subsequent heat or used AI services from another service provider.

4. Keep track of every pregnant animal and record the details of the animals that were artificially inseminated in the format given.

5. Keep track of all documentation relating to artificial insemination, pregnancy detection, farrowing, and financial transactions.

6. Give advice to farmers on how to properly detect heat, feed their animals and health care as recommended by specialists. Also, advise them on the care and management of animals during advance pregnancy and after farrowing, including care and management of new born piglets.

Gestation: Depending on the breed, size of the litter, and season, gestation lasts between 112 and 116 days. The phrase "3 months, 3 weeks, and 3 days" is frequently used to calculate gestation length in pigs (114 days). To avoid early embryonic death, it's critical to limit stress and movement of the pregnant animal throughout the first five to thirty days of pregnancy.

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Chapter - 9

AGRI-BUSINESS UNITS: EXPERIENCES FROM ICAR

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The word incubation is originally used by Student Agencies Inc., in Ithaca, USA, in 1942 for starting incubating student companies. In 1946, the first incubator was created by American Research Development (ARD), which started by several MIT alumni, to supply risk capital to entrepreneurs. The formal concept of business incubation began in the USA in 1959 when Joseph L. Mancuso opened the Batavia Industrial Centre in a Batavia, New York, warehouse. But, in 1960 incubators were came in picture started developing in respective domain areas. The loss of job opportunities in 1970s to 1980s, were gave opportunities to incubators for their accelerated growth. The 1990s witnessed further development of incubators in USA, which continues up to 1998 with same pace. But, now U.S.-based International Business Innovation Association (IBIA) is the key player at US and leading the world incubators forms. IBIA estimated that there are about 7,000 incubators worldwide. Incubation activity has not been limited to developed countries; incubation environments are now being implemented in developing countries and raising interest for financial support from organizations such as The United Nations Industrial Development Organization (UNIDO) and the World Bank.

Technology Incubation in India

The National Science & Technology Entrepreneurship Development Board (NSTEDB), established in 1982 by the Government of India under the aegis of Department of Science & Technology, is an institutional mechanism for promoting knowledge-driven and technology-intensive enterprises. The Board, aims to convert "job-seekers" into "job-generators" through Science & Technology (S&T) interventions. NSTEDB is operationalised through two major interventions, viz.

- Science & Technology Entrepreneurs Parks (STEP) 1980
- Technology Business Incubators (TBI) programme 2000.
- NSTEDB recommends the guidelines for operation and governance of incubators, which were devised in 1996 by National Business Incubation Association (NBIA).

The basic principles of incubation system

- ✓ Incubator aspires to have a positive impact on its community's economic health by maximizing the success of emerging companies; and
- ✓ The incubator itself is a dynamic model of a sustainable, efficient business operation.
- ✓ Model business incubation programs are distinguished by a commitment to incorporate industry best practices.

Since start-up companies lack many resources, experience and networks, incubators provide services which helps them get through initial hurdles in starting up a business. These hurdles include space, funding, legal, accounting, computer services and other prerequisites to running the business.

Government Initiatives for Incubation System Development in the Country

First Phase (2008 to 2014)

- ✓ The National Small Industries Corporation Limited (NSIC), a public sector undertaking under the administrative control of the Ministry of Micro, Small & Medium Enterprises had set up 45 Training-cum-Incubation Centres (TICs) from 2008 to 2012 to help those who want to become entrepreneurs with training.

- ✓ Ministry of Electronics & Information Technology (MeitY) has initiated "Technology Incubation and Development of Entrepreneurs (TIDE)" Scheme in year 2008 to promote innovation by nurturing start-ups in Information Technology, Communications & Electronics (ICTE) domain. Under the scheme, 27 TIDE Centres and 2 Virtual TIDE centres have been supported.

  Subsequently, MeitY approved TIDE 2.0 scheme in 2019 wherein as on date 41centres have been approved for support. Ministry of Electronics & IT (MeitY) has also initiated Technology Incubation and Development of Entrepreneurs (TIDE 2.0) Scheme with a target of 51 centres to be supported out of which 41 centres have been approved.

- ✓ The Indian Institute of Crop Processing Technology (IICPT), which is an autonomous institute had a Food Processing Business Incubation Centre in its campus at Thanjavur, Tamil Nadu. Six technology transfer trainings were conducted by IICPT's Incubation

Centre in 2012-13 and the total number of beneficiaries who were provided such training was 3893.

- ✓ The Scheme "Support for Entrepreneurial and Managerial Development of SMEs through Incubators", was implemented by Ministry of Micro, Small and Medium Enterprises (MSME). Government has been recognizing incubation centres in various academic institutions as business incubators for supporting the development of new ideas and their subsequent commercialization. Until 2012-13 the Government has recognized 102 academic institutions as business incubators under this scheme.
- ✓ The Government had implemented the Scheme for Incubation in Apparel Manufacturing (SIAM) which was launched on pilot basis in January 2014. The Scheme was a demand driven scheme. The objective of the Scheme was to promote entrepreneurs in apparel manufacturing by providing them an integrated workspace and linkages based entrepreneurial ecosystem with plug and play facility which help them in reducing operational and financial cost for establishing and growing a new business.

Second Phase

Initiative in Union Budget of Government of India		
2014-15	**2015-16**	**2016-17**
✓ A nationwide "District level Incubation and Accelerator Programme" for incubation of new ideas and providing necessary support for accelerating entrepreneurship. ✓ To provide credit enhancement facility for young start up entrepreneurs from Scheduled Castes, who aspire to be part of the neo-middle class, propose to set aside a sum of Rs. 200 crores, which will be operationalised through a scheme by Industrial	✓ To encourage and to grow the spirit of entrepreneurship in India and support new start-ups in the country, mechanism has been established which is known as Self-Employment and Talent Utilisation (SETU). ✓ SETU will be a Techno-Financial, Incubation and Facilitation Programme to support all aspects of start-up businesses, and other self-	300 Rurban Clusters proposed under the Shyama Prasad Mukherjee Rurban Mission. These Clusters are incubating growth centres in rural areas by providing infrastructure amenities and market access for the farmers. They will also expand employment opportunities for the youth. Service tax on services provided by Biotechnology Industry Research

Initiative in Union Budget of Government of India		
Finance Corporation of India (IFCI). ✓ Set up a "Start Up Village Entrepreneurship Programme" for encouraging rural youth to take up local entrepreneurship programs, with an initial sum of Rs. 100 crores. ✓ to create a conducive eco-system for the venture capital in the MSME sector a Rs. 10,000 crore fund was established to act as a catalyst to attract private Capital by way of providing equity, quasi equity, soft loans and other risk capital for start-up companies.	employment activities, particularly in technology-driven areas, with a grant of Rs. 1,000 crores through NITI Aayog.	Assistance Council (BIRAC) approved biotechnology incubators to incubatees being exempted, with effect from 01.04.2016. 100% deduction of profits for 3 out of 5 years for start-ups set up during April 2016 to March 2019.
201-18	**2018-19**	**2019-20**
✓ For the purpose of carry forward of losses in respect of start-ups, the condition of continuous holding of 51% of voting rights has been relaxed subject to the condition that the holding of the original promoter/promoters continues. Also the profit linked deduction available to the start-ups for 3 years out of 5 years is being changed to 3 years out of 7 years.	✓ In order to encourage start-ups, the definition of 'eligible businesses for a start-up is proposed to be aligned with the modified definition notified by DIPP. It is further proposed to extend the incorporation date for a start-up for availing benefit under section 80-IAC of the Act to 31st March, 2021 from 31st March, 2019 and rationalise the condition of turnover for availing the benefit.	Proposed to start a television programme within the DD bouquet of channels exclusively for start-ups. This is serving as a platform for promoting start-ups, discussing issues affecting their growth, matchmaking with venture capitalists and for funding and tax planning. This channel is designed and executed by start-ups themselves.

Initiative in Union Budget of Government of India
2020-21
✓ Directed to all infrastructure agencies of the government to involve youth-power in start-ups. They will help in rolling out value added services in quality public infrastructure for citizens. ✓ To provide early life funding, including a seed fund to support ideation and development of early stage Start-ups. ✓ To ease the burden of taxation on the employees by deferring the tax payment by five years or till they leave the company or when they sell their shares, whichever is earliest. ✓ An eligible Start-up having turnover up to 25 crores is allowed deduction of 100% of its the profits for three consecutive assessment years out of seven years if the total turnover does not exceed 25 crore rupees. ✓ To increase the turnover limit from existing ` 25 crore to ` 100 crores for larger start-ups. ✓ To extend the period of eligibility for claim of deduction from the existing 7 years to 10 years.

According to the Small Business Administration's website, their mission provides small businesses with four main services. These services are:

- **Plan your Business:** Turn your great idea into a great business plan
- **Launch your Business:** Turn your business plan into a reality (register, file, and start doing business)
- **Manage your Business:** Master day-to-day operations and prepare for success
- **Grow your Business:** Find new funding, locations, and customers when business is good and its time to expand.

Types of Incubators:

- Virtual business incubator: online business incubator
- Kitchen incubator: a business incubator focused on the food industry
- Public incubator: a business incubator focused on the public good
- Seed accelerator: a business incubator focused on early start-ups. Seed accelerators, also known as start-up accelerators, are fixed-term, cohort-based programs, that include

mentorship and educational components and culminate in a public pitch event or demo day.

- Corporate accelerator: a program of a larger company that acts akin to a seed accelerator
- Start-up studio: a business incubator with interacting portfolio companies
- Venture Builder: These are similar to a start-up studio, but builds companies internally.
- Venture-builders are also called tech studios, start-up factories, or venture production studios.
- Medical Incubator*:* a business incubator focused on medical devices and biomaterials.

Initiative in Indian Council of Agricultural Research (ICAR)

In the Indian National Agricultural Research System (NARS), ICAR had taken the stewardship of promulgation of IP and technology commercialization process in 2006 and as an effort to adapt to the new IP regimes, took initiative of bringing in a new policy direction through its rules and guidelines on intellectual property and technology management. At the same time, to emphasize more on innovation management and creation of agri-business environment, establishment of business incubators in NARS initiated with the National Agricultural Innovation Project (NAIP) under World Bank funding. In this project 10 Business Planning and Development (BPD) units were established (5 in ICAR institutes and 5 in State Agriculture Universities). Later, up-scaling the initial efforts, 12 more such BPD units were established in the phase 2 (2013-14).

These Units were provided the physical infrastructure necessary for technology incubation and to launch new business; including offices and lab space, and shared resources such as specialized equipment's and technical support services. Appropriate capacity building in terms of human resource was also undertaken by engaging/contracting professional help and providing required trainings to the existing inter-disciplinary professionals in the area of technology management and enterprise creation. The BPD units successfully nurtured and developed the skills of entrepreneurs and helped in commercialization of technologies. The salient progress of these BPDs are summarized as follows: In order to institutionalize the policy and operational guidelines, ICAR launched a scheme titled Intellectual property management and transfer/commercialization of Agricultural Technology Scheme in XI Plan.

This, consequently, led to establishment of an IP governance mechanism in a three tier mode across all the institutes of ICAR. The Institute Technology Management Units (ITMUs) have been established in all ICAR institutes to pursue matters related to IP management with

the purpose of accelerating transfer/commercialization of technologies in the institutes. The ten Zonal Technology Management Centres (ZTMCs) have been established to facilitate the ITMUs in their subject domain. The Intellectual Property and Technology Management (IP&TM) Unit at ICAR Hqrs does the overall facilitation; and has led by developing policy guidelines, undertaking training programs and helping the units on difficult issues beyond the capacity of ITMUs or ZTMCs.

The success achieved laid the basis for providing a continuum in the ICAR for technology commercialization, incubation and entrepreneurship development. The Scheme 'National Agriculture Incubation Fund' (NAIF) is operating at ICAR with the following major objectives

i. To establish/transform agri-business Incubator centres as leaders in NARS that would provide technology and skill up gradation, inputs supply and market support leading to promotion of viable enterprises and sustainable employment to entrepreneurs;
ii. To undertake last mile scale-up from pilot level of value chain in collaboration with stakeholders;
iii. To explore and support appropriate technologies including grassroots' innovations that are vital in future for an accelerated growth and competitive technological leadership;
iv. To impart training and capacity building to prospective entrepreneurs; generate value added manpower to compete effectively; and
v. To provide seed money support to potential incubates/entrepreneurs taking up promising innovations or technologies.

Incubation centres will also play a significant role in lending credibility to start-up enterprises and effecting the enabling environment for agribusiness entrepreneurs; which would operate profitably, leading to a catalytic effect in the growth of the overall agriculture sector. The implementation, governance and management of this component is vested with the IP&TM Unit (as the National Coordination Unit for Incubation Fund) at ICAR Headquarters. The Steering Committee for monitoring of this component has formed in XIIth plan at ICAR Hqrs level with Secretary (DARE) & DG, ICAR as the Chairman and IP&TM Unit as its Member Secretariat. One Clearing House and Facilitation Centre is established at ICAR's National Academy of Agricultural Research Management (NAARM), Hyderabad to facilitate the IP&TM Unit/ National Coordination Unit in implementation of the project. One Program Implementation Committee (PIC) had constituted in each of the nine ZTMCs and one general

PIC at NAARM will be constituted in the Chairmanship of the Directors of these respective institutes.

Salient Features of Agri Business Incubation (ABI) Centres

The Agri Business Incubation (ABI) Centres of ICAR had facilitated 1338 incubates/ entrepreneurs/start-ups for their agri-business related technical as well as infrastructural needs and graduated/ trained 616 entrepreneurs/ start-ups for starting their business in agriculture and allied sectors, 443 Entrepreneur Development Programme (EDPs) organized were organized. These efforts motivated 908 entrepreneurs/start-ups to initiate their own business.

Review/References

This article is compiled from Annual Reports of ICAR, Annual Budget speech (from 2014-15 to 2019-20) of Finance Ministers of Government of India; key word search in Parliament questions on Incubation and Start-ups from 2008 to 2019; and other relevant sources like NSTEDB, DST, DBT, CSIR etc.

Chapter 10

BANKABLE PROJECT FOR PIG FARMING

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Introduction:

In India, pig rearing is very popular among various tribal communities, backward as well as weaker section of the society. It also plays a pivotal role for improving socio-economic condition of poor, marginal and weaker section of rural people of India. Livestock, as whole is a complementary to the agriculture system in India. Therefore, it is fitted and sustainable to integrated farming system. There is no doubt that pig is the most important livestock of Eastern and northeastern India because of heavy demand of pork by tribal people. Even though there is huge demand and farmers are very much interested to rear pigs but real picture is reverse. This may be attributed to several reasons like ignorance of the farmer on scientific rearing of pigs for more profit, high cost of animal feed, good genetic material, inadequate backup from the state veterinary department and extension personals etc. Today, the goal of pig industry is to produce high quality lean meat at minimum cost and this will play an important role in improving the socio-economic status of the weaker section of the society.

Layout:

The lay out of the unit may differ from climate, land scape, size of farming etc. Building should neither be too close to the road and near to congested to avoid infection, transmission of disease and spreading of bad smell to the locality. Lay out should be designed keeping in view to minimize the cost of the economic construction and use of local material.

Building:

The building should be in good state. The essential factors to be considered in the construction of pig house are to be dry and weather proof, well ventilated, not stuffy, correctly drained, comfortable and orderly placed with the various sections.

Feed supply:

Feed constitutes roughly 70 – 80% towards the cost of production of the finish product, while the same may be 50 to 60% in other livestock enterprise. The uninterrupted supply of feed stuff is essential for the success of enterprise.

Supply of livestock:

The performance of livestock on pig is the key for the success of enterprise. Therefore, pigs of superior traits should be obtained from a recognized source, which also provides definite information about growth rate, survivability of piglets, and weight of piglets at the time of birth and feed conversion ration (FCR) of the herd. The heritability of the traits which immensely affect the final production, should also give due importance for better economic benefit.

Technical support:

To ensure the commercial viability of pig enterprise, it is essential that expert technical support is always available for monitoring the health and performance of the pigs. This can be provided by the State Govt. Central Govt. Institute, or by private practitioners who have attended requisite enterprise in their profession.

Estimate of cost of production:

The cost of production of any livestock units is a pivotal aspect on which the sale price depends. Therefore, any entrepreneurs must look into those factors and circumstances which affect the cost of production. These are –

a) Production of large litters
b) Economical use of feed, labour, building and equipment
c) Control of disease and parasite
d) The marketing of pigs at desired age, weight, at the best terms and places.
e) Efficient use of facilities can be measured in terms of pigs produced per year, average no. of litters farrowed per sow during the year and percentage of the days during the year all farrowing and nursing facilities are being used. It is usually, more profitable to raise two litters from each sow every year, If early weaning can be practiced. To calculate the cost of production, the price of following components should be kept in mind.

1) The cost of studs & structures.
2) Cost of equipment and other facilities.
3) Cost of breeding stock
4) Cost of feeding, breeding stock & piglets etc.
5) FCR value.
6) Mortality rate
7) Cost of Veterinary aid and insurance etc.

8) Cost of labour

9) Miscellaneous cost.

Parameters for Economic Pig Production (Ghungroo Breed):

A. Production Standard:

i)	Sexual maturity	- Male 8 to 9 months Female 9-10 months
ii)	Age at first furrowing	- 12 to 14 months
iii)	Litter size at birth	>10
iv)	Litter size at weaning	- 9
v)	Inter-furrowing interval	- 180 – 200 days
vi)	Weaning period	- 35-42 days
vii)	Service period	- 30 - 45 days
viii)	Pre-weaning Mortality	-10%<
ix)	Post-weaning mortality	- 5%<
x)	Replacement stock	- 10% per year
xi)	Ave. body weight at weaning	- 8 to 10 kg
xii)	Weight at 8 months (Market age)	- >80 kg
xiii)	Furrowing rate (no. of furrowing/sow/year	>1.8
xiv)	Fertility rate	>90%

B. Manpower Requirement:

ii) 2 boar + 10 sow - self employment

Financial involvement for starting a project of 10 sows unit.

1st Year investment:

A. Non-recurring (infrastructure/ building/ sty)

Sl. No	Type of sty	Area details	Approx. Cost
1	Boar pen – 2 pens	@ 80 sq. ft / pen X2 = 160 sq. ft @ Rs.200/ sq ft	32,000.00
2	Farrowing pen	2 pens @ 100 sq. ft./pen = 200 sq. ft @Rs. 200	40,000.00
3	Dry sow pen	4 pens @120 sq ft /pen = 480 sq. ft @Rs 200	96,000.00

4	Weaners sty	2 pens @ (15 x 8 sq ft. for 20 piglets each) = 240 sq. ft @Rs 200/	48,000.00
5	Growers pen	2 pens @ (20x 10 for 20 growers = 400 sq. ft. @ Rs 200/	80,000.00
6	Feed store	10ft. x 10 ft. = 100 sq. ft.@ Rs. 400/	40,000.00
	Others	Water connection, electricity connection, drainage system, waste pig preparation.	20,000.00
		Total	3,56,000.00

B. Cost of Animals:

1) 2mature male (9-10 months age) @ 5,000/ male =10,000.00
2) 10 mature females (8-10 months age)@5000/ female = 50,000.00

Total = 60,000.00

C. Working Capital (Recurring Cost):

a. Feed cost:

Sl. No	Category of animals	Details	Total cost
1	2 adult male animals	@2.5 kg per animal/day for 365 days @ Rs 25 per kg of finisher concentrate feed.	45,625.00
2.	10 adult female	@2.5 kg per animal/day for 365 days @ 25 per kg of finisher concentrate feed	2,28,125.00
3.	Weaners feed (starter feed)	With 90 % fertility, 9 gilts will produce 90 piglets @ 10 piglets/female. Keeping 5 % mortality, remaining 85 piglets will have to provide starter ration @ av. 200 g/ piglet for 1 month @Rs. 28/kg starter.	14,280.00
5.	Others	Cost of medicine, vaccines etc.	3000.00
6.	Farm utensils		1000.00
7.	Misc. cost	Water, electricity charges etc	5,000.00
		Total Running cost	2,97,030.00
Total Investment for 1st Year (A+B+C)			**7,13,030.00**

First Year Income:

1. Sale of 80 piglets @4000/ piglet = 3,20,000.00

2. Sale of pig dung (5 tonnes @500/tone) = 2,500.00

Total income = 3,22,500.00

First Year Profit and Loss:

Expenditure	= 7,13,030.00
Income	= 3,22,500.00
Net Loss	**= 3,90,530.00**

Second Year

A. Non-Recurring Cost:- Nil.

B. Recurring expenditure
   a. Feed cost:

Sl.	Animals	Details	Total cost
1	2 adult male animals	@2.5 kg per animal/day for 365 days @ Rs 25 per kg of finisher concentrate feed.	45,625.00
2.	10 adult female	@2.0 kg per animal/day for 365 days @ 25 per kg of finisher concentrate feed	2,28,125.00
3.	5 (F) and 1 (M) replacer stock	Av. @1.5kg per animal for 365 days @ Rs. 25 per kg.	68,440.00
4.	Weaners feed (starter feed)	With 90 % fertility of 10 sows with a furrowing rate 1.8 will produce gilts will produce 162 piglets @ 10 piglet / female with 1.8 furrowing per year. Keeping 5% mortality, remaining 154 piglets will have to provide starter ration @ av. 250 g/ piglet for 1 month @Rs. 28/kg starter.	32,340.00
5.	Fatter pigs	40 fattener animals @ 1.0 kg for 240 days (8 months)@Rs. 25 kg	2,40,000.00
6.	medicine, etc.		5,000.00
7.	Farm utensils		2,000.00
8.	Misc. cost	Water, electricity charges etc	5,000.00
Total Investment for 1st Year (A+B)			**6,26,530.00**

Second year Income:

1. Sale of 109 piglets @4000/	= 4,36,000.00
2. Sale of Adult animal 4 numbers females 150 kg/animal @120 kg live weight basis	= 72,000.00
3. Sale of 40 fatteners @150 per kg live weight average 80 kg each.	= 4,80,000.00
4. Sale of one adult boar 150 @70/kg	= 5000.00
5. Dung	= 5000.00
6. **Total Income**	**= 9,98,000.00**
7. Expenditure	Rs. **6,26,530.00**
8. Profit	**Rs 3,71,470.00**
9. **First year loss**	**Rs 3,90,530.00**
10. **Net loss**	**Rs 19,060.00**

So, second year onward, net profit will start.

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